

Evaluation of a large scale microfinance experiment: reduced-form and structural analysis

Kaboski and Townsend (2011 and 2012)

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March 2013

What is this lecture about?

- Evaluating the impact of a large-scale microfinance quasi-experiment
- Example of how to use a reduced-form IV, and a structural analysis in a complementary fashion.
- Highlight the strengths and weaknesses of each approach

Motivation: The importance of heterogeneity in evaluating microfinance programs

- A recurrent theme of this lecture is importance of heterogeneity when evaluating programs, both reduced-form and structural.
- Banerjee et. al. (2010) analyze RCT of classic microcredit in Hyderabad city.
 - group-based lending, small loans, female borrowers, low interest rates.
 - Patterns: on average no impact on total expenditures, but increase in durables in the short-run.
 - Masks heterogeneous effects: Business creation, business assets, self-employed hours worked, profits increase *for those who had already existing businesses*, as does their durables consumption. Their non-durable consumption does not change.
 - HHs with high propensity to become new business owners increase their durable goods' spending and decrease nondurable consumption, consistent with fixed cost to enter entrepreneurship.
 - HHs with low propensity to become new business owners instead increase their consumption of nondurables.

Motivation: The importance of heterogeneity in evaluating microfinance programs

- Crepon et. al. (2011): RCT in Morocco, with larger loan sizes in an environment with little access to credit pre-program, and lending to men.
 - Similar results, no effect on consumption (small cutback in consumption for agri + livestock)
 - No effects on business creation, but *fewer existing activities discontinued* and *scale* of activities in agri + livestock increases.

Reduced Form Evidence - Kaboski and Townsend (2012)

- Paper evaluates the short- and longer-term impacts of the very large Thailand's 'Million Baht Village Fund' program (governmental microfinance program)
- Access to high quality pre- and postprogram panel data
- Quasi-experiment/ Natural experiment setup leading to cross-household variation in credit-per-household
- What are the effects of the increased credit on total credit, consumption, agricultural investment, income growth?
- What are the general equilibrium effects?
- Next paper asks: What type of model are these findings consistent with?

KT (2012) - Description of the Program

- Big program: 1.5% of GDP in 2001
 - affected 77,000 households
- Valid quasi-experiment, since likely exogenous:
 - Surprise program: Parliament dissolved in November 2000, new government elected in January 2001
 - Variation: each village" received 1 million fund, regardless of village size
- Increased credit 1-for-1, no effect on interest rates

KT (2012) - Description of the Program (cont.)

- Set up quasi-formal micro-lending village fund
- Rules to ensure equal access
- Typical loan: 20,000 baht (\$500), one year loan limits, 2 guarantors, 7 percent nominal interest rate
- Investment or consumption loans (explicitly)

KT (2012) - Data and Outcomes

- Panel survey data from the Townsend Thai dataset.
- Five years (1997-2001) of pre-experiment data, six years (2002-2007) of post-program data.
- Supplement the data with information gathered in informal interviews conducted in the field.
- Four outcome classes:
 - short-term credit, borrowing from other formal sources (i.e., the BAAC and commercial banks); reasons for borrowing and measures of the tightness of credit markets (interest rates, default and informal borrowing).
 - Consumption and its different components: grains, dairy, meat, fuel, clothes, home repair, vehicle repair, eating out, tobacco, alcohol, ceremonies, and education.
 - Income and productive decisions: asset and income growth, and components of net income (agriculture by component, business, and wages/salaries), investment (agricultural and business), and input use (wages paid and fertilizer/pesticides), wages by type of activity
 - Differential impacts on the above variables in female-headed households (Microcredit is often targeted toward women)

- Outcome $y_{n,t}$ for household n at time t depends on the amount of short-term Village Fund credit household receives, $VFCR_{n,t}$.

$$y_{n,t} = \alpha VFCR_{n,t} + \sum_{i=1}^I \beta_i X_{i,n,t} + \phi_t + \phi_n + \varepsilon_{n,t}$$

- X_i : Household control variables such as number of adult males, adult females, children, dummy for male head, age of HH head, age of head squared, years of schooling of the head.
- Time specific effect ϕ_t and household-specific effect ϕ_n .

- Instrument used is the interaction between the inverse number of households in the village ($invHH_n$) and the post-program year dummies, $\chi_{t=t^*}$ for program year t^* .
- First stage regression:

$$VF_{CR_{n,t}} = \lambda_2 invHH_n \times \chi_{t=2002} + \lambda_3 invHH_n \times \chi_{t=2003} + \sum_{i=1}^I \delta_i X_{i,n,t} + \phi_t + \phi_n + e_{n,t}$$

- Orthogonality Assumptions:

$$\begin{aligned} \varepsilon_{n,t}, u_{n,t} &\perp invHH_n \times \chi_{t=2002} | X_{i,n,t}, \phi_t, \phi_n \\ \varepsilon_{n,t}, u_{n,t} &\perp invHH_n \times \chi_{t=2003} | X_{i,n,t}, \phi_t, \phi_n \end{aligned}$$

- α_1 measures an average effect over all households
- If believe that female-headed households are different, consider estimate $\hat{\alpha}_2$ from:

$$y_{n,t} = \alpha_1 VFCR_{n,t} + \alpha_2 VFCR_{n,t} \times \chi_{female,n} + \sum_{i=1}^I \beta_i X_{i,n,t} + \phi_t + \phi_n + \varepsilon_{n,t}$$

(instrument $VFCR_{n,t} \times \chi_{female,n}$ by $\chi_{female,n} \times invHH_n \times \chi_{t=2002}$ or $\chi_{female,n} \times invHH_n \times \chi_{t=2003}$)

- First, check "validity" of instrument (can never fully check, but can get an idea): village size not correlated with many characteristics.

Table 3. Summary: The Impact of Village Fund Credit

| Technique \ Response Variable | New Short-Term Credit Level | Consumption Level | Asset Growth Rate | Net Income Growth Rate |
|--|-----------------------------|--------------------|---------------------|------------------------|
| OLS Regression | 12,800** (1300) | 2200 (2000) | -0.108 (0.277) | 0.116** (0.38) |
| Baseline IV Regression: Only Villages With 50-200 Households | 19,200** (6700) | 17,100** (0.88) | -0.073 (0.163) | 0.737** (0.33) |
| IV Regression using All Villages | 13,800** (3700) | 24,000** (0.63) | -0.210** (0.099) | 0.211 (1.32) |
| IV Regression without 1% Outliers | 13,900** (4600) | 14,700** (5700) | -0.013 (0.014) | 0.699** (0.304) |

Table 7. Impact of Village Fund Credit on Sources of Income

| Technique \ Response Variable | Sources of Income | | | | |
|--|--------------------|--------------------|-----------------|--------------------|--------------------|
| | Business Profits | Wage and Salary | Rice Farming | Other Crops | Livestock |
| OLS Regression | 6900 (4600) | 1800** (0.09) | 1900* (1000) | 4000 (3900) | 1600 (1700) |
| Baseline IV Regression: Only Villages With 50-200 Households | 10,700 (16,100) | 12,500* (6600) | 2100 (5600) | 10,300 (11,400) | 18,900 (20,900) |
| IV Regression using All Villages | 16,400** (7000) | 6600* (3900) | -1000 (2400) | -200 (6300) | 6700 (8300) |
| IV Regression without 1% Outliers | 9700 (13,200) | 12,600** (6500) | 3600 (4000) | -9800 (12,800) | 8800 (6000) |

Table 14. Long Run Impacts

| Response Variable Year | Response Variables | | | | | |
|---------------------------|---------------------|-----------------------------|------------------------|--------------------|------------------|----------------------|
| | Village Fund Credit | New Short-Term Credit Level | Probability in Default | Consumption Level | Log Assets | Level of Net Income |
| Year 1 (2002) | 4900** (2000) | 12,500** (0.55) | -0.075 (0.050) | 9300 (7600) | -- | -- |
| Year 2 (2003) | 9200** (1100) | 15,100** (6700) | 0.096* (0.052) | 14,700 (9100) | 0.043 (0.078) | 36,100** (13,700) |
| Year 3 (2004) | 13,800** (2700) | 29,200** (11,000) | 0.014 (0.065) | 3900 (10,000) | 0.123 (0.083) | -21,200 (17,400) |
| Year 4 (2005) | 16,700** (2300) | 40,800** (12,100) | 0.179** (0.061) | 15,400 (10,500) | 0.027 (0.076) | 23,500 (23,900) |
| Year 5 (2006) | 16,900** (2000) | 46,000** (14,400) | 0.076 (0.058) | -20 (9200) | 0.016 (0.088) | 9600 (13,200) |
| Year 6 (2007) | 9200** (1500) | 17,400** (6900) | 0.184** (0.060) | -5300 (7200) | 0.095 (0.104) | -14,300 (17,700) |

A cautionary tale by Townsend and Urzua (2009)

- Even instrumental variables does not always deliver the effect we are expecting to measure: Townsend and Urzua present a cautionary example (more to come in future lecture).
- IV strategy: use an instrument for participating in the intermediated sector, namely the 'cost of use of financial sector' - here, availability of funds per capita from Village Fund.
- LATE estimate cannot tell you the effect of financial intermediation on entrepreneurs' profits vs. workers' wages because changes in the costs of using the financial sector also change occupational decisions in a non-uniform way and many other margins - point is, unobserved heterogeneity and multiple margins of response matter!
- Effects are non-monotonous when more funds available: reduced form results cannot capture these heterogeneous effects or different channels. LATE does not have a clear interpretation without monotonicity.
- With monotonicity could still at least get total effect for those induced to take up financial services (but not impact on different groups for example).

KT (2011): Overview

Overview of Structural Paper

- Few rigorous, structural estimates of the real returns to microfinance, and how they compare to direct transfer schemes.
- KT use the variation introduced by a large-scale governmental microfinance program 'The Thai Million Baht Village Fund' program.
- Build a dynamic, structural model of credit constrained and buffer-stock building households and estimate it on the pre-program data. Then use post-program data for validating their model.
- Why do we need the structural model here? Many of the impacts in KT (2012) are puzzling without an explicit theory of credit-constrained behavior.
 - HHs increased their borrowing and their consumption roughly one for one with each dollar put into the funds (cannot match with a perfect credit model, such as a permanent income model, given that interest rates did not fall)
 - HHs not initially more likely in default, despite increase in borrowing.
 - Increase in *frequency* of investment, but unclear for level of investment (puzzling if investment is divisible).

KT (2011): What ingredients from data and reduced-form paper need to be captured by model?

- Precautionary savings model to capture uninsured income shocks seen in the data
- Add limited short-term borrowing (with constraints)
- Default exists in equilibrium, so does renegotiation, to match the data.
- Investment is rare but large when it occurs: indivisible, illiquid, high-yield project, with stochastic size process
- Income growth both high and very variable over households.

- Based on standard buffer stock model of savings behavior under uncertainty (Aiyagari (1994), Deaton (1991)) with additional investment option.
- At time $t + 1$, liquid wealth of a household includes the principal and interest on liquid savings from the previous period $(1 + r) S_t$ and current realized income Y_{t+1}

$$L_{t+1} = Y_{t+1} + (1 + r) S_t$$

- Current income consists of permanent component P_{t+1} and transitory one-period shock U_{t+1} :

$$Y_{t+1} = U_{t+1} P_{t+1}$$

- Permanent income:

$$P_{t+1} = P_t GN_{t+1} + RD_{l,t} I_t^*$$

where: first term is a random walk component based on shock with drift G and shock N_{t+1} , $D_{l,t} \in \{0, 1\}$ is a decision of whether to undertake a lumpy investment project of size I_t^* or not.

- Stochastic project size:

$$I_t^* = i_t^* P_t$$

so that project opportunities are increasing in permanent income (consistent with data).

- Liquid savings can be negative, but borrowing is bound by a limit $S_t \geq \underline{s}P_t$. \underline{s} is the key parameter to calibrate the intervention (more credit will make it more negative).
- Household maximizes expected discounted utility:

$$V(L_0, I_0^*, P_0; \underline{s}) = \max_{\substack{\{C_t > 0\} \\ \{S_{t+1}\} \\ \{D_{l,t}\}}} E_0 \left[\sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\rho}}{1-\rho} \right]$$

$$C_t + S_t + D_{l,t} I_t^* \leq L_t$$

where all variables are as defined above.

- Expectations taken over all shocks:
 - N_t is random walk for permanent income: $\log(N_t)$ follows $N(0, \sigma_N^2)$
 - U_t is transitory income shock: $u_t = \log(U_t)$ follows $N(0, \sigma_u^2)$
 - i_t^* is project size relative to permanent income: $\log(i_t^*)$ follows $N(\mu_i, \sigma_i^2)$
- Default: allow for a minimal consumption level $\underline{c}P_t$ and default if consumption would fall lower:

$$\begin{aligned} D_{def;t} &= 1 \text{ if } (\underline{s} + \underline{c}) P_t < L_t \\ &= 0 \text{ else} \end{aligned}$$

in which case policies become: $C_t = \underline{c}P_t$, $S_t = \underline{s}P_t$, $D_{l,t} = 0$.

- Parameters to be estimated: $\{r, \sigma_N, \sigma_u, \sigma_E, G, \underline{c}, \beta, \rho, \mu_i, \sigma_i, \underline{s}\}$
- R is estimated using separate data and procedure.
- σ_E is the variance of a classical measurement error on income with log variance σ_E .
- Use MSM (method of simulated moments) with optimal weighting matrix.
- Use only five years pre-intervention (1997-2001)

- How to deal with heterogeneity? Literature offers two options:
 - Structural modeling to explicitly allow for all sources (or some important ones) of heterogeneity
But these require finite horizon and discretizing the choice variables (i.e., DCDP models presented above)
 - Filter out heterogeneity: standard in the buffer stock literature, to purge business cycle and household variation from data.
- Run regressions of the type

$$\ln \tilde{Z}_{n,t} = \gamma_Z X_{nt} + \theta_{Z,j,t} + e_{Z,n,t}$$

where n indexes households, j region and t time, $\tilde{Z}_{n,t}$ is either of $\tilde{Y}_{n,t}$, $\exp(\tilde{L}_{n,t}/\tilde{Y}_{n,t})$, $\tilde{C}_{n,t}$, $\tilde{D}_{n,t}$, and X_{nt} is vector of household composition variables (adult males, adult females, children, male household head, age, education, and household fixed effect), and $\theta_{Z,j,t}$ is a region-time specific effect to capture business-cycle variation.

- Construct filtered data as:

$$\ln Z_{n,t} = \gamma_Z \bar{X} + \bar{\theta}_{Z,j} + g_Z (t - 1999) + \hat{e}_{Z,n,t}$$

where g_Z is pre-intervention trend of the data and $\hat{e}_{Z,n,t}$ are the residuals.

KT (2011): SMM Intuition

- Without going into full procedure, some intuition for moment conditions used
- Of course, all parameters are identified jointly from all moment conditions, but intuitions are useful:

$$\begin{aligned}\varepsilon_s(X, r) &= \text{Earned_int}_t - rS_{t-1} \\ \varepsilon_{cr}(X, r) &= \text{Owed_int}_t - rCR_{t-1}\end{aligned}$$

where Earned_int_t and Owed_int_t are earned and owed interest on liquid savings/borrowings respectively.

- Need to solve for consumption, investment and default decisions:
 $C(L_t, P_t, I_t^*; \theta)$, $D_I(L_t, P_t, I_t^*, \theta)$, $D_{def}(L_t, P_t; \theta)$. Data is observed on actual decisions C_t , I_t , Def_t and the states L_t and Y_t .
- Define deviations of actual from predicted variables, conditional on the states. By Law of iterated expectations, these deviations should be zero and are used as moment conditions.
- With simulated method of moments: conditional expectation is computed by drawing a series of shocks for U , N and I^* and measurement error E and taking averages.

KT (2011): SMM Intuition

- Income process moments help identify the income process.
- For example; for the drift component G :

$$\varepsilon_g(L_t, Y_t, Y_{t+1}; \theta) = \log(Y_{t+1}/Y_t) - E[\log(Y_{t+1}/Y_t) | L_t, Y_t]$$

- Additional moment conditions: Define

$$\begin{aligned}\varepsilon_C(C_t, L_t, Y_t, \theta) &= C_t - E[C_t | L_t, Y_t] \\ \varepsilon_D(D_{I,t}, L_t, Y_t, \theta) &= D_{I,t} - E[D_{I,t} | L_t, Y_t] \\ \varepsilon_I(D_t, I_t, L_t, Y_t, \theta) &= D_t I_t - E[D_t I_t^* | L_t, Y_t]\end{aligned}$$

then use:

$$E[\varepsilon_C] = E[\varepsilon_D] = E[\varepsilon_I] = 0$$

and in addition:

$$\begin{aligned}E[\varepsilon_C \log Y_t] &= E[\varepsilon_D \log Y_t] = E[\varepsilon_I \log Y_t] = 0 \\ E[\varepsilon_C (L_t/Y_t)] &= E[\varepsilon_D (L_t/Y_t)] = E[\varepsilon_I (L_t/Y_t)] = 0\end{aligned}$$

KT (2011): Prediction and Evaluation

- Million Baht Program modeled as a relaxation of the borrowing limit.
- First evaluate model's predictions for 2002 and 2003, along 5 dimensions: log consumption, investment probability, log investment levels, default probability and income growth.
- Draw series of shocks of U , N and I^* and measurement error from the distributions previously estimated and simulate the paths (500 times). Creates 500 artificial datasets, made of the pre-intervention years and predicted two years.
- Then ask whether reduced-form regressions would yield similar estimates using simulated data versus real data for post-intervention.
- Model performs quite well on post-intervention data
- Important lesson: Same regressions as impact evaluation in reduced-form paper but we need the structural model to interpret those correctly (see next two slides).

KT (2011): Results and Heterogeneity

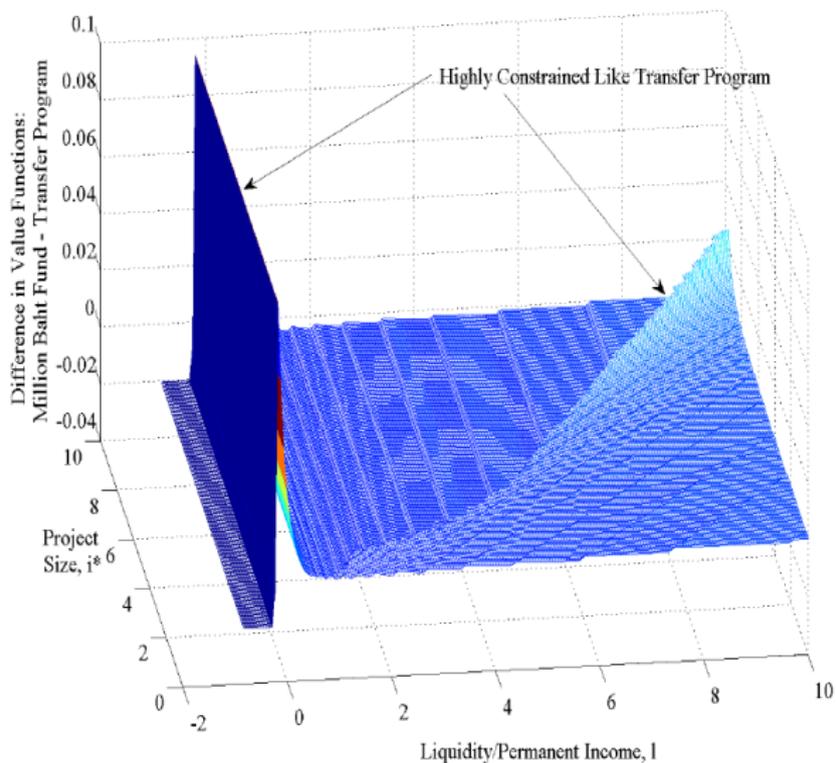
- Find large effects on consumption, but insignificant on investment and structural model can explain why.
- Average coefficients mask a lot of heterogeneity and this is where structural approach is more useful than sufficient statistics one.
- Consider the following figure, with different households being affected differently by the program
- Careful! Coefficients don't tell the full story.
 - Households who differ only in unobservables might respond differently
 - Effects may be nonlinear and time-varying

KT (2011): Results

- Household *i*: would respond to increased borrowing by increasing consumption and borrowing to the limit in response to their lower than expected income
- Household *ii* had higher than expected income and would invest and not be constrained in consumption, and would not need to borrow
- Household *iii*, though not investing will also increase consumption without borrowing by reducing its bufferstock (since it now has a relaxed borrowing constraint)
- Households *i* to *iii* would hence increase consumption, yet are very different, since *ii* and *iii* would not borrow to do so.
- Household *iv*: is in default, no effect on consumption or investment, simply increases indebtedness
- Household *v*: this is the 'target' household of microcredit programs traditionally: would increase investment in response to credit.

- Strength of structural model is that one can perform counterfactual analysis and do welfare calculations.
- Consider counterfactual policy: Pure transfer which also provides additional liquidity.
 - Advantage of Million Baht program: provides more than 1 mill. in potential liquidity since borrowers increase their credit by 1 mill., but nonborrowers also benefit from the increased potential liquidity from the relaxed borrowing constraint in the future. Borrowers have access to more liquidity than equally distributed pure transfer.
 - Disadvantage: liquidity in form of loan, hence interest costs which are high.
- Heterogeneity: Severely constrained households (in default or close) or non-constrained households prefer pure transfer. Constrained households prefer Million Baht Program.
- Compare cost of Million Baht program to transfer program which yields same expected utility.

Million Baht Fund vs. Average Transfer (P=Average Household)



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KT (2011) - Counterfactual and Welfare Analysis (continued)

- Average equivalent transfer per HH is just 7000 baht, (30 % less than the 10,100 baht per HH from Million Baht)
- Masks a lot of heterogeneity: 10% value program at 16,200 baht or more, other 10% value it at 900 baht.
- Only 24% value program more than its cost.
- Many HHs benefit disproportionately from program because of increased liquidity, but most benefit much less because of interest cost.

KT (2011): Summary

- Combine theory (precautionary savings model with indivisible investments) and policy experiment to evaluate micro finance
- Findings:
 - Short-lived increases in consumption for most
 - Increases in investment and permanent increases in consumption for small share
- Intuition: as in Aiyagari model:
 - Relax borrowing constraints \rightarrow increase consumption \rightarrow until drive down precautionary savings
 - Now add indivisible, high yield investment: Agents with high savings make high yield investment
 - Relax borrowing constraints \rightarrow those near threshold increase investment \rightarrow increase future income \rightarrow increase consumption
- Structural Model greatly useful to:
 - Interpret results (which might have been a bit obscure in reduced form)
 - Quantitative predictions, counterfactuals, and evaluation
 - Experiments can be used to test structural models

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Spring 2013

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