Group-lending with sequential financing, contingent renewal and social capital Prabal Roy Chowdhury

Presentation by Avantika Pal

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Objective

- This paper focuses on the dynamic aspects of group-lending.
- In particular, it analyses how effective sequential financing and contingent renewal are in harnessing social capital.
- It shows how under appropriate parameter configurations, there is homogenous group-formation so that the lender can ascertain the identity of a group without lending to all its members, thus screening out bad borrowers partially

Motivation

- Aghion and Morduch (2005) argue that today joint liability is only one of the elements that differentiate micro-finance from traditional banking, thus arises a need to focus on two other dynamic schemes- sequential financing and contingent renewal.
- In reality micro-lending institutions do not always enforce joint liability.
 - Loan officers in Asia and Latin America, for example, say that they see no reason to punish everyone for the actions of a single person (Aghion and Morduch, 2005)
 - In case of default, the original Grameen idea was not that group-members would have to pay for others, but rather that they would be cutoff from future loans.
 - Some recent group-lending schemes, e.g. ASA in Bangladesh and even the Grameen, have seen a move away from strict joint liability.

Key Definitions

Sequential Financing

In every round, the members of the selected group receives loans in a staggered manner.

e.g In the Grameen Bank with groups of five members each, loans are sequential in the sense that these are initially given to only two of the members (to be repaid over a period of 1 year). If they manage to pay the initial installments, then, after a month or so, another two borrowers receive loans and so on.

Key Definitions

Contingent Renewal

In case of default by a group, no member of this group ever receives a loan in the future. Moreover, in case of repayment, there is repeat lending.

Social Capital

- Takes the form of mutual help in times of distress, mutual reliance in productive activities, status in the local community, etc.
- Social penalties may also take the form of a reduced level of cooperation, or even admonishment.

- The market consists of many borrowers, such that their mass is normalized to one
- Borrower i can invest in one of two projects, P¹_i or P²_i.For every i
 - P_i^1 has a verifiable income of H and no non-verifiable income.
 - P_i^2 has no verifiable income and a non-verifiable income of b where 0 < b < H
- The sets of projects are different for different borrowers. While the borrowers know the identity of their own projects, they do not know the identity of the other borrowers projects.
- In every period, the borrowers consume all their income in that period.

- All projects require an initial investment of 1 dollar.
 - Since none of the borrowers have any funds, they have to borrow the required 1 dollar from a bank. The loan can be taken either individually or as a group.
 - The bank also does not know the identity of the projects, so that there is a moral hazard problem.
 - For every dollar loaned, the amount to be repaid is $r(\geq 1)$, where r is exogenously given.
- For the project to be profitable for the borrowers, it must be that H > r. For simplicity, we assume that H ≤ 2r, so that r < H ≤ 2r.

- A fraction $0 \le \theta \le 1$ of the borrowers have a social capital of
 - s (> 0), whereas the other borrowers have no social capital.
 - The borrowers with social capital are denoted by S, whereas the other borrowers are denoted by N.
 - The social penalty involves a loss of this social capital.
 - An S type borrower taking a group-loan is assumed to lose her social capital if she defaults and,moreover, this default affects the other group-member.
 - The social penalty is anonymous in the sense that it is imposed irrespective of whether the default affects an S type or an N type borrower.
- The borrowers all know one anothers types, but the bank does not.
- We assume that the magnitude of the moral hazard problem, quantified by b, is not too small.
- Time is discrete so that t = 0, 1, 2, ...
- $0 < \delta < 1$ denotes the common discount factor of all the agents, the borrowers, as well as the bank.

Assumption 1 : H - r < b

Suppose that a borrower has taken a loan of 1 dollar. If the borrower is of type N, then she will prefer to invest in her second project.

Assumption 2: H - r > b - s

Type S if invests in her second project, she obtains a non-verifiable income of b, but if loses her social capital, her net payoff is b-s, thus the borrower will prefer to invest in her first project.

Group-lending without Sequential Financing

Consider the following infinite horizon game.

- **Period 0**: Endogenous group-formation
 - The borrowers organize themselves into groups of two of the three types- SS, NN and SN.
 - We assume that the group-formation process follows the **optimal sorting principle** in the sense that borrowers from different groups cannot form a new group without making some member of the new group worse off.

- For every $t \ge 1$, there is a two-stage game.
 - **Stage 1:** The bank randomly selects one of the groups as the recipient and lends it two dollars which are divided equally among the two members of the selected group.
 - **Stage 2:** Both the borrowers then simultaneously invest 1 dollar into one of their two projects.
 - If the *i*th borrower invests in *P*¹_{*i*}, she has a payoff of H-r; otherwise, she has a payoff of b.
 - Given the lending policy, default by a borrower does not affect the expected income of the other borrower and hence does not attract the social penalty even if she is of type S
 - The bank has a payoff of
 - 1 2(r-1) if both the borrowers invest in P^1
 - **2** r 2 if one of the borrowers invests in P^1 and the other borrower invests in P^2

3 -2 if both the borrowers invest in P^2

More Definitions

Positive assortative matching

There are $\frac{\theta}{2}$ groups of type SS and $\frac{1-\theta}{2}$ groups of type NN.

Negative assortative matching

There are $min(\theta, 1 - \theta)$ groups of type SN, $max(\frac{1-2\theta}{2}, 0)$ groups of type NN and $max(\frac{2\theta-1}{2}, 0)$ groups of type SS.

- v_{ij} denotes expected equilibrium payoff of a type i borrower at some period t(≥ 1) if she forms a group with a type j borrower and the group receives the bank loan at this period.
- There is **positive assortative matching** if and only if $v_{SS} v_{SN} > v_{NS} v_{NN}$, else **negative assortative matching**

• If $v_{SS} - v_{SN} = v_{NS} - v_{NN}$, tie breaking rule is **negative** assortative matching

- Solution of the game: Given the lending policy of the bank, once a group receives a loan, this group has zero probability of receiving a loan in the future. Hence, the members of this group are going to behave as if they are playing a one shot game.
 - Stage 3:

$$\begin{array}{ccc} \mathsf{P}^1 & \mathsf{P}^2 \\ \mathsf{S} & \mathsf{H}\text{-}\mathsf{r} & \mathsf{b} \\ \mathsf{N} & \mathsf{H}\text{-}\mathsf{r} & \mathsf{b} \end{array}$$

 $v_{SS} = v_{SN} = v_{NS} = v_{NN} = b$

- **Stage 2:**Banks expected payoff at any period from making a loan is -2.
- Stage 1: There will be negative assortative matching.

Proposition 1

Group-lending without sequential financing is not feasible.

Remark 1 It is clear that our analysis goes through even if H > 2r.

Group-lending with sequential financing

- Period 0: Endogenous group-formation -Groups of two
- For every $t(\geq 1)$, there is a three-stage game.
 - **Stage 1** The bank randomly selects a group and lends the selected group 1 dollar.
 - Stage 2
 - One of the borrowers is randomly selected (with probability 1/2) by the group as the recipient of the 1 dollar(say B_i)B_i then decides whether to invest in P¹ or P².
 - **1** If P^2 , then B_i defaults, bank obtains nothing & there is no further loan by the bank and the game goes to the next period.

Note In case of default by B_i , B_j does not obtain the loan at all, B_i obtains either b or b-s.

2 If P^1 , then payoff is $H - r (\leq 1)$, bank gets r

Stage 3

The bank lends a further 1 dollar to the group, which is allocated to the other borrower, B_j, who decides whether to invest it in either P¹ or P².
 Note In this case, default by B_j does not affect the payoff of B_i, the group-member who had received the loan earlier.

- 1 If P^2 , payoff is b and the bank obtains nothing.
- **2** If P^1 , payoff is H-r and the bank obtains r.

- Solution of the game: Sufficient to restrict attention to one shot game.
 - **Stage 3:** Both types of borrowers would invest in their second projects.
 - **Stage 2:** Given that borrowers of both types default in stage 3, in stage 2, S type borrowers will invest in their first projects (Assumption 2) and N type borrowers will invest in their second projects (Assumption 1).

$$v_{SS} = \frac{\dot{H} - \dot{r} + b}{2}, v_{SN} = \frac{\dot{H} - \dot{r}}{2}, v_{NS} = b, v_{NN} = \frac{b}{2}$$

- **Stage 1** The expected per period payoff of the bank is $\theta r 1 \theta$
- Period 0:Negative Assortative Matching

Proposition 2

Sequential financing is feasible if and only if $\theta r - 1 - \theta \ge 0$

Remark 2

- Consider the case where, in case the loan goes to a group of type SN, the S borrower is the first recipient with probability α , $0 \le \alpha \le 1$. $v_{SS} = \frac{H-r+b}{2}, v_{SN}(\alpha) = \alpha(H-r), v_{NS}() = b, v_{NN} = \frac{b}{2}$
- There is negative assortative matching if and only if $\alpha \geq \frac{1}{2}$

Contingent renewal without sequential financing

Consider a game where the selection of the recipient group is history dependent, but in any round, all members of the recipient group receive loans simultaneously.

- Period 0 Endogenously form groups of size two
- For every $t(\geq 1)$, there is a two-stage game
 - Stage 1
 - At *t* = 1, the bank lends some randomly selected group 2 dollars.
 - t > 1, in case the recipient group at t-1 had repaid its loans, at t the bank makes a repeat loan to this group. else no member of this group ever obtains a loan, either at t or in the future.
 - **Stage 2** The borrowers simultaneously make their project choice.

Proposition 3

- If δ ≥ b-H+r/b, then the unique renegotiation-proof equilibrium involves borrowers of both types investing in their first projects at every period they obtain the loan.
- If δ < b-H+r/b, then the unique renegotiation-proof equilibrium involves all the borrowers investing in their second projects at every period they obtain the loan.</p>

$$\begin{split} v_{SS} &= v_{SN} = v_{NS} = v_{NN} = \frac{H-r}{1-\delta} \text{ if } \delta \geq \frac{b-H+r}{b} \\ v_{SS} &= v_{SN} = v_{NS} = v_{NN} = b \text{ if } \delta < \frac{b-H+r}{b} \\ \bullet \text{ if } \delta \geq \frac{b-H+r}{b} \text{ , bank's payoff} = 2(r-1) > 0 \\ \bullet \text{ if } \delta < \frac{b-H+r}{b} \text{, bank's payoff is -2} \end{split}$$

Proof: Proposition 3 consider a subgame BiBj Claim :- In any subgame perfect equilibrium . if in a period "N, Bit invests in her second project, they So must Bj , Since there is group landing , contingent renewal and no sequential financing. Thus if Bj defaults, then the group as a whole will be taken to depault and well not get a loan in the future. Thus default by Bi perse is not adversely affecting Bi Errice he humsey is defaulting So. Bi Shall not face a social sanction and it will be more attraction for him to take up the second project. Consider borrower Bi + i= 1,2 P1 P2 Option 1: the mueste in Pr till Tperiods & in CTED the period he takes up P2. Let the payof associated with this be VI = (H-R)(1-ST) + ST b (1-8) Option2: the departers right away and invests in P2, let the payoff be V2= b , V2=b $\int \sigma \delta T = \sigma \delta \qquad V_1 = \frac{H - r_1}{L - \sigma}$

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So if
$$\frac{H-x}{1-5} > b \Rightarrow (H-x) > b(1-5)$$

 $\Rightarrow H-x > b - bS$
 $\Rightarrow bS > b-H+x$
 $\Rightarrow S \ge b-H+x$
 $\Rightarrow S \ge b-H+x$
Here Bi $\pm i = 1/2$ infinitely vivests in Prushen ever
he gets a boan. Twise proves Part(i) g Proposition 3.
 $3 + \frac{H-x}{1-5} < b \Rightarrow S < b - +H+x}{b}$, then
Bi takes up Ps in every period he recervises a
loan. This proves Part (1) of Roppesition 3.
Hence proved
Recog

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Proposition 4

Group-lending with contingent renewal, but without sequential financing is feasible if and only if $\delta \geq \frac{b-H+r}{b}$

Thus, for $\delta \geq \frac{b-H+r}{b}$, the first best outcome is implemented. The argument clearly relies on the trigger strategy like aspect of contingent renewal. For $\delta < \frac{b-H+r}{b}$ b, however, all the borrowers invest in their second projects, so that contingent renewal fails to resolve the moral hazard problem.

Contingent renewal with sequential financing

- **Period 0** Borrowers endogenously form groups of size two.
- For every $t(\geq 1)$, there is a three-stage game with the following sequence of actions.
 - Stage 1
 - At *t* = 1, the bank lends some randomly selected group 1 dollars.
 - For t > 1, in case the recipient group at t-1 had repaid its loans, the bank gives the group 1 dollar in this, else no member of this group ever obtains a loan in this period or in the future.
 - Stage 2
 - One of the borrowers is randomly selected (with probability 1/2) as the recipient of the 1 dollar lent by the bank. This borrower, say B_i , then decides whether to invest the 1 dollar in P^1 or P^2 .
 - 1 If P^2 , then, depending on her type, B_i obtains either b or b-s, and the bank obtains nothing. In that case, there is no further loan in this period and the game moves to the next period.
 - 2 If P^1 , then the bank is repaid r, B_i obtains H-r and the game goes to the next stage.

- **Stage 3** The bank lends a further 1 dollar to the group, which is allocated to B_j , who decides whether to invest in P^1 or P^2 .
 - 1 If P^2 , then, depending on her type, B_i obtains either b or b-s, and the bank obtains nothing.
 - 2 If B_i invests in P^1 , then the bank is repaid r, Bi obtains H-r

Proposition 5

- If δ ≥ b-H+r/b, then the unique renegotiation-proof equilibrium involves borrowers of both types investing in their first projects at every stage when they obtain the loan.
- ② If δ < b-H+r/b then the unique renegotiation-proof equilibrium involves the S type borrowers investing in their first projects, and the N type borrower investing in their second projects at every stage when they obtain the loan.</p>

$$\begin{aligned} v_{SS} &= v_{SN} = v_{NS} = v_{NN} = \frac{H-r}{1-\delta} \text{ if } \delta \geq \frac{b-H+r}{b} \\ v_{SS} &= \frac{H-r}{1-\delta}; v_{SN} = \frac{H-r}{2}; v_{NS} = b; v_{NN} = \frac{b}{2} \text{ if } \delta < \frac{b-H+r}{b} \end{aligned}$$

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Comparison

CR+ SF Vs CR(alone)

- Under CR alone we saw that for $\delta < \frac{b-H+r}{b},$ type S was investing in project 2
- But under CR and SF , Type S has greater incentive to invest in project 1 not only under $\delta \geq \frac{b-H+r}{b}$ but also under $\delta < \frac{b-H+r}{b}$
 - **1** If S being the first recepient defaults then his partner will not get a loan in this period as well as in the future.
 - 2 If S being the second recepient defaults then his partner will not get a loan in the future.

Hence default by S attracts social penalty.



CR+ SF Vs SF(alone)

- Under SF alone we saw that type S was investing in project 1 only if he were the first recepient.
- Clearly under SF+CR , the incentive to invest in project 1 for type S is greater.

Bank's Expected Payoff

- If $\delta \ge \frac{b-H+r}{b}$, there is Negative assortative matching and bank's per period payoff is 2(r-1) > 0.
- If $\frac{b-H+r}{b+H-r} < \delta < \frac{b-H+r}{b}$, then there is positive assortative matching and expected payoff of the bank is $\frac{2\theta(r-1)-(1-\delta)(1-\theta)}{(1-\delta)[1-\delta(1-\theta)]}$
- If $\delta < \frac{b-H+r}{b+H-r}$, then there is negative assortative matching and the expected payoff of the bank is

$$\begin{array}{l} \begin{array}{l} \begin{array}{l} \frac{2(2\theta-1)(r-1)+(1-\delta)(1-\theta)(r-3)}{(1-\delta)[1-2\delta(1-\theta)]} \text{ for all } \theta \geq \frac{1}{2} \\ \end{array} \\ \begin{array}{l} \frac{\theta r-\theta-1}{1-\delta} \\ \text{ , otherwise} \end{array} \end{array}$$

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So
$$\sum expected Payoff of the bank
$$V = (20-1)\left(\frac{2(R-1)}{1-5}\right) + 2(1-0)\left[\frac{X-3}{2} + 5V\right]$$

$$V - 2E(1-0)V = 2(20-1)(R-1) + (1-0)(1-E)(R-3)$$

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$$V = \frac{2(20-1)(R-1) + (1-0)(1-E)(R-3)}{(1-E)(1-2E(1-0))}$$$$

$$\frac{[M_{1} \oplus \langle 1|2]}{[M_{1} \oplus \langle 1|2]} + then \oplus groups of type SNand (1-20) groups of type NNThe expected $V = [20 (\frac{R-3}{2}) + (1-20)(-1)] + 8V$
 $V(1-E) = D(A-3) + 20 - 1$
 $V = \frac{R_{10} - 0 - 1}{1-8}$$$

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Proposition 6

- 1 There is positive assortative matching if and only if $\frac{b-H+r}{b+H-r}<\delta<\frac{b-H+r}{b}$
- 2 If $\delta \geq \frac{b+H-r}{b}$, then group-lending with both sequential financing and contingent renewal is feasible. For $\delta < \frac{b-H+r}{b}$, group-lending is feasible if and only if
 - $\frac{b-H+r}{b+H-r} < \delta < \frac{b-H+r}{b}$ and $2\theta(r-1) (1-\delta)(1-\theta) \ge 0$, or

- $\delta < \frac{b-H+r}{b+H-r}$, $\theta \ge 1/2$ and $2(2\theta-1)(r-1) + (1-\delta)(1-\theta)(r-3) \ge 0$, or
- $\delta < \frac{b-H+r}{b+H-r}$, $\theta < 1/2$ and $\theta r \theta 1 \ge 0$

Proposition 6(i) -Central Result

- For δ < b-H+r/b the lending policy ensures that S type borrowers invest in their first projects, whereas N type borrowers invest in their second projects.
- If, in addition $\frac{b-H+r}{b+H-r} < \delta$, then contingent renewal is making SS type groups more profitable($v_{SS} > V_{SN}$), leading to positive assortative matching.
- Thus, in case an NN type group obtains the loan, the first recipient will default and the other N type borrower will not get a loan at all.
- Thus, sequential financing acts as a partial screening mechanism whereby the identity of the good and bad groups can be ascertained relatively cheaply.
- Note that, in the presence of sequential financing, contingent renewal proves to be a much more effective tool while by itself contingent renewal fails to solve the moral hazard problem.

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Optimal Lending Policy under $\delta \leq \frac{b-H+r}{b+H-r}$

- From Proposition 4, contingent renewal lending by itself is not feasible.
- Under sequential financing alone for $\theta < 1/2$, the banks payoff in this case is the same as that when sequential financing and contingent renewal are used together.
- For θ ≥ 1/2, a combination of sequential financing and contingent renewal payoff dominates sequential financing by itself.
 - Under Negative assortative matching, there will be some SS groups who will invest in project 1.
 - While under NAM in case of $\theta < 1/2$, there will be SN and NN types so profits for the bank will be lower.

A non anonymous social penalty function

- Social penalty is imposed whenever default by an S type borrower harms other S type borrowers, but not otherwise.
- Sequential Financing
 - Stage 3: Both S and N choose P²
 - Stage 2:
 - N will choose P²
 - S chooses P^2 with N and P^1 with S

$$v_{SS} = \frac{H-r+b}{2}, v_{SN} = v_{NS} = v_{NN} = \frac{b}{2}$$

- Period 0 Positive Assortative Matching
- Per period payoff of the bank is the same as heta r heta 1
- As oppposed to the anonymous case, group lending would not have been feasible without Positive Assortative Matching.

A non anonymous social penalty function

- **Contingent Lending** For Propositions 3 and 4, the argument does not depend on the presence, and thus on the nature, of the social penalty. Thus, they go through in this case also
- Sequential financing with contingent lending
 - For $\delta \geq \frac{b-H+r}{b}$ the argument is not affected.
 - For $\delta < \frac{b-\bar{H}+r}{b}$, analysis goes through whenever the borrowers are members of SS or NN type groups. However given the social penalty function, an S type borrower would behave as an N type if she has an N type partner.

$$v_{SS} = \frac{H-r}{1-\delta}, v_{SN} = v_{NS} = v_{NN} = \frac{b}{2}$$

- There is positive assortative matching if and only if $\frac{b-H+r}{b} > \delta > \frac{b-2H+2r}{b}$
- Bank's expected payoff is $\frac{2\theta(r-1)-(1-\delta)(1-\theta)}{(1-\delta)[1-\delta(1-\theta)]}$

Proposition 7

Suppose that $\delta < \frac{b-2H+2r}{b}$ and the social penalty function is non-anonymous. In case there is both sequential financing and contingent lending, the outcome involves negative assortative matching and, for $\theta \leq 1/2$, group-lending is not feasible. Whereas, if there issequential financing alone, then there is positive assortative matching and, moreover, grouplending is feasible whenever $\theta r - \theta - 1 \geq 0$

Conclusion

- We focus on some dynamic aspects of Group lending namely sequential financing and contingent renewal.
- We show that, under the appropriate parameter configurations, there is positive assortative matching, so that the bank can test whether a group is good or bad relatively cheaply, i.e. without lending to all its members, thus leading to a partial screening out of bad borrowers.
- Contingent renewal by itself may lead to collusion, thus failing to harness the social capital. Hence, it can resolve the moral hazard problem if and only if the discount factor is relatively large.
- In case the social penalty is non-anonymous and the discount factor is relatively small, sequential financing by itself may be feasible, whereas a combination of sequential financing and contingent renewal may not be.