Evaluation of Financial Systems in Developing Countries

A Policy Algorithm Using Theory and Data

Robert M. Townsend
Research and how to use it as a guide to informed public, policymakers, and private sector innovation

But not oversimplified
  • technical issues are an important part

And feedback loop to further research

Comments welcomed, both on the vision and the details
Scope and Scale

- In 2009, enumerators surveyed a total of 3,184 households across 200 villages and towns in the monthly survey and urban and rural annual surveys.
Annual

- Started in rural areas in 1997 with 192 villages
  - Chachoengsao
  - Buriram
  - Lopburi
  - Sisaket
- Resurvey in 64 villages every year since 1998
  - Allows us to assess impact of financial crisis
- Expanded to North and South in 2003 and 2004
  - Phrae & Phetchabun (North)
  - Satun & Yala (South)
Urban and Rural: Extended to Urban Areas in 2005
Thai Villages: Monthly Survey

- Started in 1998
  - 44 continuous months of data for 720 households

- Survey Design
  - 16 villages
  - 45 households per village
Households as Corporate Firms


Krislert Samphantharak, Robert M. Townsend
## Financial Statements

### Table A.2. Income Statement of Household A

<table>
<thead>
<tr>
<th>Month</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue from Cultivation</td>
<td>30,485</td>
<td>27,753</td>
</tr>
<tr>
<td>Revenue from Livestock</td>
<td>28,985</td>
<td>27,753</td>
</tr>
<tr>
<td>- Livestock Produce</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital Gains</td>
<td>1,500</td>
<td></td>
</tr>
<tr>
<td>Revenue from Fish and Shrimp</td>
<td>184,360</td>
<td>145,360</td>
</tr>
<tr>
<td>Revenue from Business</td>
<td>11,440</td>
<td>11,440</td>
</tr>
<tr>
<td>Revenue from Labor Provision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Revenues</td>
<td>6,000</td>
<td>3,000</td>
</tr>
<tr>
<td><strong>Total Revenues</strong></td>
<td><strong>232,285</strong></td>
<td><strong>187,553</strong></td>
</tr>
<tr>
<td>Cost of Cultivation</td>
<td>31,944</td>
<td>30,281</td>
</tr>
<tr>
<td>Cost of Livestock Capital Losses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Depreciation (Aging)</td>
<td>3,281</td>
<td>3,263</td>
</tr>
<tr>
<td>Other Expenses</td>
<td>28,663</td>
<td>27,018</td>
</tr>
<tr>
<td>Cost of Fish and Shrimp</td>
<td>220,176</td>
<td>167,323</td>
</tr>
<tr>
<td>Cost of Business</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of Labor Provision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of Other Production Activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Cost of Production</strong></td>
<td><strong>252,120</strong></td>
<td><strong>197,604</strong></td>
</tr>
</tbody>
</table>

### Table A.1. Balance Sheet of Household A

<table>
<thead>
<tr>
<th>Month</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash in Hand Account Receivables</td>
<td>1,966,139</td>
<td>1,862,121</td>
</tr>
<tr>
<td>Deposits at Financial Institutions</td>
<td>688,971</td>
<td>805,259</td>
</tr>
<tr>
<td>ROSCA (Net Position)</td>
<td>167,271</td>
<td>167,969</td>
</tr>
<tr>
<td>Other Lending</td>
<td>33,000</td>
<td>37,000</td>
</tr>
<tr>
<td>Inventories</td>
<td>1,346,939</td>
<td>1,440,729</td>
</tr>
<tr>
<td>Livestock</td>
<td>326,280</td>
<td>323,018</td>
</tr>
<tr>
<td>Fixed Assets</td>
<td>967,342</td>
<td>973,759</td>
</tr>
<tr>
<td>- Household Assets</td>
<td>598,758</td>
<td>596,261</td>
</tr>
<tr>
<td>- Agricultural Assets</td>
<td>66,104</td>
<td>65,829</td>
</tr>
<tr>
<td>- Business Assets</td>
<td>2,479</td>
<td>11,669</td>
</tr>
<tr>
<td>- Land and Other Fixed Assets</td>
<td>300,000</td>
<td>300,000</td>
</tr>
<tr>
<td><strong>Total Assets</strong></td>
<td><strong>5,649,079</strong></td>
<td><strong>5,762,991</strong></td>
</tr>
</tbody>
</table>

### Table A.3. Statement of Cash Flows of Household A

<table>
<thead>
<tr>
<th>Month</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Income (+)</td>
<td>-22,684</td>
<td>-12,889</td>
</tr>
<tr>
<td>Adjustments:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Depreciation (+)</td>
<td>6,075</td>
<td>6,046</td>
</tr>
<tr>
<td>- Change in Account Receivable (-)</td>
<td>-147,488</td>
<td>-116,288</td>
</tr>
<tr>
<td>- Change in Account Payable (+)</td>
<td>149,960</td>
<td>149,960</td>
</tr>
<tr>
<td>- Change in Inventory (-)</td>
<td>-126,465</td>
<td>-106,205</td>
</tr>
<tr>
<td>- Change in Other Current Assets (-)</td>
<td>1,781</td>
<td>3,263</td>
</tr>
<tr>
<td>- Consumption of Household-Produced Outputs (-)</td>
<td>-350</td>
<td>-314</td>
</tr>
<tr>
<td><strong>Cash Flow from Production</strong></td>
<td><strong>-139,171</strong></td>
<td><strong>-76,427</strong></td>
</tr>
</tbody>
</table>

[Source: Samphantharak & Townsend, 2006]
## Creation of NIPA Production Account (with Archawa Paweenawat)

### Statement of Income

<table>
<thead>
<tr>
<th>Uses</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production expenses</td>
<td>Production revenues</td>
</tr>
<tr>
<td>Interest expenses</td>
<td>Interest revenues</td>
</tr>
<tr>
<td>Depreciation</td>
<td>Capital gains</td>
</tr>
<tr>
<td>Insurance premium</td>
<td>Less: Capital losses</td>
</tr>
<tr>
<td>Property tax</td>
<td>Insurance indemnity</td>
</tr>
<tr>
<td>Net income before tax</td>
<td></td>
</tr>
<tr>
<td>Charge against revenue</td>
<td>Total revenue</td>
</tr>
</tbody>
</table>

### Production Account

<table>
<thead>
<tr>
<th>Uses</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest expenses</td>
<td>Production revenues</td>
</tr>
<tr>
<td>Less: Interest revenues</td>
<td>Less: Production expenses</td>
</tr>
<tr>
<td>Depreciation</td>
<td></td>
</tr>
<tr>
<td>Insurance premium</td>
<td></td>
</tr>
<tr>
<td>Property tax</td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td></td>
</tr>
<tr>
<td>Net income before tax</td>
<td></td>
</tr>
<tr>
<td>Less: Capital gains</td>
<td></td>
</tr>
<tr>
<td>Plus: Capital losses</td>
<td></td>
</tr>
<tr>
<td>Less: Insurance indemnity</td>
<td></td>
</tr>
<tr>
<td>Charge against output</td>
<td>Output</td>
</tr>
</tbody>
</table>
Villages’ Outputs

Chachoengsao

Buri Ram

Lop Buri

Si Sa Ket
# Saving-Investment Account

## Changes in Balance Sheet

<table>
<thead>
<tr>
<th>Uses</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in financial assets</td>
<td>Change in liabilities</td>
</tr>
<tr>
<td>Change in inventories</td>
<td>Change in net worth</td>
</tr>
<tr>
<td>Change in livestock assets</td>
<td>Contributed capital</td>
</tr>
<tr>
<td>Change in fixed assets</td>
<td>Current retained earnings</td>
</tr>
<tr>
<td>Change in total assets</td>
<td>Change in liabilities and net worth</td>
</tr>
</tbody>
</table>

## Saving-Investment Account

<table>
<thead>
<tr>
<th>Uses</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in financial assets</td>
<td>Change in net worth</td>
</tr>
<tr>
<td>Change in inventories</td>
<td>Contributed capital</td>
</tr>
<tr>
<td>Change in livestock assets</td>
<td>Current retained earnings</td>
</tr>
<tr>
<td>Change in fixed assets</td>
<td>Depreciation</td>
</tr>
<tr>
<td><strong>Plus:</strong> Depreciation</td>
<td></td>
</tr>
<tr>
<td><strong>Less:</strong> Change in liabilities</td>
<td></td>
</tr>
<tr>
<td>Gross investment</td>
<td>Gross saving</td>
</tr>
</tbody>
</table>
Allocation of Village’s Savings

Chachoengsao

Buri Ram

Lop Buri

Si Sa Ket

Financial | Current | Fixed | Gifts | Savings

1999 2000 2001 2002 2003 2004 2005

Millions

-4 -2 0 2 4 6 8 10

-4 -3 -2 -1 0 1 2 3

-4 -3 -2 -1 0 1 2 3

-4 -2 0 2 4 6 8 10

-4 -3 -2 -1 0 1 2 3

-4 -3 -2 -1 0 1 2 3
Village Balance of Payments

- **Trade balance** records the exports net of the imports of goods and services between village residents and nonresidents

  \[
  \text{Current account} = \text{Trade balance} + \text{net interest income} + \text{net transfer} - \text{tax payments}
  \]

- **Capital account** measures the change in ownerships of livestock and fixed assets between village residents and nonresidents

- **Financial account** measures the transaction of financial assets between village residents and nonresidents

- We have the balance of payments identity

  \[
  \text{Current Acc} + \text{Financial Acc} + \text{Capital Acc} = 0
  \]

- This can be summed up in the relationship:

  \[
  Y - C - I + T = (X-M)_{\text{Trade}} + (X-M)_{\text{Capital}} + \Delta \text{Inv}
  \]
Balance of Payments for Representative Villages

Chachoengsao

Buri Ram

Lop Buri

Si Sa Ket

Millions

1999 2000 2001 2002 2003 2004 2005

10

0

-10

Millions

1999 2000 2001 2002 2003 2004 2005

6

0

-6

Millions

1999 2000 2001 2002 2003 2004 2005

10

0

-10

Millions

1999 2000 2001 2002 2003 2004 2005

3

0

-3

Trade  Current  Capital  Financial
Flow of Funds: Equations and Relationship with NIPA

- Equations from NIPA:
  \[ \text{Gross Investment (GI)} = \text{Gross saving (GS)} \]
  \[ \text{Expenditures on Capital Formation (CF)} \]
  \[ \text{Net Financial Investment (NFI)} \]

- NFI = Net Acquisition of Financial Assets (NAFA) – Net Incurrence of Liabilities (NIL)

- So, GS = GI = CF + NFI = CF + NAFA – NIL or
  \[ \frac{\text{NAFA – NIL}}{(\text{Financial) Surplus}} = \frac{\text{GS – CF}}{(\text{Capital or “non-financial”) Surplus}} \]
Flow of Funds: FFA and the Townsend Thai Survey Data (with Narapong Srivisival)

Flow of Funds from Financial Corporation Sector

Flow of funds between a village in Chachoengsao and the other sectors in November 2009

What is missing from FFAs?

- Almost all of the FFAs present net financial flow between each sector and the rest of the economy. Thus, we usually do not know how much of the flow, say, into the household sector comes from financial intermediaries, non-financial businesses, or government sector.

(Data from joint collaboration with CFSP and the National Economic and Social Development Board of Thailand)
Thailand Database Archive: Two Examples Including Combination of Data Sets
(with Prad Kerdpairoj, Yukio Koriyama and Xiaowen Yang)
Models and Methods

- Use GE Theory for Developing Countries:
  - Understanding
    - positive economics
    - my starting point previously
  - Here we go normative
    - evaluating/analyzing impact of past or contemplated policy/interventions
    - this is what I am doing in this talk

- A research algorithm
  - Testing a benchmark from theory
  - Fits? If so stop, otherwise
  - Does not fit? Anomalies
    - policy induced
      - then fix, remedy
    - or due to obstacles
      - then estimate, distinguish barriers
    - base policy on mitigating obstacles
  - Merges into the bigger goal: Design of better contracts, markets and (regulatory and other) policy
# A Broader View of the Existence and the Welfare Theorems: Failure Implies Interventions as Necessary for Optima

## Works
- Infinite Horizon economies
  - Debreu (1954), "Valuation Equilibrium and Pareto Optimum"
  - Jones (1983), "Existence of Equilibria with Infinitely Many Consumers and Infinitely Many Commodities: A Theorem Based on Models of Commodity Differentiation"
- Private Information
  - Prescott and Townsend (1984), "General Competitive Analysis in an Economy with Private Information"
- Indivisibilities
  - Rogerson (1988), "Indivisible labor, lotteries and equilibrium"

## May Work
- Externalities and Lindahl Equilibria
- Private Information:
  - Prescott and Townsend (1984), "Pareto Optima and Competitive Equilibria with Adverse Selection and Moral Hazard"
  - Bisin and Gottardi (2006), "Efficient Competitive Equilibria with Adverse Selection"
- Collateral Constraints
  - Kilethiong and Townsend "Moral Hazard, Retrading, Externality, and Its Solution"
  - -, "Market Based, Segregated Exchanges in Securities with Default Risk"

## Does not work
- OLG, at least in general
- Incomplete markets
- Monetary economies
  - Manuelli and Sargent (2009), Alternative Monetary Policies in a turnpike economy
Micro Founded General Equilibrium Macro Models

- Ultimate goal is vision of entire economy as it is now and as it might be with improvements
- CGE
  - Harberger, 1962
  - Shoven–Whalley, 1973
- RBC–DSGE
  - Prescott et al, etc.
- Further link between micro and macro: If benchmark neoclassical standards fail, neoclassical separation fails
  - Basis for CGE DSGE models is questionable
    - so, constructing new generation of models here but very much following GE tradition
First Benchmark: Risk Sharing in Consumption/Investment
(Joint Work with Mauro Alem)

\[ \max_{c_{it}(h^t), i_t(h^t)} \sum_{i=1}^{N} \lambda_i \left\{ u(c_{i0}, \xi_{i0}) + \sum_{t=1}^{\infty} \beta^t \sum_{h^t} \text{prob}(h^t | h_0) u[c_{it}(h^t), \xi_{it}] \right\} \quad \text{subject to} \]

\[ \sum_{i=1}^{N} c_{it}(h^t) \leq C_t(h^t) \quad \text{for all } t \]

\[ C_t(h^t) = \sum_{i=1}^{N} f[k_{i,t}(h^{t-1}), \theta_t + \epsilon_{it}] - \sum_{i=1}^{N} I_{it}(h^t) - \sum_{i=1}^{N} g[I_{it}(h^t), k_{it}(h^{t-1}), \omega_{it}] \quad \text{for } t > 0 \]

\[ \lambda_i \beta^t \text{prob}(h^t | h_0) u'(c_{it}, \xi_{it}) = \mu(h^t) \]

\[ \begin{aligned} &\left\{ 1 + \frac{\partial g[I_{it}(h^t), k_{it}(h^{t-1}), \omega_{it}]}{\partial I_{it}} \right\} \mu(h^t) \\ &\quad = \sum_{h_{t+1}} \mu(h^t, h_{t+1}) \left[ \frac{\partial f[k_{i,t+1}(h^t), (\theta_{t+1} + \epsilon_{i,t+1})]}{\partial k_{i,t+1}} - \frac{\partial g[I_{i,t+1}(h^{t+1}), k_{i,t+1}(h^t), \omega_{i,t+1}]}{\partial k_{i,t+1}} \right] \end{aligned} \]
Empirical Implementation

\[ u^k(c^k, \xi_{it}) = -\frac{1}{\sigma} \exp \left\{ -\sigma \left( \frac{c^k}{A^k} + \xi_{it} \right) \right\} \]

\[ \sum_{k=1}^{N^'} \frac{c^k}{A^k} = \frac{1}{\sigma} \left( \log(\lambda^i) - \frac{1}{N} \sum_{j=1}^{N^'} \log(\lambda^j) \right) - \frac{1}{\sigma} \left[ \frac{\sum_{k=1}^{N^'} A^k \log(A^k)}{\sum_{k=1}^{N^'} A^k} - \frac{1}{N} \sum_{j=1}^{N^'} \frac{\sum_{k=1}^{N^'} A^k \log(A^k)}{\sum_{k=1}^{N^'} A^k} \right] + \frac{1}{N} \sum_{j=1}^{N^'} \frac{\sum_{k=1}^{N^'} c^k}{A^k} + \xi_{it} \]

\[ c_{it} = f_i + dem_i + d_t + \xi_{it} \]

\[ q_{it} = f_i(k_{it}, \theta_i + \epsilon_{it}) = (\theta_i + \epsilon_{it})k_{it} \]

\[ g_i(I_{it}, k_{it}, \omega_{it}) = \frac{1}{2} \left( \frac{I_{it}}{k_{it}} \right)^2 k_{it} + I_{it}(\omega_{it} + b_i) \]

\[ p(h') = \sum_{h_{i+1}} \left[ (\theta_{i,t+1} + \epsilon_{i,t+1}) + \frac{1}{2} \left( \frac{I_{i,t+1}}{k_{i,t+1}} \right)^2 \right] p(h_{i,t+1}) \]

\[ \frac{I_{it}}{k_{it}} = c_{st} + d_t + b_i + \omega_{it} \]
Tests of Efficient Risk Sharing: Monthly Coefficients on Idiosyncratic Risk – Most Villages Pass

Table 2: Tests of efficient risk sharing.

<table>
<thead>
<tr>
<th>village</th>
<th>coeff.</th>
<th>std. err.</th>
<th>p-value</th>
<th>obs.</th>
<th>HH</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chachoengsao</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.0090</td>
<td>0.0054</td>
<td>0.112</td>
<td>1764</td>
<td>21</td>
<td>0.103</td>
</tr>
<tr>
<td>4</td>
<td>-0.0028</td>
<td>0.0070</td>
<td>0.692</td>
<td>2016</td>
<td>24</td>
<td>0.176</td>
</tr>
<tr>
<td>7</td>
<td>0.0032</td>
<td>0.0085</td>
<td>0.718</td>
<td>924</td>
<td>11</td>
<td>0.211</td>
</tr>
<tr>
<td>8</td>
<td>-0.0011</td>
<td>0.0048</td>
<td>0.827</td>
<td>1260</td>
<td>15</td>
<td>0.239</td>
</tr>
<tr>
<td>Buriram</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-0.0081</td>
<td>0.0113</td>
<td>0.479</td>
<td>2352</td>
<td>27</td>
<td>0.130</td>
</tr>
<tr>
<td>10</td>
<td>0.0051</td>
<td>0.0047</td>
<td>0.304</td>
<td>1008</td>
<td>11</td>
<td>0.199</td>
</tr>
<tr>
<td>13</td>
<td>0.0098</td>
<td>0.0057</td>
<td>0.105</td>
<td>1596</td>
<td>18</td>
<td>0.250</td>
</tr>
<tr>
<td>14</td>
<td>0.0073</td>
<td>0.0060</td>
<td>0.237</td>
<td>1932</td>
<td>22</td>
<td>0.246</td>
</tr>
<tr>
<td>Lop Buri</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.0099</td>
<td>0.0068</td>
<td>0.160</td>
<td>1932</td>
<td>23</td>
<td>0.074</td>
</tr>
<tr>
<td>3</td>
<td>-0.0102</td>
<td>0.0132</td>
<td>0.452</td>
<td>1260</td>
<td>15</td>
<td>0.137</td>
</tr>
<tr>
<td>4</td>
<td>-0.0008</td>
<td>0.0062</td>
<td>0.898</td>
<td>2520</td>
<td>30</td>
<td>0.080</td>
</tr>
<tr>
<td>6</td>
<td>0.0004</td>
<td>0.0057</td>
<td>0.945</td>
<td>2100</td>
<td>25</td>
<td>0.146</td>
</tr>
<tr>
<td>Sisaket</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.0057</td>
<td>0.0041</td>
<td>0.177</td>
<td>2352</td>
<td>28</td>
<td>0.180</td>
</tr>
<tr>
<td>6</td>
<td>0.0004</td>
<td>0.0034</td>
<td>0.899</td>
<td>3276</td>
<td>39</td>
<td>0.185</td>
</tr>
<tr>
<td>9</td>
<td>0.0132*</td>
<td>0.0033</td>
<td>0.000</td>
<td>3024</td>
<td>36</td>
<td>0.217</td>
</tr>
<tr>
<td>10</td>
<td>0.0128</td>
<td>0.0058</td>
<td>0.041</td>
<td>1596</td>
<td>19</td>
<td>0.157</td>
</tr>
<tr>
<td>pooled</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>0.0034</td>
<td>0.0017</td>
<td>0.052</td>
<td>30576</td>
<td>364</td>
<td>0.167</td>
</tr>
</tbody>
</table>

[Source: Chiappori, Samphantharak, Schulhofer–Wohl and Townsend, 2011]
Poor without networks are more vulnerable to shocks

Remedy
- could be private or public
- in principle internal

Table 4: Effect of household income on household consumption for households not in any kinship network.

<table>
<thead>
<tr>
<th></th>
<th>annual</th>
<th>semiannual</th>
<th>quarterly</th>
<th>monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. All households, without controls for household size</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Δincome</td>
<td>0.035*</td>
<td>0.019</td>
<td>0.014</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td>(0.012)</td>
<td>(0.008)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>partial R²:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>aggregate shocks</td>
<td>0.093</td>
<td>0.113</td>
<td>0.096</td>
<td>0.092</td>
</tr>
<tr>
<td>income</td>
<td>0.024</td>
<td>0.005</td>
<td>0.003</td>
<td>0.000</td>
</tr>
<tr>
<td>Observations/households</td>
<td>954/159</td>
<td>2,054/158</td>
<td>4,104/152</td>
<td>11,122/134</td>
</tr>
</tbody>
</table>

B. All households, with controls for household size

<table>
<thead>
<tr>
<th></th>
<th>annual</th>
<th>semiannual</th>
<th>quarterly</th>
<th>monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δincome</td>
<td>0.033*</td>
<td>0.018</td>
<td>0.014</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td>(0.011)</td>
<td>(0.008)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>partial R²:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>agg. shocks, household size</td>
<td>0.111</td>
<td>0.115</td>
<td>0.098</td>
<td>0.094</td>
</tr>
<tr>
<td>income</td>
<td>0.020</td>
<td>0.004</td>
<td>0.003</td>
<td>0.000</td>
</tr>
<tr>
<td>Observations/households</td>
<td>954/159</td>
<td>2,054/158</td>
<td>4,104/152</td>
<td>11,122/134</td>
</tr>
</tbody>
</table>

C. Bottom income quartile, without controls for household size

<table>
<thead>
<tr>
<th></th>
<th>annual</th>
<th>semiannual</th>
<th>quarterly</th>
<th>monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δincome</td>
<td>0.188*</td>
<td>0.143*</td>
<td>-0.020</td>
<td>-0.072*</td>
</tr>
<tr>
<td></td>
<td>(0.034)</td>
<td>(0.046)</td>
<td>(0.012)</td>
<td>(0.017)</td>
</tr>
<tr>
<td>partial R²:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>aggregate shocks</td>
<td>0.105</td>
<td>0.267</td>
<td>0.257</td>
<td>0.337</td>
</tr>
<tr>
<td>income</td>
<td>0.204</td>
<td>0.052</td>
<td>0.000</td>
<td>0.001</td>
</tr>
<tr>
<td>Observations/households</td>
<td>210/35</td>
<td>455/35</td>
<td>891/33</td>
<td>2,407/29</td>
</tr>
</tbody>
</table>

D. Bottom income quartile, with controls for household size

<table>
<thead>
<tr>
<th></th>
<th>annual</th>
<th>semiannual</th>
<th>quarterly</th>
<th>monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δincome</td>
<td>0.177*</td>
<td>0.140*</td>
<td>-0.022</td>
<td>-0.072*</td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td>(0.049)</td>
<td>(0.014)</td>
<td>(0.017)</td>
</tr>
<tr>
<td>partial R²:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>agg. shocks, household size</td>
<td>0.240</td>
<td>0.275</td>
<td>0.290</td>
<td>0.337</td>
</tr>
<tr>
<td>income</td>
<td>0.169</td>
<td>0.050</td>
<td>0.000</td>
<td>0.001</td>
</tr>
<tr>
<td>Observations/households</td>
<td>210/35</td>
<td>455/35</td>
<td>891/33</td>
<td>2,407/29</td>
</tr>
</tbody>
</table>

[Source: Chiappori, Samphantharak, Schulhofer-Wohl and Townsend, 2011]
Investment: Cash Flow Sensitivity
Monthly (Joint Work with Krislert Samphanthararak)

- Note again low wealth

Table 6.5. Initial Wealth and Investment—Cash Flow Sensitivity

<table>
<thead>
<tr>
<th>Dependent Variable: investment in Fixed Assets (%)</th>
<th>Initial Wealth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower Third (1)</td>
</tr>
<tr>
<td>Cash flow $/Total fixed assets $ t$-$1$</td>
<td>0.244***</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
</tr>
<tr>
<td>(Cash flow $ t$, $t$-$1$, $t$-$2$)/Total fixed assets $ t$-$1$</td>
<td>0.152***</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
</tr>
<tr>
<td>(Cash flow $ t$, $t$-$1$, $t$-$2$)/Total fixed assets $ t$-$1$</td>
<td>0.200***</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
</tr>
<tr>
<td>Future profitability</td>
<td>28.66***</td>
</tr>
<tr>
<td></td>
<td>(8.29)</td>
</tr>
<tr>
<td>Total fixed assets $ t$-$1$</td>
<td>-0.167</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
</tr>
<tr>
<td>Calendar month dummies</td>
<td>Yes</td>
</tr>
<tr>
<td>Calendar year dummies</td>
<td>Yes</td>
</tr>
<tr>
<td>HH fixed effects</td>
<td>Yes</td>
</tr>
<tr>
<td>Constant</td>
<td>182.8</td>
</tr>
<tr>
<td></td>
<td>(119)</td>
</tr>
<tr>
<td>Observations</td>
<td>1385</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Remarks: The data cover the period during January 1999–December 2005. Cash flow is cash flow from production as described in the construction of the accounts in this monograph. Future Profitability is the average of the monthly rates of return on household’s total fixed assets over the next 12 months. Both cash flows and future profitability are normalized by household’s total fixed assets at the beginning of the month. All regressions are OLS. Standard errors are in parentheses. * is statistically significant at 10%; ** is statistically significant at 5%; and *** is statistically significant at 1%.
## Annual Data: Consumption and Investment

### Urban vs. Rural (with Hoai–Luu Nguyen)

- **Consumption mixed investment – rural much worse**

### Change in Consumption on Change in Income (Levels), Incremental Effect: Rural

<table>
<thead>
<tr>
<th>Overall</th>
<th>Central</th>
<th>Northeast</th>
<th>Central</th>
<th>Northeast</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall</strong></td>
<td>.057*** (.000)</td>
<td>.109*** (.000)</td>
<td>.004 (.832)</td>
<td><strong>Crisis</strong></td>
</tr>
<tr>
<td><strong>Recovery</strong></td>
<td>.013 (.675)</td>
<td>.082*** (.001)</td>
<td>.003 (.919)</td>
<td><strong>Recovery</strong></td>
</tr>
<tr>
<td><strong>Wealth</strong></td>
<td>(-1.3e-12***) (.000)</td>
<td>(-7.8e-07***) (.013)</td>
<td>(-6.3e-06***) (.000)</td>
<td>(-1.1e-06**) (.021)</td>
</tr>
<tr>
<td><strong>Crisis</strong></td>
<td>(-7.3e-07) (.135)</td>
<td>(-5.4e-06***) (.000)</td>
<td>(-8.8e-06***) (.000)</td>
<td><strong>Recovery</strong></td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>.109*** (.000)</td>
<td>.004 (.832)</td>
<td>.112*** (.000)</td>
<td>.082*** (.001)</td>
</tr>
</tbody>
</table>

### Change in Consumption on Change in Income: Urban

<table>
<thead>
<tr>
<th>Overall</th>
<th>Central</th>
<th>Northeast</th>
<th>North</th>
<th>South</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall</strong></td>
<td>.030*** (.000)</td>
<td>.043*** (.000)</td>
<td>.012* (.000)</td>
<td>.111*** (.000)</td>
</tr>
<tr>
<td><strong>Wealth</strong></td>
<td>(-3.2e-9**) (.000)</td>
<td>(-5.2e-9**) (.000)</td>
<td>2.1e-9 (.000)</td>
<td>(-4.7e-8) (.000)</td>
</tr>
<tr>
<td><strong>South</strong></td>
<td>2.2e-8 (.000)</td>
<td>2.2e-8 (.000)</td>
<td>(-4.7e-8) (.000)</td>
<td>2.2e-8 (.000)</td>
</tr>
</tbody>
</table>

### Investment Change on Income Change (Scaled), Incremental Effect: Rural

<table>
<thead>
<tr>
<th>Overall</th>
<th>Central</th>
<th>Northeast</th>
<th>Central</th>
<th>Northeast</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall</strong></td>
<td>2.28*** (.000)</td>
<td>.068*** (.000)</td>
<td>2.84*** (.000)</td>
<td>.103*** (.000)</td>
</tr>
<tr>
<td><strong>Wealth</strong></td>
<td>(-5.7e-05***) (.000)</td>
<td>(-4.1e-06***) (.000)</td>
<td>(-2.1e-05***) (.000)</td>
<td>(-3.5e-06***) (.001)</td>
</tr>
</tbody>
</table>

### Investment Change on Change in Income: Urban

<table>
<thead>
<tr>
<th>Overall</th>
<th>Central</th>
<th>Northeast</th>
<th>North</th>
<th>South</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall</strong></td>
<td>(-.026***) (.000)</td>
<td>(-.028***) (.000)</td>
<td>(-.007) (.000)</td>
<td>(-.023*) (.000)</td>
</tr>
<tr>
<td><strong>Wealth</strong></td>
<td>4.5e-15 (.000)</td>
<td>1.3e-14 (.000)</td>
<td>1.4e-15 (.000)</td>
<td>(-3.2e-14) (.000)</td>
</tr>
</tbody>
</table>

*Note:*** indicates significance levels.*
Interventions

- Rainfall Insurance
  - at the individual level

- Reasons for limited take up

- Basis risk
Heterogeneity and Basis Risk
(with Kamilya Tazhibayeva)

Rain shock is common for villages in same province.

It is common for a hhd with multiple plots in a given year to have higher (than hhd mean) yield on one plot and lower yield on another plot.

Remaining heterogeneity in yields after accounting for common rain shock and all fixed effects (soil, hhd, village, year).

<table>
<thead>
<tr>
<th>Year</th>
<th>Change</th>
<th>vill. 2702</th>
<th>vill. 2710</th>
<th>vill. 2713</th>
<th>vill. 2714</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>down</td>
<td>25</td>
<td>50</td>
<td>75</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>both</td>
<td>75</td>
<td>25</td>
<td>25</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>up</td>
<td>0</td>
<td>25</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>2000</td>
<td>down</td>
<td>33</td>
<td>33</td>
<td>38</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>both</td>
<td>67</td>
<td>22</td>
<td>38</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>up</td>
<td>0</td>
<td>44</td>
<td>25</td>
<td>58</td>
</tr>
<tr>
<td>2001</td>
<td>down</td>
<td>67</td>
<td>44</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>both</td>
<td>33</td>
<td>39</td>
<td>38</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>up</td>
<td>0</td>
<td>17</td>
<td>38</td>
<td>39</td>
</tr>
<tr>
<td>2002</td>
<td>down</td>
<td>14</td>
<td>37</td>
<td>42</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>both</td>
<td>57</td>
<td>47</td>
<td>33</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>up</td>
<td>29</td>
<td>16</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>2003</td>
<td>down</td>
<td>40</td>
<td>41</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>both</td>
<td>60</td>
<td>47</td>
<td>47</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>up</td>
<td>0</td>
<td>12</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>2004</td>
<td>down</td>
<td>0</td>
<td>31</td>
<td>24</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>both</td>
<td>50</td>
<td>23</td>
<td>41</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>up</td>
<td>50</td>
<td>46</td>
<td>35</td>
<td>33</td>
</tr>
<tr>
<td>2005</td>
<td>down</td>
<td>0</td>
<td>25</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>both</td>
<td>50</td>
<td>31</td>
<td>47</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>up</td>
<td>50</td>
<td>44</td>
<td>47</td>
<td>38</td>
</tr>
<tr>
<td>2006</td>
<td>down</td>
<td>50</td>
<td>45</td>
<td>40</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>both</td>
<td>50</td>
<td>36</td>
<td>45</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>up</td>
<td>0</td>
<td>18</td>
<td>15</td>
<td>19</td>
</tr>
</tbody>
</table>
To test the full risk-sharing assumption, we can estimate the following specification

\[ C_{it} = \alpha_i + \beta \overline{C}_{vt} + \delta_w Y_{it} + \varepsilon_{it} \]

with full risk-sharing, the \( \beta \) would be equal to 1 and the \( \delta \) would be equal to zero.

However, Deaton (1990) shows that the OLS estimation of the \( \beta \) will be biased toward 1, even though there is no true relationship between \( \overline{C}_{vt} \) and \( C_{it} \)

\[ \overline{C}_{vt} = \alpha^B + \delta^B \overline{Y}_{vt} + \hat{\varepsilon}_{vt} \quad \hat{\beta} = 1 - \frac{\hat{\delta}^W}{\hat{\delta}^B} \]

We can reject the null hypothesis of full risk-sharing (i.e. \( \beta = 1 \))

The estimated values of \( \beta \) lie between 0.64–0.84

And, extending to counties in country, the estimated values of \( \beta \) are lower at village level than at household level, suggesting that the risk-sharing is worse at village level.
If the international capital market is perfect, capital should flow to the countries with the highest returns on investment, and there should be no correlation between a country’s saving rate and its investment rate.

On the other hand, Feldstein and Horioka (1980) find that the national saving rate and the national investment rate are highly correlated within the OECD countries.

To test whether the similar pattern exists in our village economies, we estimate the following equation:

\[ I_{vt} = \alpha + \beta S_{vt} + \delta_v \]

We get the estimated value for \( \beta \) at 0.05 and insignificant.

On the other hand, if we change from the saving level to the saving plus gifts, the estimated values of \( \beta \) for the level specification is 0.277, which is significant at 5% level.
## Table 1
### Number of Sampled Households and Amphoes

<table>
<thead>
<tr>
<th></th>
<th>Kingdom</th>
<th>North</th>
<th>Northeast</th>
<th>Central</th>
<th>South</th>
<th>Bangkok</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of households in matched amphoes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>8501</td>
<td>1784</td>
<td>2469</td>
<td>1637</td>
<td>923</td>
<td>1688</td>
</tr>
<tr>
<td>1986</td>
<td>2266</td>
<td>690</td>
<td>357</td>
<td>319</td>
<td>563</td>
<td>337</td>
</tr>
<tr>
<td>1986–88: 1986</td>
<td>7120</td>
<td>1633</td>
<td>1558</td>
<td>1691</td>
<td>1205</td>
<td>1033</td>
</tr>
<tr>
<td>1988</td>
<td>1905</td>
<td>431</td>
<td>347</td>
<td>321</td>
<td>403</td>
<td>403</td>
</tr>
<tr>
<td>1988–90: 1988</td>
<td>7351</td>
<td>1664</td>
<td>1688</td>
<td>1551</td>
<td>1192</td>
<td>1256</td>
</tr>
<tr>
<td>1990</td>
<td>8090</td>
<td>1690</td>
<td>1857</td>
<td>1688</td>
<td>1381</td>
<td>1474</td>
</tr>
<tr>
<td><strong>Number of matched amphoes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1975–81</td>
<td>227</td>
<td>60</td>
<td>56</td>
<td>59</td>
<td>41</td>
<td>11</td>
</tr>
<tr>
<td>1981–86</td>
<td>42</td>
<td>12</td>
<td>7</td>
<td>6</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>1986–88</td>
<td>128</td>
<td>28</td>
<td>27</td>
<td>28</td>
<td>31</td>
<td>14</td>
</tr>
<tr>
<td>1988–90</td>
<td>691</td>
<td>158</td>
<td>193</td>
<td>172</td>
<td>127</td>
<td>41</td>
</tr>
</tbody>
</table>

*Note: All households must have resided in current amphoe for 10 or more years.*
# Tests

## Table 1

<table>
<thead>
<tr>
<th>Region, Year and Community Type</th>
<th>Income and Consumption Growth Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F test for All Occupation Groups</strong></td>
<td><strong>Different Measures of Income and Consumption</strong></td>
</tr>
<tr>
<td>Y</td>
<td>C</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>1</td>
<td>N</td>
</tr>
<tr>
<td>2</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>N</td>
</tr>
<tr>
<td>4</td>
<td>N</td>
</tr>
<tr>
<td>5</td>
<td>N</td>
</tr>
<tr>
<td>6</td>
<td>NE</td>
</tr>
<tr>
<td>7</td>
<td>NE</td>
</tr>
<tr>
<td>8</td>
<td>NE</td>
</tr>
<tr>
<td>9</td>
<td>NE</td>
</tr>
<tr>
<td>10</td>
<td>NE</td>
</tr>
<tr>
<td>11</td>
<td>C</td>
</tr>
<tr>
<td>12</td>
<td>C</td>
</tr>
<tr>
<td>13</td>
<td>C</td>
</tr>
<tr>
<td>14</td>
<td>C</td>
</tr>
<tr>
<td>15</td>
<td>C</td>
</tr>
<tr>
<td>16</td>
<td>S</td>
</tr>
<tr>
<td>17</td>
<td>S</td>
</tr>
<tr>
<td>18</td>
<td>S</td>
</tr>
<tr>
<td>19</td>
<td>S</td>
</tr>
<tr>
<td>20</td>
<td>S</td>
</tr>
</tbody>
</table>

Notes: This table presents the results of F-tests for the joint significance of dummy variables from regressions given by equations in the text. The dependent variables are increased income (Y) and consumption (C) growth rates. Where the division is by occupation, consumption is equal to expenditures on food, clothing, shoes, and tobacco, and income is equal to wages, profits from farming, entrepreneurial income, and income of kind. A * indicates that the test is significant at the 10% level. ** indicates significance at the 5% level. Y = North, NE = Northeast, C = Central, S = South, B = Bangkok.
Vulnerability to Risk by Occupation and Region

- By occupation of the head
- Entrepreneurs display income elasticities that are higher than for all households generally
- Income elasticity in the greater Bangkok
- The coefficients and significance of regional average consumption variables or fixed effects counterparts tend to go down for entrepreneurs
- Little pooling of risk among entrepreneurs
- Farmers in the north and northeast actually pass some tests for full insurance
Regional Shocks: Two Contrasting Pictures

- Some important shocks
  - rubber prices
  - geographic concentration – featuring combination of CDD and SES data

![Map of rubber trees in Thailand](image)

![Graph of real rubber price](image)

Figure 3-1: Real rubber price (1996 Thai baht / kg * \( \frac{1}{100} \). Source IFS)

Paxson uses rainfall

With James Vickery

Here we use rubber price shocks as an exogenous source of variation in income, consumption and savings, so transitory income is decomposed as

$$y_{it}^{T} = \alpha_2 E_{it} R_t + \varepsilon_{it}.$$  

$R_t$ is the price of rubber at time $t$, and $E_{it}$ indexes the household’s sensitivity to rubber price shocks, while $\varepsilon_{it}$ captures other sources of transitory fluctuations in income.

Substituting these in, household income is given by:

$$y_{it} = \alpha_0 + X_{it} \alpha_1 + \alpha_2 E_{it} R_t + \varepsilon_{it}$$

$$c_{it} = \delta_0 + X_{it} \delta_1 + \delta_2 E_{it} R_t + u_{it}$$
Interventions

- Policy remedies
  - price insurance

- Commodity options
  - Case–Shiller indexed products

- Create
  - new instruments
  - new institutions
  - new financial markets
  - (with caveats, another talk)

- But look at role of existing financial institutions first
  - by name/type
Table 1
Policy Functions for the Different Financial Regimes

<table>
<thead>
<tr>
<th>Policy</th>
<th>Consumption</th>
<th>Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{i0} = 1$ (participation)</td>
<td>for all $t &gt; 0$</td>
<td>$c_{it} = c_i(\lambda_t, \xi_{it}, \bar{c}_t)$</td>
</tr>
<tr>
<td>$P_{i0} = 0$ (autarky)</td>
<td>for all $t &gt; 0$</td>
<td>$c_{it} = c_i(k_{it}, \xi_{it}, \theta_t + \epsilon_{it}, \omega_{it})$</td>
</tr>
</tbody>
</table>

$c_{it} = P_{i0}[f_i + dem_i + d_i + \xi_{it}] + (1 - P_{i0}) \left[ \eta_0 k_{it} + \eta_1 \left( \frac{q_{it}}{k_{it}} \right) + \chi_{it} \right] \quad I_{it} = P_{i0}[\text{const}_i + d_i + b_i + \omega_{it}] + (1 - P_{i0}) \left[ \phi_0 + \phi_1 \left( \frac{q_{it}}{k_{it}} \right) + v_{it} \right]$

Table 2
Correlation of Instruments (listed in columns 2, 4, 6) with Frequency of Use

<table>
<thead>
<tr>
<th>Instrument</th>
<th>HEAD</th>
<th>P-value</th>
<th>TIME</th>
<th>P-value</th>
<th>GIS</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAAC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Borrowing</td>
<td>.0869</td>
<td>(.0050)</td>
<td>.0675</td>
<td>(.0307)</td>
<td>.2115</td>
<td>(.0000)</td>
</tr>
<tr>
<td>- Savings</td>
<td>.0667</td>
<td>(.0313)</td>
<td>.0602</td>
<td>(.0540)</td>
<td>.2140</td>
<td>(.0000)</td>
</tr>
<tr>
<td>Commercial Banks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Borrowing</td>
<td>-.0209</td>
<td>(.4995)</td>
<td>-.0795</td>
<td>(.0108)</td>
<td>.0977</td>
<td>(.0016)</td>
</tr>
<tr>
<td>- Savings</td>
<td>.0558</td>
<td>(.0714)</td>
<td>-.0988</td>
<td>(.0015)</td>
<td>.0889</td>
<td>(.0041)</td>
</tr>
<tr>
<td>Agric. Cooperatives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Borrowing</td>
<td>.1062</td>
<td>(.0006)</td>
<td>.0045</td>
<td>(.8847)</td>
<td>.1818</td>
<td>(.0000)</td>
</tr>
<tr>
<td>- Savings</td>
<td>.1527</td>
<td>(.0000)</td>
<td>-.0013</td>
<td>(.9678)</td>
<td>.1897</td>
<td>(.0000)</td>
</tr>
<tr>
<td>PCG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Borrowing</td>
<td>.2186</td>
<td>(.0000)</td>
<td>-.0961</td>
<td>(.0020)</td>
<td>.1312</td>
<td>(.0000)</td>
</tr>
<tr>
<td>- Savings</td>
<td>.1943</td>
<td>(.0000)</td>
<td>-.0930</td>
<td>(.0028)</td>
<td>.1668</td>
<td>(.0000)</td>
</tr>
<tr>
<td>Informal sector</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Borrowing</td>
<td>NA</td>
<td>-</td>
<td>.0174</td>
<td>(.5770)</td>
<td>.0098</td>
<td>(.7522)</td>
</tr>
<tr>
<td>- Savings (Rice)</td>
<td>NA</td>
<td>-</td>
<td>.1228</td>
<td>(.0001)</td>
<td>.0696</td>
<td>(.0244)</td>
</tr>
</tbody>
</table>

Notes: GIS is the Geographical Information System instrument, TIME measures the travel time from the village to the district center and HEAD is the response of the Headman to questions about institutional presence. Frequent use is a dummy variable indicating whether the household had a transaction with named institution in 3 out of the 4 years in the panel. Note that informal sector borrowing is not highly correlated with the two available instruments.
### Table 4: Impact of Financial Institutions on Consumption Smoothing (Eq. 24)

<table>
<thead>
<tr>
<th></th>
<th>F-test P₀ dt = 0</th>
<th>η₁</th>
<th>P₀ η₁</th>
<th>F-test η₁ + P₀ η₁ = 0</th>
<th>P-value</th>
<th>P-value</th>
<th>P-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BAAC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS</td>
<td>1.66</td>
<td>.249***</td>
<td>-.062</td>
<td>13.04</td>
<td>(.157)</td>
<td>(.000)</td>
<td>(.439)</td>
<td>(.000)</td>
</tr>
<tr>
<td>IV</td>
<td>17.21</td>
<td>.571***</td>
<td>-.618***</td>
<td>.31</td>
<td>(.002)</td>
<td>(.000)</td>
<td>(.000)</td>
<td>(.578)</td>
</tr>
<tr>
<td><strong>Commercial Banks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS</td>
<td>8.01</td>
<td>.246***</td>
<td>-.094</td>
<td>7.97</td>
<td>(.000)</td>
<td>(.000)</td>
<td>(.234)</td>
<td>(.0048)</td>
</tr>
<tr>
<td>IV</td>
<td>29.58</td>
<td>.299***</td>
<td>-.223*</td>
<td>1.08</td>
<td>(.000)</td>
<td>(.000)</td>
<td>(.072)</td>
<td>(.300)</td>
</tr>
<tr>
<td><strong>Agric. Cooperatives</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS</td>
<td>7.17</td>
<td>.204***</td>
<td>-.006</td>
<td>1.95</td>
<td>(.000)</td>
<td>(.000)</td>
<td>(.966)</td>
<td>(.163)</td>
</tr>
<tr>
<td>IV</td>
<td>34.25</td>
<td>.303***</td>
<td>-1.427</td>
<td>.77</td>
<td>(.000)</td>
<td>(.010)</td>
<td>(.304)</td>
<td>(.379)</td>
</tr>
<tr>
<td><strong>PCG – Village Funds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS</td>
<td>1.19</td>
<td>.221***</td>
<td>-.116</td>
<td>.33</td>
<td>(.313)</td>
<td>(.000)</td>
<td>(.539)</td>
<td>(.567)</td>
</tr>
<tr>
<td>IV</td>
<td>23.82</td>
<td>.196***</td>
<td>.427</td>
<td>1.31</td>
<td>(.000)</td>
<td>(.000)</td>
<td>(.455)</td>
<td>(.253)</td>
</tr>
<tr>
<td><strong>Informal Sector</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS</td>
<td>4.45</td>
<td>.117***</td>
<td>.223***</td>
<td>50.35</td>
<td>(.001)</td>
<td>(.001)</td>
<td>(.000)</td>
<td>(.000)</td>
</tr>
<tr>
<td>IV</td>
<td>32.70</td>
<td>.156***</td>
<td>.114</td>
<td>13.44</td>
<td>(.000)</td>
<td>(.001)</td>
<td>(.279)</td>
<td>(.000)</td>
</tr>
</tbody>
</table>

### Table 5: Impact of Financial Institutions on Investment Sensitivity to Shocks (Eq. 25)

<table>
<thead>
<tr>
<th></th>
<th>F-test P₀ dt = 0</th>
<th>φ₁</th>
<th>P₀ φ₁</th>
<th>F-test φ₁ + P₀ φ₁ = 0</th>
<th>P-value</th>
<th>P-value</th>
<th>P-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BAAC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS</td>
<td>1.76</td>
<td>.031***</td>
<td>-.192***</td>
<td>77.19</td>
<td>(.5151)</td>
<td>(.000)</td>
<td>(.000)</td>
<td>(.000)</td>
</tr>
<tr>
<td>IV</td>
<td>3.54</td>
<td>.162***</td>
<td>-1.372***</td>
<td>270.36</td>
<td>(.3150)</td>
<td>(.000)</td>
<td>(.000)</td>
<td>(.000)</td>
</tr>
<tr>
<td><strong>Commercial Banks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS</td>
<td>.06</td>
<td>.010***</td>
<td>-.058*</td>
<td>2.26</td>
<td>(.983)</td>
<td>(.002)</td>
<td>(.066)</td>
<td>(.133)</td>
</tr>
<tr>
<td>IV</td>
<td>6.54</td>
<td>-.003</td>
<td>.026</td>
<td>.07</td>
<td>(.088)</td>
<td>(.807)</td>
<td>(.739)</td>
<td>(.787)</td>
</tr>
<tr>
<td><strong>Agric. Cooperatives</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS</td>
<td>.00</td>
<td>.010***</td>
<td>.381***</td>
<td>9.32</td>
<td>(.999)</td>
<td>(.002)</td>
<td>(.003)</td>
<td>(.002)</td>
</tr>
<tr>
<td>IV</td>
<td>2.98</td>
<td>-.011</td>
<td>.436</td>
<td>.04</td>
<td>(.395)</td>
<td>(.403)</td>
<td>(.844)</td>
<td>(.848)</td>
</tr>
<tr>
<td><strong>PCG – Village Funds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS</td>
<td>.03</td>
<td>.010***</td>
<td>.019</td>
<td>.01</td>
<td>(.994)</td>
<td>(.002)</td>
<td>(.956)</td>
<td>(.932)</td>
</tr>
<tr>
<td>IV</td>
<td>2.56</td>
<td>-.012</td>
<td>.966</td>
<td>.06</td>
<td>(.464)</td>
<td>(.473)</td>
<td>(.805)</td>
<td>(.807)</td>
</tr>
<tr>
<td><strong>Informal Sector</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLS</td>
<td>1.20</td>
<td>.030***</td>
<td>-.162***</td>
<td>58.12</td>
<td>(.308)</td>
<td>(.000)</td>
<td>(.000)</td>
<td>(.000)</td>
</tr>
<tr>
<td>IV</td>
<td>.02</td>
<td>.332***</td>
<td>-2.696***</td>
<td>90.01</td>
<td>(.991)</td>
<td>(.000)</td>
<td>(.000)</td>
<td>(.000)</td>
</tr>
</tbody>
</table>
Overall is fine but impact by occupation is tricky despite exogenous variation.

Townsend and Urzua (2009)

Effects are non-monotone: When intermediated sector becomes easier to use, some non-talented entrepreneurs may decide to become wage earners and lend their wealth instead. On the other hand, some talented people who were wage-earners and had insufficient wealth before, now decide to become entrepreneurs.

Hence, we are capturing simultaneously the pure effect of financial intermediation AND the effect of occupational choice.

What if we only look at the effect on those who were entrepreneurs and stayed entrepreneurs? But this is not a random group: Those who chose to stay entrepreneurs are those with the lowest setup costs or highest talent (according to the model). Of course, if we were able to observe TALENT, we could just use IV, controlling for talent.
# Model Simulation Where We Know The Truth: Generated Local Average Treatment Effects

## Model of Occupational Choice and Financial Intermediation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Number of movers</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta^{LATE(Q)}(0.25, 1)$</td>
<td>0.388</td>
<td>3,757</td>
<td>From autarky to financial intermediation</td>
</tr>
<tr>
<td></td>
<td>0.355</td>
<td>911</td>
<td>From wage worker under autarky to wage worker under financial intermediation</td>
</tr>
<tr>
<td></td>
<td>−0.203</td>
<td>176</td>
<td>From wage worker under autarky to entrepreneur under financial intermediation</td>
</tr>
<tr>
<td></td>
<td>0.752</td>
<td>75</td>
<td>From entrepreneur under autarky to wage worker under financial intermediation</td>
</tr>
<tr>
<td></td>
<td>0.430</td>
<td>2,595</td>
<td>From entrepreneur under autarky to entrepreneur under financial intermediation</td>
</tr>
</tbody>
</table>
Caution #2: Endogenous Industrial Organization (with Juliano Assunção and Sergey Mityakov)

Figure 2: Evolution of BAAC and commercial banks

Figure 4: Commercial bank (red) x BAAC (green) ($\beta = 0.9, \lambda = 1, \tau = 2$)
Current and Evolving Market Boundaries: Financial Institutions Anticipate Future Markets

- Welfare loss due to Nash Equilibrium in strategic game
- Note welfare loss is now linked to (inefficient) market structure
  - not simply micro behavior
Caution #3: Financial Access Criteria Too Narrow
Formal and/or Informal Financial Networks (with Cynthia Kinnan)

In turn, 3019 borrows from Commercial Bank. As such, 2012 has indirect access.
Each node denoted by a number represents a household in the village. A line between two nodes represents a kinship relationship between the two households. The location of the nodes in the network maps does not correspond to the geographic location of the households.
Empirical Specifications: Consumption and Investment

- Modify standard omnibus insurance specification to allow the effect of income fluctuations to depend on
  - presence of kin
  - net worth
  - direct and indirect connections to financial institutions

\[ c_{ivt} = \alpha_1 y_{ivt} + \alpha_2 y_{ivt} \times l_{i,F} + \beta_1 y_{ivt} \times k_i + \beta_2 y_{ivt} \times \bar{w}_i \]
\[ + \theta_i + \delta_{l_{i,F},t} + \epsilon_{it} \]

- Link \( l \) is direct or any, \( l \in \{d, r\} \)
- \( \delta_{l_{i,F},t} \equiv \) common time effect for all households connected to the financial system

\[ \left( \frac{l}{A} \right)_{ivt} = \alpha_1 \left( \frac{y}{A} \right)_{ivt} + \alpha_{21} \left( \frac{y}{A} \right)_{ivt} \times l_{i,F} + \beta_{11} \left( \frac{y}{A} \right)_{ivt} \times k_i \]
\[ + \gamma_1 l_{i,F} + \gamma_2 k_i + \delta_{vt} + \epsilon_{it} \]
**Consumption and Investment Are Different**

- Consumption smoothed by networks
- Investment by kin
- First hint of models with obstacles

### Kinship, financial access and consumption smoothing

<table>
<thead>
<tr>
<th>Direct or indirect link</th>
<th>Income change</th>
<th>Income changeX...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.1645***</td>
<td>.1645***</td>
</tr>
<tr>
<td></td>
<td>[.0122]</td>
<td>[.0122]</td>
</tr>
<tr>
<td><strong>Income changeX...</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net worth</td>
<td>-2.1e-04***</td>
<td>-2.1e-04***</td>
</tr>
<tr>
<td>(mill. baht)</td>
<td>[7.4e-05]</td>
<td>[7.4e-05]</td>
</tr>
<tr>
<td>Kin in</td>
<td>.0102***</td>
<td>.0102***</td>
</tr>
<tr>
<td>village</td>
<td>[.0028]</td>
<td>[.0028]</td>
</tr>
<tr>
<td>Indirect link</td>
<td>0.0015</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[.0025]</td>
<td></td>
</tr>
<tr>
<td>Any link</td>
<td>-.1647***</td>
<td>-.1658***</td>
</tr>
<tr>
<td></td>
<td>[.0122]</td>
<td>[.0124]</td>
</tr>
<tr>
<td>N</td>
<td>4.30E+04</td>
<td>4.30E+04</td>
</tr>
</tbody>
</table>

### Kinship, financial access and investment

<table>
<thead>
<tr>
<th>Income</th>
<th>IncomeX...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Any link</td>
</tr>
<tr>
<td></td>
<td>to bank</td>
</tr>
<tr>
<td></td>
<td>Kin in</td>
</tr>
<tr>
<td></td>
<td>village</td>
</tr>
<tr>
<td></td>
<td>Net worth</td>
</tr>
<tr>
<td></td>
<td>(mill. baht)</td>
</tr>
<tr>
<td></td>
<td>Main effects</td>
</tr>
<tr>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>N</td>
<td>6055</td>
</tr>
<tr>
<td></td>
<td>5794</td>
</tr>
</tbody>
</table>

- Income: .1078* (.0649)  .6526*** (.195)
- IncomeX...:
  - Any link: -.1268 (.1288)
  - to bank: -.4136*** (.1549)
  - Kin in village: -0.1087 (.0762)

- Main effects: Y, Y
- N: 6055, 5794
Mechanisms: Bridge Loans

Correlation Between Amount Repaid and Amount Borrowed

<table>
<thead>
<tr>
<th>Lender 1 (Long Term)</th>
<th>Lender 2 (Short Term)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loan A (Old)</td>
<td>Loan B</td>
</tr>
<tr>
<td>Loan C (New)</td>
<td></td>
</tr>
</tbody>
</table>

(Flow of Repayment) % of Total (51.7 M Baht)

<table>
<thead>
<tr>
<th>‘Repay’ Loan</th>
<th>Short Term</th>
<th>Long Term</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Target’ Loan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short Term</td>
<td>0.2</td>
<td>30.7</td>
<td>30.9</td>
</tr>
<tr>
<td>Long Term</td>
<td>27.6</td>
<td>41.4</td>
<td>69.1</td>
</tr>
<tr>
<td>Total</td>
<td>27.8</td>
<td>72.2</td>
<td>100</td>
</tr>
</tbody>
</table>
Regression Results: Consumption and Investment Are Different

- **Consumption Risk Sharing**
  - Borrowing worsens risk sharing, but not on the subset that uses bridge loan

- **Risk Aversion:** from Schulhofer-Wohl (2011), and see below also
  - Borrowing associated with low risk aversion, but not on the subset that rollover loan

- **Investment Risk Sharing**
  - Borrowing improves risk sharing; bridge loan per se has no additional effect

- **Risk Adjusted ROA:** Productivity, and see below also
  - Rollover loan reduces ROA (not robust when used unadjusted ROA)
  - Story, households rolling over have weaker productivity - should not borrow in the first place with hindsight?
Let \( \nu_{it} \) be the residuals from linearly projecting the time series of log consumption for household \( i \) on a household–specific intercept, time trend, and month dummies. Log consumption is the left–hand side of (4). Thus, since (4) holds and projection is a linear operator, the log consumption residuals \( \nu_{it} \) must equal the total of the residuals we would obtain from separately projecting each term on the right–hand side of (4).

Let \( \ell_{jt} \) be the residual we would obtain if we hypothetically projected \((-ln\lambda_{jt})\) on an intercept, a time trend, and month dummies.
Volatility of Aggregate Consumption, By Village
Caution #4: Welfare Gains (or Losses!) from Hypothetical Elimination of Aggregate (Village) Risk

- Heterogeneity, varying risk aversion: huge policy qualification
  - There are losers

![Graph showing willingness to pay vs. risk tolerance for different villages.](chart)

[Source: Chiappori et al, 2010]
Specifically, efficiency requires that household $h$ behaves as if it were solving the program:

$$\max_{L,C} \sum_{i=1}^{I_h} \mu_{i,h} \sum_{s} \pi_s \left[ U_{i,h} \left( L_{s,i,h}, C_{s,i,h} \right) \right]$$

Under household $h$ overall budget constraint in each state $s$,

$$\sum_{i=1}^{I_h} C_{s,i,h} + \sum_{i=1}^{I_h} \omega_{s,i,h} L_{s,i,h} = \sum_{i=1}^{I_h} \omega_{s,i,h} T_i + y_{s,1,h} + \ldots + y_{s,I_h,h} + \tau_{s,h}, s = 1, \ldots, S$$
Risk Sharing With Labor Participation: Check #1

- We find a modified benchmark with Bonhomme, Chiappori, Townsend and Yamada (2012)

\[
\log (T - l_s^i) = A_i + C_i D_s^h - E_i \log w_s^i
\]

\[
\frac{\lambda_s}{\pi_{s,l_s^i,h}} \leq (1 - \alpha_{i,h})(1-\alpha_{i,h})(1-\gamma_{i,h})\left(\frac{w_s^{i,h} T}{\alpha_{i,h}}\right)^{(1-\alpha_{i,h})(1-\gamma_{i,h})-1}
\]

- Note: In partial equilibrium, wage variation does matter, and it should for productivity
  - some things should fluctuate with wages

- 1 standard deviation negative shock increases participation
  - –.05473126

- Increases hours_w
  - .00034717

- But these numbers are larger for the low wealth, confirming all of above
Risk Sharing with Production, Check #2: CAPM

The economy consists of

- $I$ households
- Each household $j$ has access to $J_j$ technologies, whose production is linear in capital
- If technology $i$ is run by household $j$, the return $r^j_i$ is asset and individual specific, $R^i_j$ for hh $j$ aggregate

Characterize expected returns given that

- Consumption is allocated efficiently across households ("risk-sharing")
- Capital is allocated efficiently across individuals and projects ("production efficiency")
A Basic Model

- The value function of the social planner is

\[
V(W) = \max_{\tau_j, k_j^j} \left( \sum_{j=1}^{J} \lambda_j u_j \left( \sum_{i=1}^{I} r_j^i k_j^i + \tau_j \right) + \phi E \left[ V(W') \right] \right)
\]

subject to aggregate resource constraint

\[
\sum_{j=1}^{J} \left( \sum_{i=1}^{I} r_j^i k_j^i + \tau_j \right) + \sum_{j=1}^{J} \sum_{i=1}^{I} k_{j}^{ii} = W,
\]

\(W\) is the aggregate wealth of the whole economy at the beginning of the current period, i.e.

\[
W = \sum_{j=1}^{J} \sum_{i=1}^{I} (1 + r_j^i) k_j^i
\]

\([\tau_j]: \lambda_j u_j(c_j) = \mu \) for all \(j\)

\([k_j^{ii}]: \phi E \left[ V_W(W') (1 + r_j^{ii}) \right] = \mu \) for all \(i\) and all \(j\)

where \(\mu\) is the shadow price of consumption in the current period.
A Basic Model, cont.

- Finally, for each i and j, we get

\[ 1 = \frac{\phi E[V_w(W') \left(1+r_j^{ii}\right)]}{\mu} = \frac{\phi V_w(W')}{\mu} \left(1+r_j^{ii}\right) = E[m'R_j^{ii}] \]

- Next, since \( E[m'R_j^{ii}] = E[m'] E[R_j^{ii}] + \text{cov}(m', R_j^{ii}) \), we have

\[ E[R_j^{ii}] = \frac{1}{E[m']} - \frac{\text{cov}(m', R_j^{ii}) \text{var}(m')}{\text{var}(m')} E[m'] \]

\[ E[R_j^{ii}] = \gamma' + \beta_{m',ij} \lambda_{m',ij} \]

- Step 1: Compute household beta from a simple time-series regression for each HH

\[ R_{j,t}^l = \alpha_j + \beta_j R_{M,t} + \varepsilon_{j,t} \]

- Step 2: Cross-sectional regression for each village, using time-series average

\[ \overline{R}_j^l = \sum_{t=1}^{T} R_{j,t}^l \] as proxy for expected return \( E(R^j) \)

\[ \overline{R}_j^l = \alpha + \lambda \beta_j + \eta_j \]
Panel D: Network as Market

Remarks: Horizontal Axis = Beta; Vertical Axis = Expected Return. Each graph represents each of the networks. We treat each network as the market. From left to right and from top to bottom are networks from Buriram (village 14), Lopburi (villages 1, 4, and 6), and Srisaket (villages 1, 6, and 9).
So Far So Good in the Checks, More or Less, But Things Can Go Really Bad: Marginal Product of Capital

- Poor investing and saving in own enterprise–long term remedy
- Even risk adjusted, we get similar picture
- Even taking out idiosyncratic risk
- As we shall see below, this is most consistent with buffer stock, limited credit model

[Pawasutipaisit & Townsend, 2010]
So potentially credit interventions from the outside might help, as either catalyst for internal informal arrangements, or outside management/funding

- Welfare gains could be huge

- Government runs a (quasi–experimental) policy experiment
  - Million Baht Village Funds
Buffer Stock, Lumpy Investment Modeling: The Intervention as Relaxing Credit Constraint

(with Kaboski, *Econometrica*, 2011)

• Caveat: heterogeneous treatment and IV, not same here
Investment, Access to Credit, and Productive Heterogeneity
Regression Specification (with Emily Breza)

Let $A_{\text{high},n}$ be a measure of household productivity or marginal product.

We want to estimate:

$$y_{n,t} = \alpha + \beta_1 VFCR_{n,t} + \beta_2 A_{\text{high},n} \times VFCR_{n,t} + \beta_3 A_{\text{high},n} + \gamma X_{n,t} + \epsilon_{n,t}$$

- We instrument for $VFCR_{n,t}$ and $A_{\text{high},n} \times VFCR_{n,t}$.
- As in Kaboski and Townsend (2012), identification comes from the timing of the credit intervention.

First stage:

$$VFCR_{n,t} = \delta_n + \theta_t + \theta_n + \lambda_1 \text{invHH}_{t,n} +$$

$$+ \lambda_1 \sum_{\tau=2002}^{2006} \text{invHH}_{t,n}X_{t=\tau} + \epsilon_{n,t}$$
Credit, Investment, and Productive Heterogeneity
Baseline Results (with Emily Breza)

Main Results:

<table>
<thead>
<tr>
<th></th>
<th>Consumption</th>
<th>Investment</th>
<th>Started New Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>VFCR</td>
<td>1.545*</td>
<td>0.0260</td>
<td>4.06e-06</td>
</tr>
<tr>
<td></td>
<td>(0.815)</td>
<td>(0.328)</td>
<td>(2.54e-06)</td>
</tr>
<tr>
<td>Ahigh*VFCR</td>
<td>0.445</td>
<td>0.586*</td>
<td>-2.83e-06*</td>
</tr>
<tr>
<td></td>
<td>(0.528)</td>
<td>(0.325)</td>
<td>(1.62e-06)</td>
</tr>
</tbody>
</table>

Alternative Specifications:

<table>
<thead>
<tr>
<th></th>
<th>More Restrictive Instruments</th>
<th>Value Added Y</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consumption</td>
<td>Investment</td>
</tr>
<tr>
<td>VFCR</td>
<td>1.515**</td>
<td>0.0825</td>
</tr>
<tr>
<td></td>
<td>(0.684)</td>
<td>(0.214)</td>
</tr>
<tr>
<td>Ahigh*VFCR</td>
<td>0.345</td>
<td>0.501</td>
</tr>
<tr>
<td></td>
<td>(1.900)</td>
<td>(0.752)</td>
</tr>
</tbody>
</table>
Where Things Go Really Bad, Second Case: Cash Management in Thai Villages

- Cash Management in Thai Villages

\[ m(t + \Delta) = m(t) - e(t + \Delta) + \omega(t + \Delta) - d(t + \Delta) \]

where \( e \) is net cash outflow and \( d \) is deposit into bank (and net lending in informal money market) and \( \omega \) is withdrawal from bank (plus borrowing informal money market).
Household wants to minimize the expected discounted value of the sum of two cost: the flow opportunity cost \( R \) and the adjustment cost \( b \).

\[
V(m) = \begin{cases} 
  b + \min_{m'} V(m') & \text{if } m \leq 0 \\
  \min \left\{ \Delta Rm + \frac{1}{1+\Delta r} E[V(m-e)] \right\} & \text{if } m > 0 
\end{cases}
\]

\[
E[V(m-e)] = V(m+z_n) \kappa_n \Delta 
+ V(m-\Delta c + \sigma \Delta^{1/2}) \frac{1-(\kappa_p + \kappa_n) \Delta}{2} 
+ V(m-z_p) \kappa_p \Delta 
+ V(m-\Delta c - \sigma \Delta^{1/2}) \frac{1-(\kappa_p + \kappa_n) \Delta}{2}
\]
Good Fitting Households But the Anomaly Is Still There

- Average money balances are 30

\[ \mathbb{E}[e], \mathbb{E}[e^2], \kappa_p, z_p, \kappa_n, z_n \]

\[ \mathbb{E}[e] = \Delta[c + \kappa_p z_p - \kappa_n z_n] \]
\[ \mathbb{E}[e^2] = (1 - \Delta(\kappa_n + \kappa_p))(\Delta^2 c^2 + \Delta \sigma^2) + \kappa_p \Delta(z_p)^2 + \kappa_n \Delta(z_n)^2 \]

Table 2: Net Cash Consumption for Rural Thai Households by Occupation

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Statistics</th>
<th>Implied Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \mathbb{E}[e] )</td>
<td>( \text{Std}[e] )</td>
</tr>
<tr>
<td>All</td>
<td>mean</td>
<td>-0.13</td>
</tr>
<tr>
<td></td>
<td>median</td>
<td>-0.015</td>
</tr>
</tbody>
</table>
Figure 1: Avg. cash balances $M$ and avg. size of withdrawals $W$ and deposits $D$

Figure 2: Annual Frequency of adjustments: $N_a$, $N_w$ and $N_d$
Where Things Go Really Bad, Case 3: Lifecycle

- 44% have decreases in net worth
  - even at younger ages
- More worryingly, consumption is not smooth:
Lifecycle Planner Intervention

Wealth management for the Poor

- **Innovative project**
- Banks have models not based on econ theory
- Kotlikoff software for US - not for a developing country
- Rich get advice, for Poor maybe even more crucial
Intervention

Training modules and Planner: advise and explain to households the availability of instruments, their functioning, and various important financial concepts.

Planner allows to show households simulations of their predicted income paths under various scenarios, as well as show them optimal policy.

Goal is to help households think through various scenarios, understand logic of consumption smoothing, rather than give rigid recommendations.

Intervening across several dimensions:
- Reducing transactions costs
- Improving knowledge
- Improving computational ability
- Reducing uncertainty regarding instruments, linked to ambiguity aversion

To distinguish those margins: Tests of initial knowledge, followed by ‘quizzes’ after training modules to test knowledge improvement.

As an important by-product: we will elicit from household current strategies and plans thanks to survey
Outcomes tested

Four broad categories of outcomes:
1. Knowledge improvements (quizzes)
2. Subjective well-being
3. Improved use of financial instrument
4. Following of the recommendations given by modules and Planner:
   - is consumption smoother?
   - more savings accounts, less cash at home?
   - increase or decrease in savings relative to Planner recommendations?
   - Do they keep a plan for budget and cash management?
   - Improved use of insurance?
Back to Algorithm

- What if we are getting it wrong?
- What if there are serious underlying obstacles?
- Remediable or not?
- If so, how?
- Structural models of dynamic financial constraints
  - exogenously incomplete markets
    - *autarky* (no access to financial markets) (A)
    - *saving only* (S)
    - *non-contingent debt* (B)
  - endogenously incomplete markets
    - *moral hazard* (MH) due to unobserved effort
    - *moral hazard with unobserved investment* (UI)
    - *limited commitment* (LC)
    - UNOBSERVED OUTPUT
  - complete markets / *full information* (FI)
What We Do
(with Alexander Karaivanov)

- Develop methods based on mechanism design, dynamic programming, linear programming, and maximum likelihood to
  - **compute** (Prescott and Townsend, 84; Phelan and Townsend, 91; Doepke and Townsend, 06)
  - **estimate** (via maximum likelihood)
  - **statistically test** the alternative models (Vuong, 89)

- Apply these methods to simulated data and actual data from Thai villages and urban communities
Timing

- Start at some initial state: \( k, (k, w) \) or \( (k, b) \) depending on the model regime (\( w \) is promised utility in the MH regime, \( b \) is debt/savings)
- Capital, \( k \) and effort, \( z \) used in production
- Output, \( q \) realized, financial contract terms implemented (transfers, \( \tau \) or new debt/savings, \( b' \))
- Consumption, \( c \) and investment, \( i \equiv k' - (1 - \delta)k \) decided/implemented,
- Go to next period state: \( k', (k', w') \) or \( (k', b') \) depending on regime
Mechanism Design Models of Financial Markets

- Allow state- and history-contingent transfers, $\tau$
- Dynamic optimal contracting problem between a risk-neutral lender and the household

$$V(w, k) = \max_{\{\pi(\tau, q, z, k', w'|k, w)\}} \sum_{T \times Q \times Z \times K' \times W'} \pi(\tau, q, z, k', w'|k, w)[q - \tau + (1/R)V(w', k')]$$

s.t. promise-keeping:

$$\sum_{T \times Q \times Z \times K' \times W'} \pi(\tau, q, z, k', w'|k, w)[U(\tau + (1 - \delta)k - k', z) + \beta w'] = w,$$

and s.t. Bayes-rule consistency, adding-up, and non-negativity as before.
Moral Hazard

- Additional constraints
  - incentive–compatibility, $\forall (\bar{z}, \hat{z}) \in Z \times Z$

$$\sum_{T \times Q \times K' \times W'} \pi(\tau, q, \bar{z}, k', w'| k, w)[U(\tau + (1 - \delta)k - k', \bar{z}) + \beta w'] \geq \sum_{T \times Q \times K' \times W'} \pi(\tau, q, \bar{z}, k', w'| k, w) \frac{P(q|\hat{z}, k)}{P(q|\bar{z}, k)}[U(\tau + (1 - \delta)k - k', \hat{z}) + \beta w']$$

- We also compute a moral hazard model with unobserved $k$ and $k'$ (UI)
  - adds dynamic adverse selection as source of financial constraints
### Table 8 - Parameter Estimates Using 1999-00 Thai Data

with estimated production function

#### Investment and income, \((k, i, q)\) data

<table>
<thead>
<tr>
<th>Model</th>
<th>(\gamma_{me})</th>
<th>(\sigma)</th>
<th>(\theta)</th>
<th>(\rho)</th>
<th>(\mu_{w/b})</th>
<th>(\gamma_{w/b})</th>
<th>LL Value$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moral hazard - MH</td>
<td>0.1225</td>
<td>0.2910</td>
<td>0.3999</td>
<td>0.0829</td>
<td>0.6719</td>
<td>0.6630</td>
<td>-3.3055</td>
</tr>
<tr>
<td>Full information - FI</td>
<td>0.1246</td>
<td>0.1357</td>
<td>0.5019</td>
<td>0.0829</td>
<td>0.9999</td>
<td>0.5709</td>
<td>-3.2932</td>
</tr>
<tr>
<td>Limited commitment - LC</td>
<td>0.1003</td>
<td>3.5826</td>
<td>5.3433</td>
<td>4.1522</td>
<td>0.2377</td>
<td>0.5405</td>
<td>-3.0270</td>
</tr>
<tr>
<td>Borrowing &amp; lending - B</td>
<td>0.0947</td>
<td>0.8689</td>
<td>0.3148</td>
<td>1.6088</td>
<td>0.8935</td>
<td>0.0073</td>
<td>-2.6072</td>
</tr>
<tr>
<td>Saving only - S *</td>
<td>0.0860</td>
<td>1.3109</td>
<td>0.1318</td>
<td>1.7553</td>
<td>0.8934</td>
<td>0.0073</td>
<td>-2.5809</td>
</tr>
<tr>
<td>Autarky - A</td>
<td>0.1202</td>
<td>3.1710</td>
<td>1.2000</td>
<td>0.8570</td>
<td>n.a.</td>
<td>n.a.</td>
<td>-2.8135</td>
</tr>
</tbody>
</table>

#### Consumption and income, \((c, q)\) data

<table>
<thead>
<tr>
<th>Model</th>
<th>(\gamma_{me})</th>
<th>(\sigma)</th>
<th>(\theta)</th>
<th>(\rho)</th>
<th>(\mu_{w/b})</th>
<th>(\gamma_{w/b})</th>
<th>LL Value$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moral hazard - MH *</td>
<td>0.1337</td>
<td>0.8959</td>
<td>3.0124</td>
<td>6.4093</td>
<td>0.8406</td>
<td>0.0200</td>
<td>-0.9548</td>
</tr>
<tr>
<td>Full information - FI</td>
<td>0.1449</td>
<td>0.4798</td>
<td>0.1070</td>
<td>0.0603</td>
<td>0.5494</td>
<td>0.0486</td>
<td>-1.0220</td>
</tr>
<tr>
<td>Limited commitment - LC</td>
<td>0.1480</td>
<td>1.1857</td>
<td>0.2140</td>
<td>0.0000</td>
<td>0.3068</td>
<td>0.1809</td>
<td>-1.0817</td>
</tr>
<tr>
<td>Borrowing &amp; lending - B *</td>
<td>0.1319</td>
<td>4.6155</td>
<td>0.2341</td>
<td>1.6389</td>
<td>0.6172</td>
<td>0.0202</td>
<td>-0.9306</td>
</tr>
<tr>
<td>Saving only - S *</td>
<td>0.1275</td>
<td>0.8959</td>
<td>3.4102</td>
<td>1.3859</td>
<td>0.6877</td>
<td>0.0507</td>
<td>-0.9475</td>
</tr>
<tr>
<td>Autarky - A</td>
<td>0.1669</td>
<td>0.5718</td>
<td>1.9309</td>
<td>3.3244</td>
<td>n.a.</td>
<td>n.a.</td>
<td>-1.1059</td>
</tr>
</tbody>
</table>

#### Combined consumption, investment, and income, \((c, q, i, k)\) data

<table>
<thead>
<tr>
<th>Model</th>
<th>(\gamma_{me})</th>
<th>(\sigma)</th>
<th>(\theta)</th>
<th>(\rho)</th>
<th>(\mu_{w/b})</th>
<th>(\gamma_{w/b})</th>
<th>LL Value$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moral hazard - MH</td>
<td>0.1783</td>
<td>0.0430</td>
<td>0.2125</td>
<td>0.1109</td>
<td>0.3543</td>
<td>0.0194</td>
<td>-3.0764</td>
</tr>
<tr>
<td>Full information - FI</td>
<td>0.1409</td>
<td>0.0756</td>
<td>0.2341</td>
<td>-0.0507</td>
<td>0.5055</td>
<td>0.1045</td>
<td>-3.0765</td>
</tr>
<tr>
<td>Limited commitment - LC</td>
<td>0.3011</td>
<td>1.2008</td>
<td>1.9982</td>
<td>-1.5178</td>
<td>0.5000</td>
<td>0.0000</td>
<td>-3.9885</td>
</tr>
<tr>
<td>Borrowing &amp; lending - B</td>
<td>0.1086</td>
<td>2.4584</td>
<td>1.1571</td>
<td>2.9476</td>
<td>0.7135</td>
<td>0.0517</td>
<td>-2.4193</td>
</tr>
<tr>
<td>Saving only - S *</td>
<td>0.1171</td>
<td>2.4803</td>
<td>0.4450</td>
<td>3.0311</td>
<td>0.9183</td>
<td>0.0289</td>
<td>-2.4516</td>
</tr>
<tr>
<td>Autarky - A</td>
<td>0.1398</td>
<td>2.8836</td>
<td>9.2000</td>
<td>2.4871</td>
<td>n.a.</td>
<td>n.a.</td>
<td>-2.7372</td>
</tr>
</tbody>
</table>

**Notes:** 1. Bootstrap standard errors in the parentheses; 2. Normalized (divided by \(n\)) log-likelihood values; 3. \(\mu_{w/b}\) and \(\gamma_{w/b}\) reported relative to grid span

* denotes the best fitting regime (including tied)
### Table 5 - Model Comparisons\(^1\) using Thai Rural Data - Baseline Vuong Test Results

<table>
<thead>
<tr>
<th>Comparison</th>
<th>MH vs MLC</th>
<th>MH vs B</th>
<th>MH vs S</th>
<th>MH vs A</th>
<th>FL vs LC</th>
<th>FL vs B</th>
<th>FL vs S</th>
<th>FL vs A</th>
<th>LC vs B</th>
<th>LC vs S</th>
<th>LC vs A</th>
<th>B vs S</th>
<th>B vs A</th>
<th>S vs A</th>
<th>Best Fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Using (k,i,q) data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 years: 1999-00</td>
<td>MH* tie B*** S*** A***</td>
<td>tie B*** S*** A***</td>
<td>B*** S*** A***</td>
<td>S*** B*** S***</td>
<td>S***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2 years: 2004-05</td>
<td>F*** MH*** B*** S*** A***</td>
<td>F*** B*** S*** A***</td>
<td>B*** S*** A***</td>
<td>tie B*** S***</td>
<td>tie B***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Using (c,q) data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 year: 1999</td>
<td>MH*** MH** MH** tie MH***</td>
<td>F*** tie tie F***</td>
<td>tie tie LC**</td>
<td>S*** B***</td>
<td>S*** MH,S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2 year: 2005</td>
<td>tie MH*** tie tie tie</td>
<td>F*** tie S*** tie</td>
<td>B** S*** tie</td>
<td>S** tie</td>
<td>S** S*S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Using (c,q,i,k) data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1 years: 1999-00</td>
<td>tie MH*** B*** S*** A***</td>
<td>F*** B*** S*** A***</td>
<td>B*** S*** A***</td>
<td>S*** tie</td>
<td>S*** tie</td>
<td>S*** tie</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2 years: 2004-05</td>
<td>F*** MH*** B*** S*** A***</td>
<td>F*** B*** S*** A***</td>
<td>B*** S*** A***</td>
<td>S*** tie</td>
<td>S*** tie</td>
<td>S*** tie</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Two-year panel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1 (c,q) data, years: 1999 and 00</td>
<td>MH*** MH** B*** S*** MH**</td>
<td>F*** B*** S*** tie</td>
<td>B*** S*** tie</td>
<td>tie B*** S***</td>
<td>S*** B,S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.2 (c,q) data, years: 1999 and 05</td>
<td>MH*** MH** tie tie MH**</td>
<td>F*** B*** S*** tie</td>
<td>B*** S*** tie</td>
<td>tie B*** S***</td>
<td>S*** B,S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Dynamics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1 99 k distribution &amp; 04-05 (c,q,i,k)</td>
<td>F*** MH*** B*** tie tie</td>
<td>F*** B*** tie FL*</td>
<td>B*** S*** A***</td>
<td>B*** B***</td>
<td>S*** B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2 99 k distribution &amp; 05 (c,q)</td>
<td>tie MH*** tie tie MH***</td>
<td>F*** tie tie F***</td>
<td>B*** S*** A***</td>
<td>tie B*** S***</td>
<td>S*** S,B,FL,MH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.3 99 k distribution &amp; 04-05 (k,i,q)</td>
<td>F*** LC*** B*** S** MH**</td>
<td>tie B*** S* FL**</td>
<td>B*** S* LC**</td>
<td>B*** B*** S***</td>
<td>S*** B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 6 - Model Comparisons\(^1\) using Thai Rural Data - Networks

<table>
<thead>
<tr>
<th>Comparison</th>
<th>MH vs MLC</th>
<th>MH vs B</th>
<th>MH vs S</th>
<th>MH vs A</th>
<th>FL vs LC</th>
<th>FL vs B</th>
<th>FL vs S</th>
<th>FL vs A</th>
<th>LC vs B</th>
<th>LC vs S</th>
<th>LC vs A</th>
<th>B vs S</th>
<th>B vs A</th>
<th>S vs A</th>
<th>Best Fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Networks by friend/relative</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 (c,q) data, in network, n=391</td>
<td>MH*** MH*** MH*** MH* MH***</td>
<td>F*** tie tie F***</td>
<td>tie tie LC**</td>
<td>S*** B***</td>
<td>S*** MH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2 (k,i,q) data, in network</td>
<td>tie tie B*** S*** A***</td>
<td>F*** B*** S*** A***</td>
<td>B*** S*** A***</td>
<td>S*** B**</td>
<td>S*** S***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3 (c,q,i,k) data, in network</td>
<td>tie MH*** MH*** S*** A**</td>
<td>F*** B*** S*** A***</td>
<td>B*** S*** A***</td>
<td>S*** tie</td>
<td>S*** tie</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4 (c,q) data, not in network</td>
<td>tie MH*** tie tie tie</td>
<td>F*** tie tie tie</td>
<td>tie tie tie</td>
<td>tie B* tie</td>
<td>all tied</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5 (c,q,i,k) data, not in network</td>
<td>tie MH*** tie S*** tie</td>
<td>F*** tie S*** A**</td>
<td>B*** S*** A***</td>
<td>S*** tie</td>
<td>S*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Networks by gift or loan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 (c,q) data, in network, n=357</td>
<td>F*** MH*** MH*** tie MH***</td>
<td>F*** F*** F*** F***</td>
<td>tie S*** LC*</td>
<td>S*** B***</td>
<td>S*** F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2 (k,i,q) data, in network</td>
<td>tie B*** S*** A***</td>
<td>tie B*** S*** A***</td>
<td>B*** S*** A***</td>
<td>S** B**</td>
<td>S** S**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3 (c,q,i,k) data, in network</td>
<td>tie MH*** B*** S*** A**</td>
<td>tie B*** S*** A**</td>
<td>B*** S*** A**</td>
<td>S*** tie</td>
<td>S**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4 (c,q) data, not in network</td>
<td>tie MH*** MH*** tie MH**</td>
<td>F*** F*** tie FL*</td>
<td>tie tie tie</td>
<td>S*** tie</td>
<td>S*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5 (c,q,i,k) data, not in network</td>
<td>tie MH*** MH*** S*** tie</td>
<td>F*** B*** S*** tie</td>
<td>B*** S*** A***</td>
<td>tie S**</td>
<td>S**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: 1. *** = 1%, ** = 5%, * = 10% two-sided significance level, the better fitting model abbreviation is displayed; 2. Vuong statistic cutoffs: >2.575 = ***; >1.96 = **; >1.645 = *; <1.645 = "tie"
### Table 7 - Model Comparisons using Thai Urban Data - Vuong Test Results

<table>
<thead>
<tr>
<th>Comparison</th>
<th>MH</th>
<th>HI (LC)</th>
<th>MH</th>
<th>HI</th>
<th>MH</th>
<th>HI</th>
<th>FL (LC)</th>
<th>FL</th>
<th>FI</th>
<th>FLL</th>
<th>B</th>
<th>B</th>
<th>B</th>
<th>A</th>
<th>SVA</th>
<th>Best Fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Using (c,q,i,k) data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MH</td>
</tr>
<tr>
<td>1.1. years: 2005-06</td>
<td>MH***</td>
<td>MH***</td>
<td>MH***</td>
<td>MH***</td>
<td>MH***</td>
<td>FL***</td>
<td>B***</td>
<td>S***</td>
<td>FI*</td>
<td>B***</td>
<td>S***</td>
<td>A***</td>
<td>S***</td>
<td>B***</td>
<td>S***</td>
<td>MH</td>
</tr>
<tr>
<td>1.2. years: 2008-09</td>
<td>MH***</td>
<td>MH***</td>
<td>MH***</td>
<td>MH***</td>
<td>MH***</td>
<td>FL***</td>
<td>B***</td>
<td>S***</td>
<td>tie</td>
<td>B***</td>
<td>S***</td>
<td>A***</td>
<td>S***</td>
<td>B***</td>
<td>S***</td>
<td>MH</td>
</tr>
<tr>
<td>2. Using (c,q) data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MH,FI</td>
</tr>
<tr>
<td>2.1. year: 2005</td>
<td>tie</td>
<td>MH**</td>
<td>MH**</td>
<td>MH**</td>
<td>MH**</td>
<td>FL**</td>
<td>FL**</td>
<td>FL**</td>
<td>LC***</td>
<td>tie</td>
<td>LC***</td>
<td>S***</td>
<td>B***</td>
<td>S***</td>
<td>MH,FI</td>
<td></td>
</tr>
<tr>
<td>2.2. year: 2009</td>
<td>MH*</td>
<td>MH***</td>
<td>tie</td>
<td>MH*</td>
<td>MH**</td>
<td>FL**</td>
<td>tie</td>
<td>tie</td>
<td>FL**</td>
<td>B***</td>
<td>S***</td>
<td>A***</td>
<td>tie</td>
<td>B***</td>
<td>S***</td>
<td>MH,B</td>
</tr>
<tr>
<td>3. Using (k,i,q) data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MH</td>
</tr>
<tr>
<td>3.1. years: 2005-06</td>
<td>tie</td>
<td>MH***</td>
<td>tie</td>
<td>S***</td>
<td>tie</td>
<td>FL**</td>
<td>tie</td>
<td>S***</td>
<td>tie</td>
<td>B***</td>
<td>S***</td>
<td>tie</td>
<td>S***</td>
<td>tie</td>
<td>S*</td>
<td>S,B</td>
</tr>
<tr>
<td>3.2. years: 2008-09</td>
<td>FL*</td>
<td>tie</td>
<td>B**</td>
<td>S***</td>
<td>A***</td>
<td>FL**</td>
<td>B***</td>
<td>S***</td>
<td>tie</td>
<td>B***</td>
<td>S***</td>
<td>A**</td>
<td>tie</td>
<td>tie</td>
<td>S*</td>
<td>S,B</td>
</tr>
<tr>
<td>4. Two-year panel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MH</td>
</tr>
<tr>
<td>4.1. (c,q) data, years: 2005 and 06</td>
<td>tie</td>
<td>MH***</td>
<td>tie</td>
<td>MH**</td>
<td>tie</td>
<td>FL**</td>
<td>FL**</td>
<td>tie</td>
<td>S***</td>
<td>tie</td>
<td>S***</td>
<td>B**</td>
<td>S***</td>
<td>B**</td>
<td>S***</td>
<td>S,MH,FI</td>
</tr>
<tr>
<td>4.2. (c,q) data, years: 2005 and 09</td>
<td>MH**</td>
<td>MH**</td>
<td>MH**</td>
<td>MH**</td>
<td>MH**</td>
<td>FL**</td>
<td>FL**</td>
<td>FL**</td>
<td>FL**</td>
<td>tie</td>
<td>S***</td>
<td>tie</td>
<td>S***</td>
<td>B**</td>
<td>S***</td>
<td>MH</td>
</tr>
</tbody>
</table>

### Table 9 - Model Comparisons using Thai Data - Robustness Runs

<table>
<thead>
<tr>
<th>Comparison</th>
<th>MH</th>
<th>HI (LC)</th>
<th>MH</th>
<th>HI</th>
<th>MH</th>
<th>HI</th>
<th>FL (LC)</th>
<th>FL</th>
<th>FI</th>
<th>FLL</th>
<th>B</th>
<th>B</th>
<th>B</th>
<th>A</th>
<th>SVA</th>
<th>Best Fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Runs with hidden output (HO) and unobserved investment (UI) models²</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MH</td>
</tr>
<tr>
<td>6.1 hidden output model, (c,q,i,k)</td>
<td>tie</td>
<td>tie</td>
<td>B***</td>
<td>S***</td>
<td>A***</td>
<td>HO***</td>
<td>B,S</td>
<td>SVA</td>
<td>Best fit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2 unobserved investment model, (c,q,i,k)</td>
<td>UI**</td>
<td>UI***</td>
<td>B**</td>
<td>S***</td>
<td>tie</td>
<td>UI**</td>
<td>B</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Rural data

<table>
<thead>
<tr>
<th>Rural data</th>
<th>v MH</th>
<th>v FL</th>
<th>v B</th>
<th>v S</th>
<th>v A</th>
<th>v LC</th>
<th>Best fit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>v MH</td>
<td>v FL</td>
<td>v B</td>
<td>v S</td>
<td>v A</td>
<td>v LC</td>
<td>B</td>
</tr>
<tr>
<td>5.1 hidden output model, (c,q,i,k)</td>
<td>tie</td>
<td>tie</td>
<td>B***</td>
<td>S***</td>
<td>A***</td>
<td>HO***</td>
<td>B,S</td>
</tr>
<tr>
<td>5.2 unobserved investment model, (c,q,i,k)</td>
<td>UI**</td>
<td>UI***</td>
<td>B**</td>
<td>S***</td>
<td>tie</td>
<td>UI**</td>
<td>B</td>
</tr>
</tbody>
</table>

#### Urban data

<table>
<thead>
<tr>
<th>Urban data</th>
<th>v MH</th>
<th>v FL</th>
<th>v B</th>
<th>v S</th>
<th>v A</th>
<th>v LC</th>
<th>Best fit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>v MH</td>
<td>v FL</td>
<td>v B</td>
<td>v S</td>
<td>v A</td>
<td>v LC</td>
<td>Best fit</td>
</tr>
<tr>
<td>5.1 hidden output model, (c,q,i,k)</td>
<td>HO**</td>
<td>HO***</td>
<td>HO**</td>
<td>HO**</td>
<td>HO**</td>
<td>HO**</td>
<td>HO</td>
</tr>
<tr>
<td>5.2 unobserved investment model, (c,q,i,k)</td>
<td>UI**</td>
<td>UI***</td>
<td>UI**</td>
<td>UI**</td>
<td>UI**</td>
<td>UI**</td>
<td>UI</td>
</tr>
</tbody>
</table>
Thai vs. Simulated Data; Business Assets Transition Matrix

Rural data

Urban data

Saving only (S)

Moral hazard (MH)

Note: axis labels correspond to k percentiles; 1 is 10th, 5 is 90th; values larger than $4 \times 10^{-3}$ plotted in color.
Thai vs. Simulated Data: Return on Assets

Rural data, 1999–2005

Urban data, 2005–2009

Saving only (at rural MLE estimates)

Saving only (at urban MLE estimates)

Moral hazard (at rural MLE estimates)

Moral hazard (at urban MLE estimates)

Each circle represents a household
Policy Experiment

- With heterogeneity simple reduction in the gross interest rate $R$ from 1.05 to 1.025
Bundling Credit/Insurance/Savings: Model Intervention

- Observed heterogeneity: initial wealth \( W_0 \), and other characteristics (schooling, occupation type, number of family members, etc.) \( S \). Both the agent and the bank know those.

- Unobserved heterogeneity: "talent" or "potential for success", \( \theta \), private information of the agent. We assume it is distributed following a distribution \( \Pi(\theta) \) in the population.

- Initial transfer \( b(\theta) \)

\[
T'(q, w, \theta) = rb + T(q, w, \theta)
\]

\[
c(\theta, q, w) = W_0 + q + w + (1 - r)b(\theta) - k(\theta) - T(\theta, q, w)
\]

\[
k(\theta) \leq b(\theta) + W_0
\]

\[
f(q\mid l, k; \theta)
\]

\[
\eta W_0 \geq rb(\theta) + T(w, q, \theta)
\]

- Policy to deal with obstacles: If limited commitment, collateral requirement by the bank

\[
\eta W \geq rb(\theta) + T(w, q, \theta)
\]

- If moral hazard then adding a monitoring technology

- Goal
  - Distinguish regime
  - Target policy appropriately
  - But regime may be wrong—
### Questions

1. **Mobile Banking**
   - a. Why do customers need to go the bank branch to (i) open savings account and (ii) initiate loans (as oppose to mobile teller conducting this at customer’s home/business)

### BOT’s Answers (1st)

- Off premise transactions need to be approved by the Bank of Thailand (BOT) on a case by case basis. This is to ensure the compliance with Anti-Money Laundering and Combating the Financing of Terrorism (AML/CFT) policy as well as consumer protection purposes. Details are as shown below.
  
  **i. Open savings account**
  
  All banks need to comply with a guideline on know your customer and customer due diligence (KYC/CDD) practices, which are major components of Anti-Money Laundering and Combating the Financing of Terrorism (AML/CFT) measures before starting a new relationship with customers.

  **ii. Initiate loans**
  
  Functions relating to business decision, management responsibility, check and balance and risk management are compulsory to do by banks only. Thus, credit analysis and loan approval which are one of strategic functions are not allowed to conduct by agents.

### Questions (2nd round)

- We would like to check what you mean by on a case by case basis. Do you mean that each bank needs to get approval once so as to be able to use off premise transactions for all of its customers? Or does the bank need to get approval every time it wants to do an off premise transaction (that is, approval for each customer)?

### BOT’s Answers (2nd)

- The BOT’s approval for off premises transactions, generally, based on the type or period of the services banks want to offer. For example, if a bank wants to offer new MF products off premises and wants to get approval from the BOT, that approval would be for all customers of the same services and probably at different locations.
Welfare Gains: The Big Picture, GE Effects

- Moll–Townsend–Zhorin: Finance and Development:
  - Limited Commitment vs. Private Information
Optimal Contract: Bellman Equation

\[ v(a, z) = \max_{e, x, k, l, c(\varepsilon), a'(\varepsilon)} \sum_{\varepsilon} p(\varepsilon | e) \left\{ u[c(\varepsilon), e] + \beta \mathbb{E}v[a'(\varepsilon), z'] \right\} \quad \text{s.t.} \]

\[ \sum_{\varepsilon} p(\varepsilon | e) \{ c(\varepsilon) + a'(\varepsilon) \} \]

\[ \leq \sum_{\varepsilon} p(\varepsilon | e) \left\{ x[z\varepsilon k^\alpha l^\gamma - w l - (r + \delta)k] + (1 - x)w \varepsilon \right\} + (1 + r)a \]

and s.t. regime-specific constraints

Capital Accumulation
Limited Commitment

- effort, \( e \), observed \( \Rightarrow \) perfect insurance against production risk, \( \varepsilon \).

- But collateral constraint:

\[ k \leq \lambda a, \quad \lambda \geq 1. \]
Private Information

- effort, e, unobserved \(\Rightarrow\) moral hazard problem.

- Note: moral hazard for both entrepreneurs and workers.

- IC constraint:

\[
\sum_{\varepsilon} p(\varepsilon|e) \{ u[c(\varepsilon), e] + \beta \mathbb{E}v[a'(\varepsilon), z'] \} \\
\geq \sum_{\varepsilon} p(\varepsilon|\hat{e}) \{ u[c(\varepsilon), \hat{e}] + \beta \mathbb{E}v[a'(\varepsilon), z'] \} \quad \forall e, \hat{e}, x
\]
Steady State Equilibrium

- Prices $r$ and $w$, and corresponding quantities such that:

(i) Taking as given $r$ and $w$, quantities are determined by optimal contract

(ii) Markets clear

\[
\int l(a, z; w, r)dG(a, z) = \int n(a, z; w, r)dG(a, z) \\
\int k(a, z; w, r)dG(a, z) = \int adG(a, z).
\]
Mixtures of Moral Hazard and Limited Commitment: As in Urban and Rural

<table>
<thead>
<tr>
<th></th>
<th>FB</th>
<th>LC</th>
<th>MH</th>
<th>Mix -LC</th>
<th>Mix - MH</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>1.0</td>
<td>0.8230</td>
<td>0.8046</td>
<td>0.8136</td>
<td></td>
</tr>
<tr>
<td>TFP</td>
<td>1.0</td>
<td>0.9418</td>
<td>0.9187</td>
<td>0.9216</td>
<td></td>
</tr>
<tr>
<td>Capital Stock</td>
<td>1.0</td>
<td>0.7496</td>
<td>0.7617</td>
<td>0.7825</td>
<td></td>
</tr>
<tr>
<td>Wage</td>
<td>1.0</td>
<td>0.9282</td>
<td>0.9134</td>
<td>0.9240</td>
<td></td>
</tr>
<tr>
<td>Interest Rate (%)</td>
<td>4.08</td>
<td>3.52</td>
<td>4.66</td>
<td>3.75</td>
<td></td>
</tr>
<tr>
<td>% Entrepreneurs</td>
<td>26.98</td>
<td>37.36</td>
<td>35.33</td>
<td>6.67</td>
<td>52.58</td>
</tr>
</tbody>
</table>

*Table:* Comparison of Regimes
Transition Can Be Hugely Important: Wealth Distribution

*Figure:* Initial (solid line) and terminal (dashed line) wealth distribution
Welfare Gains: In Earlier Models, Substantial

- Kenichi Ueda: Endogenous financial deepening with a removable government induced wedge

Figure 21. Welfare Gains from Reduction in Entry Cost, 100000 to 65000 baht (7 to 4.5 model unit)

Figure 23. Investment-to-Output Ratio
Welfare Gains/Losses: In a Model of Occupation Choice Moving the Wage
(with Xavier Gine)

Figure 5: Welfare Comparison in 1979: Townsend-Thai Data
Conclusions

- We know enough from interaction of theory and data to guide policy
- In several instances, do not need all the data as in Thai project, can do in other countries now
  - add data to existing cross-section, panels, key variables
  - standardized measurement, as in NIPA and flow of funds
- There are striking deviations from benchmark standards in the data
  - insurance for the poor
  - marginal product of capital
  - cash holdings
  - lifecycle
- Redoing in some cases with obstacles or incomplete markets
  - fill in contracts/markets
  - with obstacles, these are indicators of specific remedies (costs and benefits)
- Can learn from past interventions, quasi experiments
- Sorting out demand vs. supply as in lifecycle/training
- New optimal interventions, as in bundling, require new regulatory understandings
- Next steps
  - designing interventions which compensate losers
  - policy based on industrial organization and micro founded macro modeling
  - thinking through overall financial design