Matching for Credit: Implications for Econometric Analysis and Market Design

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Motivation: one-sided matching

Economists often observe data on interactions...

- which students teamed up in study groups;
- which characters formed entrepreneurial teams;
- which firms merged with each other.

Example 1: Rules on inter-cultural mix of an organisation

1. **direct effect**: Do communication problems outweigh the synergies within mixed teams?
2. direct effect is net of **sorting bias**: Are open-minded workers more likely to sort into mixed teams?
3. **participation effect**: Does the applicant pool change if the management stipulates mixed teams?

Motivation: microcredit

Lending to the poor without any financial securities

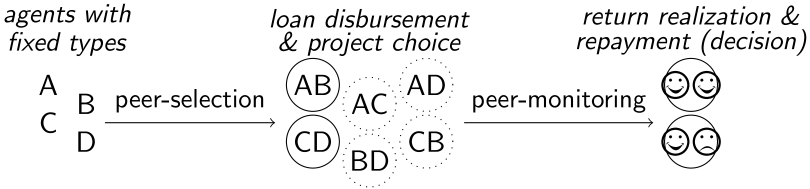
- 2005: UN declared "International Year of Microcredit"
- 2006: Muhammad Yunus awarded Nobel Peace Prize
- 2010: First IPO of Indian microfinance institute SKS

Enabled by innovation in contract design

- high screening, monitoring and enforcement costs
- joint-liability delegates responsibilities to self-selected groups
- But: groups avoid liability payments if projects fail concurrently

$\rightarrow$ Is there a role for rules to diversify groups?

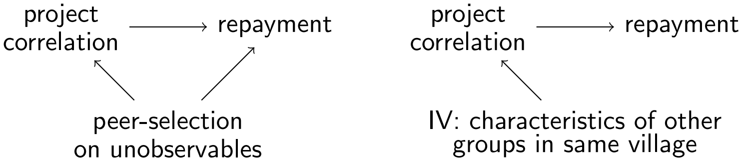
Example 2: Group lending (sequence of events)



Market design question

Should MFIs prevent the grouping together of borrowers who are exposed to similar income shocks?

Econometric problem and identification strategy



Contributions

Empirical work

- ambigous empirical results: three studies find a negative effect and one – Ahlin/Townsend (2007) – finds the opposite
- sorting bias is well recognised in literature, but experimental studies fail to estimate policy-relevant parameters
- current paper is the first to simultaneously account for group selection and outcomes with credible exclusion restriction

Theoretical models of joint-liability lending

- this is not a paper that considers what is the optimal contract. Instead, it informs the optimal design of market rules
- it develops the key trade-offs of conflicting predictions of asymmetric information models in Ahlin/Townsend (2007) and Ghatak (2000)

Outline

Model set-up (Stiglitz/Weiss 1981)

Agents and projects

- risk neutral agents with no collateral invest in ind. projects
- inherently different prob. of success, $p \in [\underline{p}, 1]$
- same expected returns, i.e. $p \cdot y(p) = E$
- project covariation modelled by adding/subtracting const. $\bar{\epsilon}$

	j succeeds (p_j)	j fails ($1 - p_j$)
i succeeds (p_i)	$p_i p_j + \bar{\epsilon}$	$p_i(1 - p_j) - \bar{\epsilon}$
i fails ($1 - p_i$)	$(1 - p_i)p_j - \bar{\epsilon}$	$(1 - p_i)(1 - p_j) + \bar{\epsilon}$

Information and contract

- agents know each others' risk-type, p, but lender does not
- pooling contract with fixed interest payment, r
- liability payment, q, is due if group member's project fails

$\rightarrow$ Expected payoff: $u_i = E - rp_i - q[p_i(1 - p_j) - \bar{\epsilon}]$

Participation effect

Expected payoff of agent i matching with agent j

- $u_i = \underbrace{E}_{return} - \underbrace{rp_i}_{interest} - \underbrace{q[p_i(1-p_j) - \bar{\epsilon}]}_{joint\ liability}$

Matching on risk type (Ghatak 1999) and credit rationing

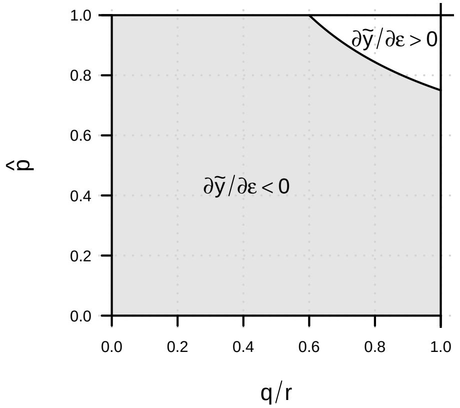
- homogenous matching in equilibrium, thus $p_i = p_j$
- cut-off type $\hat{p}$ solves participation equation with equality
$$E - r\hat{p} - q[\hat{p}(1-\hat{p}) - \bar{\epsilon}] = \bar{u}.$$
- i.e. credit is rationed for agents with projects safer than $\hat{p}$.

Repayment effects of increased project covariation $\bar{\epsilon}$

+ draws safer types into the portfolio (Ahlin/Townsend 2007)
− but overall, does not offset loss of liability payment (this paper)

Participation effect (cont'd)

Conditions for positive repayment effect of project correlation for uniform distribution of risk type



$\rightarrow \partial\tilde{y}/\partial\epsilon < 0$ if $\hat{p} < 0.75$ or $q/r < 0.6$

Outline

Empirical strategy: direct effect

Sorting bias: Let a group's expected repayment be given as

$$Y_{ij} = 1[Y^* > c] \text{ with: } Y^*_{ij} = \beta_0 + \beta_1 \cdot \gamma_i \gamma_j + \delta \cdot (d_i + d_j) + \zeta_{ij}. \quad (1)$$

If $(d_i + d_j)$ is unobserved, then $\hat{\beta}_1^{ols}$ is biased upwards when $\delta < 0$ and cov($\gamma_i \gamma_j$,$(d_i + d_j)$) $<$0.

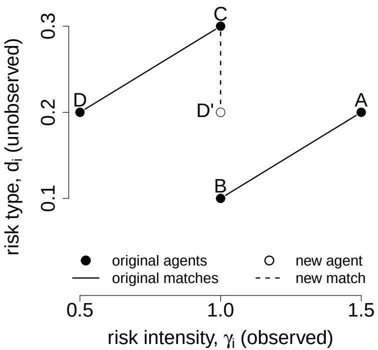
Empirical strategy: Estimate unobserved group risk as a residual in the matching model

$$D_{ij} = 1[V_{ij} \in \Gamma_\mu] \quad \text{with:} \quad V_{ij} = \alpha \cdot \gamma_i \gamma_j + (d_i + d_j)$$

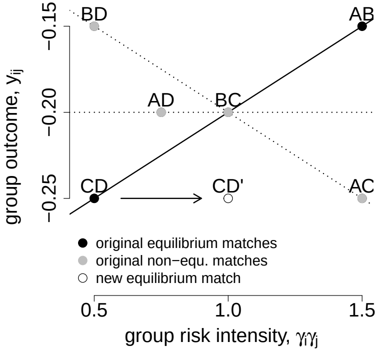
and selection-correct repayment equation (1).

Identification

(a) One-sided matching and exogenous variation



(b) Regression bias and resolution with exogenous variation

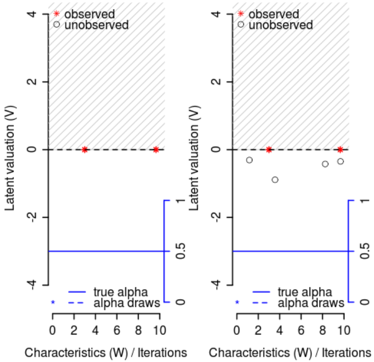


→ Recall: $Y_{ij} = \delta \cdot (d_i + d_j)$

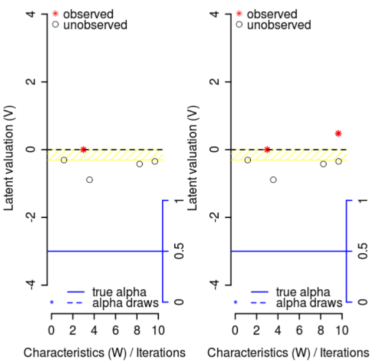
Estimation: Gibbs sampler for matching model

Matching estimator (illustrated)

(a) Draw match valuations for unobserved groups

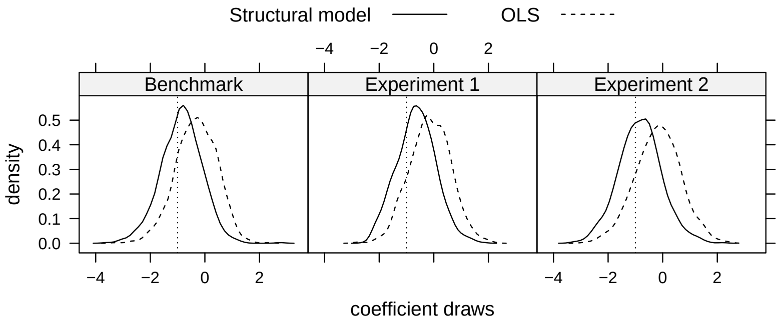


(b) Draw match valuations for 1st observed group



Monte-Carlo simulations

Posterior distributions of parameters for 40 two-group markets based on 1,000 draws. True slope parameter $\beta = -1$.



Benchmark: All members (6/6); all counterfactuals (922/922)
Experiment 1: 5 randomly sampled group members
Experiment 2: 250 randomly sampled counterfactual groups

Outline

Data

Robert M. Townsend (2000) data on BAAC groups in Thailand

- BAAC is largest lender in rural Thailand
- 39 villages from 2 regions randomly sampled with stratification
- in every village, as many BAAC groups as possible were surveyed, up to two: 68 groups and 316 borrowers in total

Variables

- *wst*: coincidence of economically bad years
- $p_i p_j$: interaction of groups' project success probability, with

$$p_i = \frac{E_i - L_i}{H_i - L_i}$$

based on borrower i's expected income in an average year E_i, good year H_i and bad year L_i.

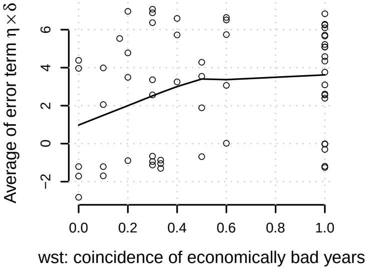
	Probit 1	Probit 2	Structural
Outcome equation			
Response: repayment_outcome = 1 if group never repaid late			
Risk type			
- success_prob p_i	–	+1	+1
- success_prob_int $p_i p_j$	–	0.238 (1.606)	1.571 (1.813)
Project covariation			
- same_worst_year *wst*	0.170 (0.289)	-0.015 (0.219)	-0.586 (0.243)**
Controls			
- loan_size	–	0.263 (0.421)	0.970 (0.362)**
- loan_size_sqrd	–	-0.050 (0.088)	-0.187 (0.080)*
- ln(group_age)	-0.040 (0.054)	-0.116 (0.161)	-0.395 (0.109)***
- FE for two-group vill's	YES	YES	YES
	N=68	N=68	N=68
Matching equation			
Response: group observability indicator = 1 if group is observed			
Risk type			
- success_prob_int $p_i p_j$	–	–	-0.778 (0.992)
Project covariation			
- same_worst_year *wst*	–	–	0.356 (0.119)**
	–	–	N=5,342
Variance			
covariance δ	–	–	0.512 (0.127)***

*S.E. in parentheses; one-sided significance at 0.1, 1, 5, 10% denoted by ***, **, *, and .*

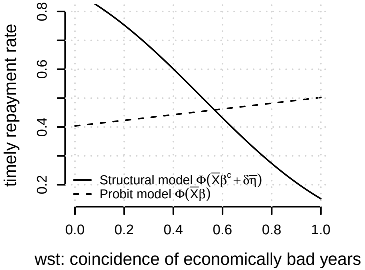
Direct effect: Probit vs. structural model

Decomposition of sorting bias and direct effect.

(a) Equilibrium groups with high project covariation have better unobservables



(b) Probit predictions (dashed line) comprise direct effect (straight line) and sorting bias



→ A one s.d. increase in *wst* has two opposing effects.

1. drop in prob. of timely payment by 22 percentage points (p.p.).
2. groups have observables and unobs. that are on avg. 28 p.p. safer.

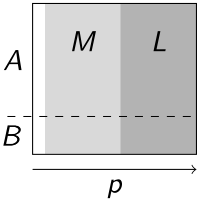
Direct effect: Assumptions

Preferences

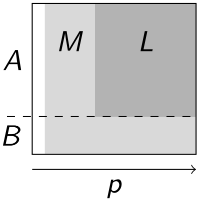
- aligned in risk type $p \in [0.5, 1)$, in that borrowers always prefer a safer partner (irrespective of their own type), but also
- assortative in exposure type $s \in \{A, B\}$, in that borrowers only value partners of their own type.

Matching on risk type (horizontal axis) and exposure type

(a) Aligned preferences I



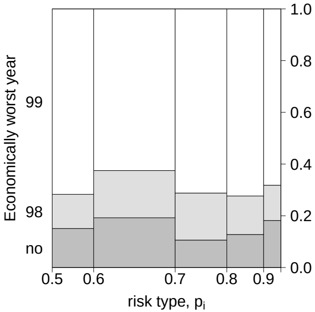
(b) Aligned preferences II



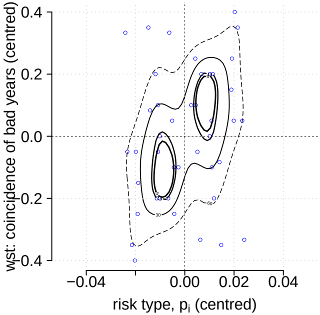
Direct effect: Assumptions (cont'd)

Validation of assumptions underlying the matching model

(a) Assumption of independence $p \perp s$



(b) Assumption of aligned preferences



Conclusion

Empirical analysis of endogenous groups

- distinction between participation and direct effect allows test of ex-ante versus ex-post mechanisms
- useful where evaluation of adverse selection models requires that moral hazard effects are not in force, and vice versa
- method is implemented in R package matchingMarkets

Economic theories of microfinance

- theories must consider that matching also takes place on other dimensions – such as common shocks – with adverse effects

Microfinance practice

- group lending clients – about 65 million worldwide – could benefit if lenders were to actively diversify borrower groups