Optimal (Partial) Group Liability in Microfinance Lending

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Motivation

- Microfinance lending has been heralded as an important instrument in poverty alleviation (Morduch 1999)
- There are now over 70 million microfinance clients worldwide, making microcredit the most common source of credit for household enterprises (de Mel, McKenzie, and Woodruff 2008)
- Much of the success of microfinance has been credited to group liability, whereby borrowers are responsible for their borrowing group members' failed loans (Aghion and Morduch 2005)

Group Liability versus Individual Liability

- Possible advantages of group liability lending:
  - Reduces adverse selection and moral hazard (Ghatak and Guinnane 1999)
  - Creates incentives for within group risk sharing (Besley and Coate 1995)
- Possible disadvantages of group liability lending:
  - Dissuades the lowest risk individuals from borrowing (Giné and Karlan 2009)
  - Can result in strategic default (Besley and Coate 1995)
- Limited empirical evidence finds no difference in default between group liability and individual liability borrowers (Giné and Karlan 2009)
- So far, the debate has ignored a third possibility: partial group liability

This Paper

- Develops a group borrowing model incorporating partial group liability
- Demonstrates the existence of a partial group liability that minimizes default rates
    - Group liability creates incentives for intra-group transfers to cover fellow member's bad shocks
    - Too much group liability can lead to strategic default
- Extends the basic model in two ways to disentangle strategic default from correlated returns to borrowing
- Structurally estimates both model extensions to determine the *de facto* group liability enforced by individual loan officers
- Shows that the estimated loan officer-specific liabilities predict default rates out of sample in a way consistent with the model
    - Suggests partial liability of about 75% could substantially reduce the incidence of default

Outline of Talk

- Model
  - Basic Model
  - Extension #1: Household Structure
  - Extension #2: Group Size
- Data
- Results
  - Structural Estimation of the Model
  - Partial Group Liability and Default
- Conclusion

Setup

- Similar to (Besley and Coate 1995)
- Two risk-neutral borrowers i and $g(i)$
- Each takes out a loan that costs I to repay
- Realized returns to borrowing R_i and $R_{g(i)}$ are stochastic and possibly correlated
  - R_i and $R_{g(i)}$ known to i and $g(i)$, but not the lender
  - R_i and $R_{g(i)}$ independent of effort, i.e. no moral hazard
  - R_i and $R_{g(i)}$ have same mean μ and variance σ^2, i.e. no adverse selection
  - $\mu > \frac{I}{\beta}$, where $\beta < 1$ is the time discounting factor
- Once R_i and $R_{g(i)}$ are realized, members can transfer returns to each other

Group Liability

- Limited liability: if a borrower defaults, her only penalty is the inability to borrow in the future
  - No direct penalty from MFI consistent with empirical setting
  - Ignores potential social sanctions against defaulters
  - Let βV be value to borrower of being eligible to borrow in future
- Group liability: if $g(i)$ defaults but i repays, then i incurs a penalty $P \in [0, I]$
  - $P = 0 \Leftrightarrow$ Individual liability
  - $P = I \Leftrightarrow$ Full group liability
  - $P \in (0, I) \Leftrightarrow$ Partial group liability

Timing of each Borrowing Period

1. Eligible individuals choose whether or not to borrow
2. Those choosing to borrow are paired with a group member and returns R_i and $R_{g(i)}$ are realized
3. Returns are observed and transfers are made
4. Group members simultaneously decide whether or not to repay their loans
5. Repayers repay I (plus P if their group member defaulted) and remain eligible to borrow in the future period. Defaulters become ineligible to borrow in future periods. All borrowers get to keep their returns from borrowing.

Equilibrium

- All eligible borrowers choose to borrow
- Transfers are only made if they allow group member to repay
- Maximum transfer a borrower is willing to make is $T^* \equiv \min\{P, \beta V - I\}$
- If group member defaults, borrower will repay only if $\beta V - I \geq P$, if $\beta V - I < P$, borrower will strategically default
- Hence $P^* \equiv \beta V - I$ minimizes default rates
- Can show that following equation implicitly defines P^*

$$P^* = \frac{\beta\mu - I}{1 - \beta \Pr(i \text{ and } g(i) \text{ repay})}$$

- Goal of remainder of paper: estimate P^*

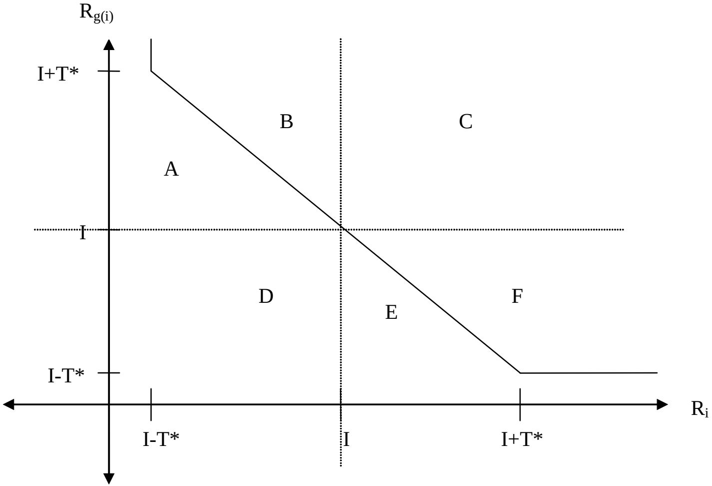

Figure: Group Member Returns and Default

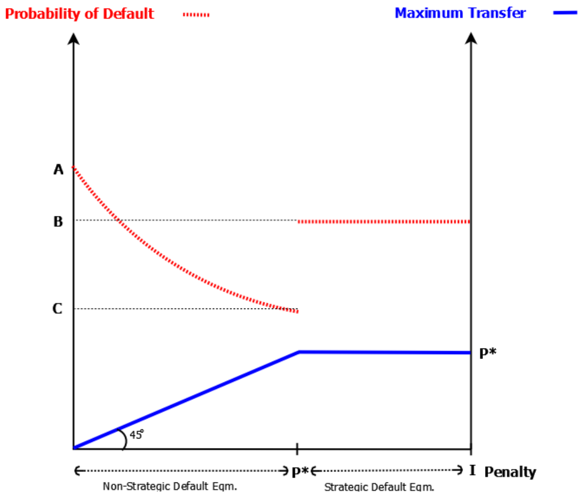

Figure: Effect of Group Liability on Transfers and Probability of Default

Inability to Identify Model Parameters

- Suppose we only observe whether or not each group member defaults
  - Four possible outcomes: $\{repay, default\}_i \times \{repay, default\}_{g(i)}$
- Model is parameterized by μ, σ^2, ρ, and P after normalizing cost of borrowing to 1 and assuming a MVN distribution of returns
- Hence, model is underidentified
- Intuition: observing that when one group member defaults, the other always defaults as well could be either because of strategic default or highly correlated returns to borrowing
- Need to extend the basic model to disentangle strategic default from correlated returns

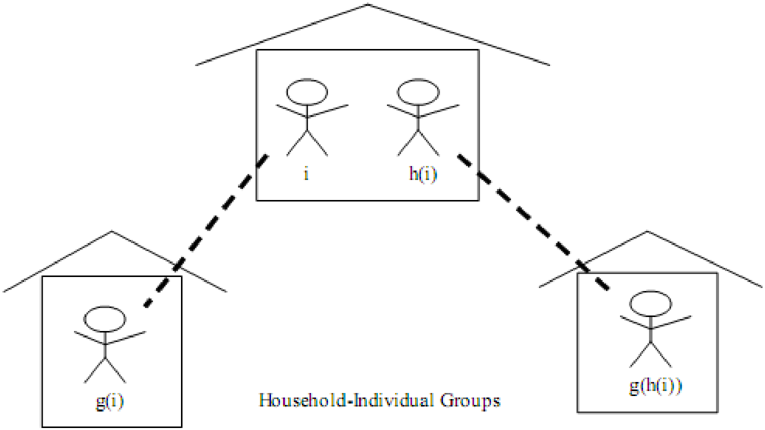

Figure: Household-Individual Group Structure

Household Structure

- Consider two individual who live in the same household, i and $h(i)$, where each is in a separate borrowing group with $g(i)$ and $g(h(i))$, respectively
- Assume i and $h(i)$ pool their returns to borrowing
- Can map $\left(R_i + R_{h(i)}, R_{g(i)}, R_{g(h(i))}\right) \in \mathbb{R}^3 \to \{repay, default\}_i \times \{repay, default\}_{h(i)} \times \{repay, default\}_{g(i)} \times \{repay, default\}_{g(h(i))}$
- Now observe 16 possible outcomes (14 of which have positive probability of occuring) and, given MVN, model is parameterized by only six unknowns $(\mu, \sigma^2, \rho_{i,h(i)}, \rho_{i,g(i)}, \rho_{g(i),g(h(i))}, P)$
- Intuition: can disentangle correlated returns from strategic default by examining how i's response to defaults by $g(i)$ and $g(h(i))$ differs.

Group Size

- Difficult to extend model to more than 2 borrowers, since the model gets exponentially more complicated
- Simplication: each group member treats the rest of the group like they are pooling their returns
- Assume that in a group of $N+1$ members, if k members default, then the penalty each repayer pays is $\frac{k}{N+1-k}P$
- As in simple model, will repay if $\beta V - I \geq \frac{k}{N+1-k}P$
- Then $\exists$ k^* such that $\beta V - I \geq \frac{k^*}{N+1-k}P$ and $\beta V - I < \frac{k^*+1}{N-k^*}$, i.e. k^* is the maximum number of defaulters a borrower is willing to tolerate before she strategically defaults
- Intuition for identification: if P is high, then k^* will be low, so we should observe either one or two members in a group defaulting or the entire group defaulting, not some intermediate value

Table: Observed Composition of Defaults by Group Size

	Number of Members in Borrowing Group						
Defaulting members	2	3	4	5	6	7	8
1	14.08%	13.93%	7.81%	6.90%	0%	14.29%	0%
2	85.92%	7.38%	6.25%	6.90%	5.26%	0%	0%
3		78.69%	3.13%	0%	0%	0%	0%
4			82.81%	0%	0%	0%	0%
5				86.21%	0%	0%	0%
6					94.74%	0%	0%
7						85.71%	0%
8							100.00%

Each column is a different group size. Each row indicates the number of group members that defaulted (conditional on there being one default). Full sample.

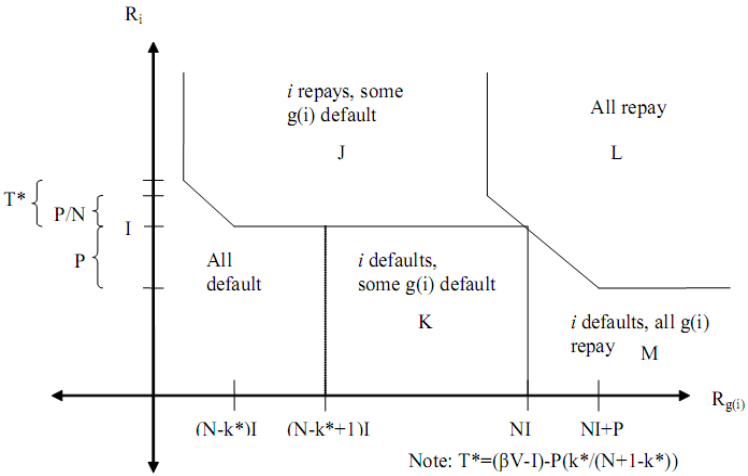

Figure: Default and Returns in Multiple Member Borrowing Groups: $(\beta V - I)\,\frac{N-k^*}{k^*+1} < P < (\beta V - I)\,\frac{N+1-k^*}{k^*}$

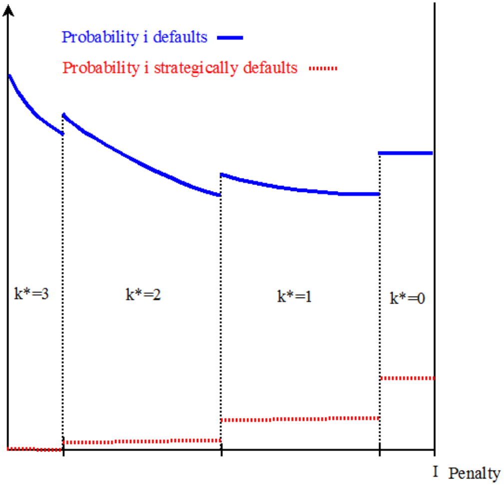

Figure: Effect of Group Liability on Default in Groups with Multiple Members

Data

- Administrative data from a large MFI in southern Mexico
- 30,000 loans across 17 branches and 84 loan officers
- But very little information on the characteristics of the borrowers

Table: Summary Statistics for all Group Loans

Variable	Mean	(Std. Dev.)	Min.	Max.
Default	0.045	(0.207)	0	1
Age	38.612	(11.44)	13.933	87.441
Sex (1=male)	0.181	(0.385)	0	1
Loan Amount (pesos)	10036.727	(12145.261)	384.61	260000
Tenure with Bank (weeks)	51.208	(33.35)	4.429	311.143
Interest Rate (annual)	0.461	(0.052)	0	1.725
Loan Length (weeks)	28.417	(6.295)	3.714	107.571
Group Size	4.472	(3.437)	2	31
N		33772		

Table: Summary Statistics for Household-Individual Groups

Variable	Mean	(Std. Dev.)	Min.	Max.
Default	0.036	(0.186)	0	1
Age	38.691	(11.918)	18.209	82.188
Sex (1=male)	0.183	(0.387)	0	1
Loan Amount (pesos)	9666.183	(8903.115)	763.070	101680
Tenure with Bank (weeks)	48.287	(29.625)	13.857	172.286
Interest Rate (annual)	0.457	(0.046)	0	0.565
Loan Length (weeks)	27.733	(3.836)	13.857	54.143
Group Size	5.036	(3.993)	2	27
N		1782		

Group Liability

- Officially, if a group member defaults, the entire group is dissolved and each borrower gets "restructured" into an individual loan
- But branches and individual loan officers had a great deal of autonomy
- Q: "If someone in your group fails to pay, can the group still take out another loan?"
  - "Clients cannot continue with another loan unluss they give an appropriate rationale" (General Director)
  - "The group can't get another loan until the restructured loan is paid. But there are always exceptions." (Branch Manager A)
  - "Yes, everyone can. It depends on the reaons the individual failed to repay. The goal is that the client does not leave." (Branch Manager B)
- Exploiting this variation in *de facto* group liability, I estimate loan officer-specific values of P, $\hat{P}_o$

Structural Estimation

- Households-Individual sample: individuals living at the same address in the same town who have overlapping loans with different borrowing groups
- For household structure extension, other group members are treated as a single individual, i.e. $g(i)$ is considered to have defaulted if any group member defaulted (similar for $h(i)$ and $g(h(i))$)
- For group size extension, account for the number of other group members who defaulted and the size of the group
- Assume returns have a multivariate normal distribution
- Within the household-individual sample, use ML to estimate the model parameters and the loan officer specific penalties to most closely match the observed combinations of defaults
- Do this separately for the household structure extension and the group size extension

Table: STRUCTURALLY ESTIMATED MODEL PARAMETERS

	Household Structure		Multiple Group Members	
	Estimate	SE (x10^9)	Estimate	SE (x10^9)
Mean Returns to Borrowing	1.267	0.005	1.446	0.029
Variance of Returns to Borrowing	0.101	0.031	0.384	0.014
Correlation between group members	0.001	0.083	0.381	0.008
Correlation between household members	-0.001	0.022	N/A	N/A
Correlation between g(i) and g(h(i))	-0.031	0.161	N/A	N/A

Intepreting the Structural Estimates

- Given observed interest rates, suggests gross monthly returns to borrowing of 11% (household-individual) to 15.5% (group size), similar to experimental findings (de Mel, McKenzie, and Woodruff 2008)
- High variance suggests that 20% (household-individual) to 23.6% (group size) of the time, individuals incurred negative returns (net of interest) on their loans.
- Household-individual estimates suggest that $P^* = 0.8733$. Yet $\hat{P}_o > P^*$ for 45 of the 58 loan officers (68% of loans) in the sample, suggesting the incidence of strategic default is high.
- Estimates of P_o was highly correlated (0.88) across the two estimation strategies.

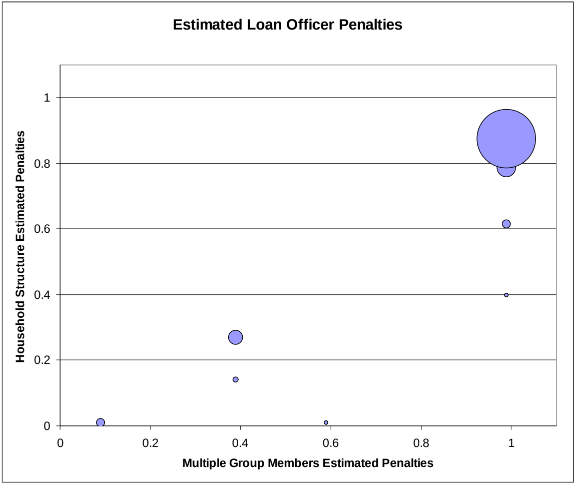

Figure: Estimated Loan Officer Specific Group Liabilities

Predicting Default Rates

- To what extent is $\hat{P}_o$ able to predict default rates out of sample, i.e. for loans that the loan officer l oversaw that were not in the household-individual sample?

$$D_n^o = \alpha + \gamma_1 \hat{P}_o + \gamma_2 \hat{P}_o^2 + X_n \beta + \varepsilon_n \quad (1)$$

- The basic model and extensions suggest a U-shaped relationship between P and default rates, i.e. $\gamma_1 < 0$ and $\gamma_2 > 0$.
- Discussions with the MFI suggested that borrowers were (somewhat) randomly assigned to loan officers within a given branch
  - Hence, by including branch fixed effects, plausible that $E\left(\hat{P}_o \varepsilon_n\right) = 0$
  - However, branch fixed effects severely curtail the variation in $\hat{P}_o$
- Can correct for (classical?) measurement error in $\hat{P}_o$ by instrumenting for the $\hat{P}_o$ estimated by the group size extension with the $\hat{P}_o$ estimated by the household structure extension

Table: Loan Officer Penalties and Default Rates (out of sample)

	(1) HH	(2) HH	(3) HH	(4) Group	(5) Group	(6) Group	(7) IV	(8) IV	(9) IV
Loan Officer Penalty	-0.614***	-0.643***	-0.337***	-0.157	-0.046	0.467**	-1.833***	-1.864***	-0.441
	(0.082)	(0.086)	(0.088)	(0.143)	(0.141)	(0.200)	(0.298)	(0.302)	(0.652)
Loan Officer Penalty	0.561***	0.593***	0.250***	0.092	0.009	-0.476***	1.397***	1.424***	0.259
(squared)	(0.071)	(0.075)	(0.078)	(0.110)	(0.108)	(0.172)	(0.220)	(0.224)	(0.537)
Constant	0.145***	0.279***	0.136*	0.096***	0.139**	0.053	0.477***	0.554***	0.195
	(0.020)	(0.053)	(0.079)	(0.036)	(0.063)	(0.087)	(0.080)	(0.093)	(0.126)
Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Branch Fixed Effects	No	No	Yes	No	No	Yes	No	No	Yes
Year Fixed Effects	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Observations	25643	25643	25643	25643	25643	25643	25643	25643	25643
R-squared	0.015	0.043	0.086	0.002	0.030	0.085	.	.	0.076

Borrowing-group clustered standard errors reported in parentheses. Controls include age, sex, loan amount, tenure with bank, interest rate, loan length, and group size. HH columns use the loan officer penalties structurally estimated by incorporating household structure. Group columns use the loan officer penalties structurally estimated by incorporating group size. IV columns instrument for the penalties estimated using group size with the penalties estimated using household structure. Stars indicate statistical significance: * $p<.10$ ** $p<.05$ *** $p<.01$

Table: Loan Officer Penalties and Default Rates (in sample)

	(1) HH	(2) HH	(3) HH	(4) Group	(5) Group	(6) Group	(7) IV	(8) IV	(9) IV
Loan Officer Penalty	-1.507***	-1.470***	-0.966**	4.981*	5.039*	4.101**	17.119*	15.782**	0.000
	(0.432)	(0.419)	(0.428)	(2.785)	(2.671)	(1.935)	(8.920)	(7.945)	(0.038)
Loan Officer Penalty	1.279***	1.242***	0.686**	-3.670*	-3.710*	-3.170**	-12.361*	-11.412**	-0.362*
(squared)	(0.361)	(0.352)	(0.347)	(2.012)	(1.929)	(1.410)	(6.458)	(5.751)	(0.212)
Constant	0.382***	0.477***	0.212	-1.303*	-1.259*	-1.053*	-4.800*	-4.301*	0.253
	(0.108)	(0.127)	(0.169)	(0.786)	(0.752)	(0.557)	(2.501)	(2.223)	(0.177)
Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Branch Fixed Effects	No	No	Yes	No	No	Yes	No	No	Yes
Year Fixed Effects	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Observations	1782	1782	1782	1782	1782	1782	1782	1782	1782
R-squared	0.051	0.066	0.117	0.041	0.061	0.125	.	.	0.101

Borrowing-group clustered standard errors reported in parentheses. Controls include age, sex, loan amount, tenure with bank, interest rate, loan length, and group size. HH columns use the loan officer penalties structurally estimated by incorporating household structure. Group columns use the loan officer penalties structurally estimated by incorporating group size. IV columns instrument for the penalties estimated using group size with the penalties estimated using household structure. Stars indicate statistical significance: * $p<.10$ ** $p<.05$ *** $p<.01$

Results

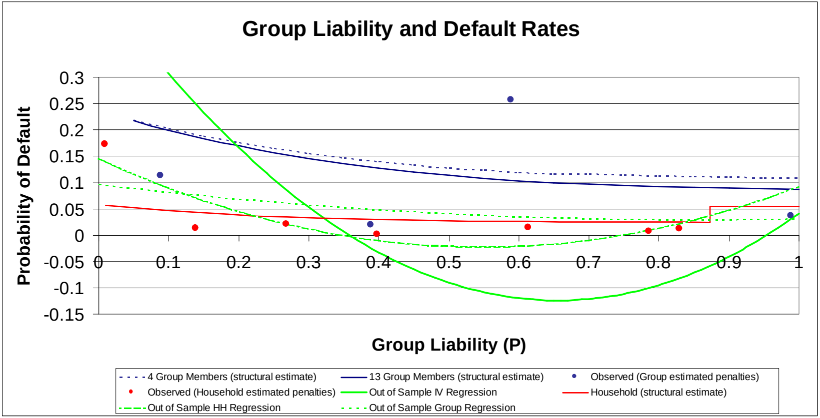
Group Liability and Default Rates
Probability of Default
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Group Liability (P)
4 Group Members (structural estimate)
13 Group Members (structural estimate)
Observed (Group estimated penalties)
Observed (Household estimated penalties)
Out of Sample IV Regression
Household (structural estimate)
Out of Sample HH Regression
Out of Sample Group Regression

Table: Estimated Optimal Group Liability

Methodology	Optimal Liability	Reduction in Default:	
		Optimal Liability	75% Liability
Structural Estimates			
Household-Individual	87.33%	2.96%	2.91%
Multiple Group Members	100.00%	0.00%	-0.68%
Out of Sample Regressions			
Penalties estimated using Household-Individual Model			
No controls	54.73%	11.51%	9.20%
Controls	54.22%	11.51%	9.20%
Branch FE	67.56%	12.42%	9.86%
Penalties estimated using Multiple Group Members Model			
No controls*	67.56%	0.19%	0.10%
Controls*	85.41%	0.20%	0.10%
Branch FE	100.00%	0.00%	-0.75%
IV regressions			
No controls	65.58%	16.55%	15.31%
Controls	65.45%	17.01%	15.71%
Branch FE*	85.00%	0.58%	0.32%

Astericks indicate the estimated coefficients were statistically insignificant. "Reduction in Default" columns report the estimated decline in default rates (in percentage points) from full group liability.

Conclusion

- The paper developed a tractable model of partial liablity group borrowing
  - Increasing group liability increases the willingness of borrowers to cover group members in the case of low returns
  - But increasing liability too much will lead to strategic default
- Structural estimates of two extensions of the model estimate high but variable returns to borrowing, similar to experimental findings
- Exploiting the variation in de facto group liability across loan officers, this paper shows the predicted U-shaped relationship between liability and default rates
- Structural estimates and reduced form regression results suggest that moving to 75% group liability could substantially reduce the incidence of default

Next Steps

- Replicating the results in other settings
  - Structurally estimation only requires observing group size and individual default
- Experimental variation in P
  - Relying on variation across loan officers in P begs the question why such variation exists
  - Could be that loan officers have closer to optimal P because they are better loan officers on other dimensions
  - Randomly assigning P overcomes such concerns

Thank you!

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