A Structural Evaluation of a Large-Scale Quasi-Experimental Microfinance Initiative

Kaboski and Townsend (Econometrica, 2011)

Marco Duarte and Mizuhiro Suzuki

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The Thai Million Baht Fund program

What is the effect of a microcredit intervention program on the credit market and on household behaviour?

- Thai government's transfer program of village-level microcredit funds, beginning in 2001:
  - $\$24,000$ distributed to each of the 77,000 Thai villages;
  - every village was eligible;
  - money was a grant to the village fund.
- Villagers organize the fund and distribute loans through competitive applications:
  - loans uncollateralized, though most required guarantors;
  - common loan criteria: reasons for borrowing, ability to repay and need for funds.
  - low default rates (3%);
  - average nominal interest rate of 7% (above average money market rate in Bangkok).

Previous analyses

Gertler, Levine and Moretti (2003), **Karlan and Zinman (2009)**, **Banerjee, Duflo, Glennerster and Kinnan (2010)**,

Kaboski & Townsend (2009) : Reduced-form paper, where village size is used as IV for village fund credit. Results:

- more borrowing
- no change on interest rate
- higher level of consumption
  - almost one to one increase with additional money in the fund
- no effect on investment

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PUZZLE!

Kaboski & Townsend, 2011

Summary

- Structural model of household behaviour:
  - borrowing constraints,
  - income uncertainty,
  - high-yield indivisible investment opportunities.
- Estimate parameters using preprogram data;
  - Method of Simulated Moments
- Predictive Power:
  - Simulate the program shock
  - Compare the predicted effect with the real data
- Cost-Benefit Analyses.

Model

Restrictions

At $t+1$,

- Liquid wealth:[1]

$$L_{t+1} \equiv Y_{t+1} + S_t(1+r) \equiv P_{t+1}U_{t+1} + S_t(1+r)$$

- Permanent income:

$$P_{t+1} = P_t G N_{t+1} + RD_{I,t} I_t^* \equiv P_t G N_{t+1} + RD_{I,t} i_t^* P_t$$

- Borrowing Constraint:

$$S_t \geq \underline{s} P_t$$

- Default:

$$[\underline{s}P_t > L_t - \underline{c}P_t] \Rightarrow [D_{def,t} = 1] \Rightarrow [C_t = \underline{c}P_t, S_t = \underline{s}P_t, D_{I,t} = 0]$$

[1] $\log U_{t+1} \sim N(0, \sigma_u^2)$, $\log N_{t+1} \sim N(0, \sigma_N^2)$, $\log i_t^* \sim N(\mu_i, \sigma_i^2)$

Model

Sequential Problem

$$V(L_0, I_0^*, P_0) = \max_{\{C_t>0\},\{S_{t+1}\},\{D_{I,t}\}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\rho}}{1-\rho} \right]$$

subject to:

$$C_t + S_t + D_{I,t} I_t^* \leq L_t = P_t U_t + S_{t-1}(1+r)$$

$$P_t = P_{t-1} G N_t + R D_{I,t-1} i_{t-1}^* P_{t-1}$$

$$\underline{s} P_t \leq S_t$$

Model

Simplifying

We can define $P^{1-\rho}v(l, i^*) \equiv V(L, I^*, P)$, where:

$$v(l, i^*) = \quad \max_{c,d_l} \left\{ \frac{c^{1-\rho}}{1-\rho} + \beta\mathbb{E}\left[(p')^{1-\rho} v\left(U' + \frac{(1+r)(l-c-d_l i^*)}{p'}, i^{*\prime} \right) \right] \right\}$$

subject to:

$$(l - c - d_l i^*) \geq \underline{s}$$

$$p' = GN' + Rd_l i^*$$

Model

Solution Example

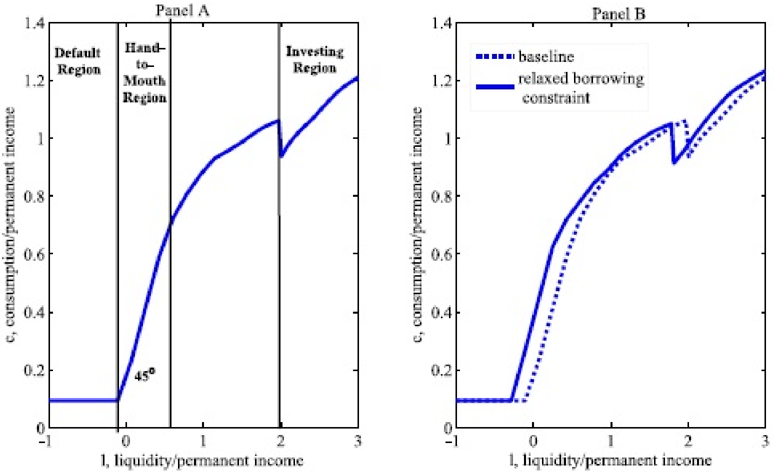

Figure: Consumption policy for fixed i^*.

Data

1. For year t and household n, gross data from TTDP: $\tilde{C}_{n,t}$, $\tilde{I}_{n,t}$, $\tilde{D}_{def,n,t}$, $\tilde{Y}_{n,t}$ and $S_{n,t}$.

2. Adjusting for Demographic and Cyclical Variation $\tilde{z} \in \{\tilde{C}_{n,t}, \tilde{D}_{def,n,t}, \tilde{Y}_{n,t}, \exp(\tilde{L}_{n,t}/\tilde{Y}_{n,t})\}$:
   2.1 Regress: $\log(\tilde{z}_{n,t}) = \gamma_z X_{n,t} + \theta_{z,j,t} + e_{z,n,t}$
   2.2 Define: $\log(z_{n,t}) = \hat{\gamma}_z \bar{X} + \bar{\theta}_{z,j} + g_z(t - 1999) + \hat{e}_{z,n,t}$

3. Calibrating investment return R:

$$\varepsilon_R = Y_t - \text{imputed labor income}_t - R(\text{physical assets}_t)$$

Final Data: $\{C_{n,t}, I_{n,t}, D_{def,n,t}, Y_{n,t}, S_{n,t}\}_{(n,t)=(1,1997)}^{(715,2001)}$ and $R = 0.11$.

Identification

Parameters: $\{r, \sigma_N, \sigma_u, G, \underline{c}, \beta, \rho, \mu_i, \sigma_i, \underline{s}, \sigma_E\}$ **Moments**(ε):

$$\mathbb{E}[(\text{Interest Income})_t - rS_{t-1}] = 0$$
$$\mathbb{E}[(\text{Debt Repayment})_t - rCR_{t-1}] = 0$$
$$\mathbb{E}[ln(Y_{t+1}/Y_t) - \mathbb{E}[(Y_{t+1}/Y_t)|L_t, Y_t]] = 0$$
$$\mathbb{E}[D_{def,t} - \mathbb{E}[D_{def,t}|L_t, Y_t]] = 0$$

$$\mathbb{E}\left[\begin{array}{l} [ln(Y_{t+k}/Y_t) - \mathbb{E}[ln(Y_{t+k}/Y_t)]]^2 - \\ \quad \mathbb{E}[[ln(Y_{t+k}/Y_t) - \mathbb{E}[ln(Y_{t+k}/Y_t)]]^2|L_t, Y_t] \quad (k = 1, 2, 3) \end{array}\right] = 0$$

For $z \in \{C_t, D_{I,t}, D_{I,t}I_t\}$,

$$\mathbb{E}[z - \mathbb{E}[z|L_t, Y_t]] = 0$$
$$\mathbb{E}[(z - \mathbb{E}[z|L_t, Y_t]) \log(Y_t)] = 0$$
$$\mathbb{E}[(z - \mathbb{E}[z|L_t, Y_t])(L_t/Y_t)] = 0$$

Method of Simulated Moments

Moment Condition: $\mathbb{E}[\varepsilon(\theta)] = 0$

- Simulate the error terms R times
  - U_t: transitory income shock
  - N_t: shock in permanent income
  - I_t^*: random project size
  - multiplicative measurement error in income $\sim \log N(0, \sigma_E)$
- Solve the dynamic programming problem to obtain $\varepsilon(\theta)^{(r)}$ for each time
- Take the average and use $\frac{1}{R}\sum_{r=1}^{R}\varepsilon(\theta)^{(r)}$ as $\mathbb{E}[\varepsilon(\theta)]$

Results

PARAMETER ESTIMATES AND MODEL FIT

Parameter Estimates		
Parameter	Estimate	Std. Error
Borrowing/savings interest rate, r	0.054	0.003
Deviation of log permanent income shock, σ_N	0.31	0.11
Deviation of log transitory income shock, σ_U	0.42	0.07
Deviation of log measurement error shock, σ_E	0.15	0.09
Exogenous income growth, G	1.047	0.006
Minimum consumption, $\underline{c}$	0.52	0.01
Discount factor, β	0.926	0.006
Intertemporal elasticity, ρ	1.20	0.01
Mean log project size, μ_i	1.47	0.09
Deviation of log project size, σ_i	6.26	0.72
Borrowing limit, $\underline{s}$	−0.08	0.03

Pre-Intervention Averages		
Variable	Data	Model
C_t	75,200	75,800
D_t	0.116	0.116
I_t	4600	4600
DEF_t	0.194	0.189
$\ln(Y_{t+1}/Y_t)$	0.044	0.049

Predictive Power: Thai Million Baht Fund Program

1. For each village v, a surprise decrease in liquidty constraint from $\underline{s} = -0.08$ to $\underline{s}_v^{mb}$:

$$\frac{1}{\mathcal{N}} \sum_{n=1}^{\mathcal{N}} \{\mathbb{E}[B_{n,t,v}^{mb} | L_{n,t}, Y_{n,t}, ; \underline{s}_v^{mb}] - \mathbb{E}[B_{n,t,v} | L_{n,t}, Y_{n,t}, ; \underline{s}]\}$$

$$= \frac{\text{Funding per village (950,000 baht)}}{\#\text{ HHs in village}_v}$$

2. Simulate 500 post-program data and run regressions with (a) Actual post-program data, (b) Simulated post-program data:

$$Z_{n,t} = \sum_{j \in \text{post program}} \alpha_{Z,j} \frac{950,000}{\#\text{ HHs in village}_v} \mathcal{I}_{t=j} + \theta_t + e_{n,t}$$

Predictive Power

Figure: Reduced Form Regression Estimates: Actual Data Versus Model Simulated Data

	Consumption		Investment Probability	
	$\gamma_{C,2002}$	$\gamma_{C,2003}$	$\gamma_{D,2002}$	$\gamma_{D,2003}$
Actual data				
“Impact” coefficient[b]	**1.39**	**0.90**	**6.3e−6**	−0.2e−6
Standard error	**0.39**	**0.39**	**2.4e−6**	2.4e−6
Simulated data				
Average “impact” coefficient[a]	**1.10**	0.73	**5.6e−6**	3.6e−6
Average standard error	**0.48**	0.48	**2.5e−6**	2.5e−6
Chow test significance level[c]	0.55		0.51	

	Investment		Default Probability		Income Growth	
	$\gamma_{I,2002}$	$\gamma_{I,2003}$	$\gamma_{\mathrm{DEF},2002}$	$\gamma_{\mathrm{DEF},2003}$	$\gamma_{\Delta \ln Y,2002}$	$\gamma_{\Delta \ln Y,2003}$
Actual data						
“Impact” coefficient[b]	−0.04	−0.17	**−5.0e−6**	**6.4e−6**	−9.4e−6	**12.6e−6**
Standard error	0.19	0.19	**2.4e−6**	**2.4e−6**	6.1e−6	**6.1e−6**
Simulated data						
Average “impact” coefficient[a]	0.41	0.35	**−9.0e−6**	−0.2e−6	0.3e−6	0.3e−6
Average standard error	0.23	0.23	**2.3e−6**	2.3e−6	5.9e−6	5.9e−6
Chow test significance level[c]	0.99		0.27		0.30	

Cost-Benefit Analysis

Which has lower cost, the microcredit or a simple liquidity transfer program?

- Solve for T_n:

  $$\mathbb{E}[V(L, P, I^*; \underline{s}_v^{mb} | Y_{n,v}, L_{n,v})] = \mathbb{E}[V(L + T_n, P, I^*; \underline{s} | Y_{n,v}, L_{n,v})]$$

- Average cost of 7000 baht per household (30% less)

- Large heterogeneity across households