

Group lending, repayment incentives and social collateral

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Received September 1992; final version received November 1993

Abstract

In this paper, we investigate the impact on repayment rates of lending to groups which are made jointly liable for repayment. This type of scheme, especially in the guise of the Grameen Bank in Bangladesh, has received increasing attention. We set up and analyze the ‘repayment game’ which group lending gives rise to. Our analysis suggests that such schemes have both positive and negative effects on repayment rates. The positive effect is that successful group members may have an incentive to repay the loans of group members whose projects have yielded insufficient return to make repayment worthwhile. The negative effect arises when the whole group defaults, even when some members would have repaid under individual lending. We also show how group lending may harness social collateral, which serves to mitigate its negative effect.

Keywords: Grameen Bank; Joint liability; Lending

JEL classification: G2; O2

1. Introduction

The purpose of this paper is to explore the role of group lending in improving repayment rates in environments where banks have limited sanctions against

* Corresponding author. Dilip Abreu, Abhijit Banerjee, Andrew Foster, George Mailath, Hal Varian, three anonymous referees and seminar participants at Boston University and the University of Michigan have provided valuable comments and advice at various stages. The first author also thanks the Lynde and Harry Bradley Foundation and the Pew Charitable Trusts for financial support. The usual disclaimer applies.

delinquent borrowers. Group lending schemes have a long practical history,¹ but much recent interest stems from the performance of the Grameen Bank in Bangladesh. This bank, which lends only to the very poor, has enjoyed considerably higher repayment rates than similar credit programs using traditional lending practices.² Its success has led many to advocate setting up such schemes world wide, including in the U.S..³ Thus, in addition to featuring interesting incentive problems, an analysis of the impact of group lending on repayment rates is particularly timely.

The key feature of group lending is *joint liability*. This says that all group members are treated as being in default if any one member of the group does not repay his loan. Our aim is to understand the impact of this principle on repayment decisions. Since group loans induce interdependence between borrowers, we model this interdependence by specifying a *repayment game* to represent repayment incentives. While acknowledging that there are many potential ways of doing this, we believe that the set-up used here brings out several salient effects.

Our game-theoretic analysis of repayment decisions under group lending yields a simple and intuitive characterization of the trade-off between it and individual lending in terms of repayment rates. There are two countervailing incentive effects to consider. First, there is a positive effect, resulting from the possibility that a successful borrower may repay the loan of a partner who obtains a bad return on his project. There is also a negative effect, which arises if the entire group defaults, when at least some members would have repaid had they not been saddled with the weight of liability for their partners' loans.

A second feature of our analysis is an attempt to capture the idea that group lending may be able to harness *social collateral*. Under an individual lending contract, all the borrower has to fear, if he defaults, is the penalties that the bank can impose on him. Under group lending, he may also incur the wrath of other group members. If the group is formed from communities with a high degree of social connectedness, this may constitute a powerful incentive device, since the costs of upsetting other members in the community may be high. We model this by postulating a social penalty function that describes the punishments available within a group, but not to the bank. We show how such penalties may help to mitigate the negative effects of group lending referred to above. Indeed, we establish that if social penalties are sufficiently severe, group lending will necessarily yield higher repayment rates than individual lending.

¹ Group lending has a long and varied history reviewed in Adams and Landman (1979) and Huppi and Feder (1990). Grameen Bank apart, the performance of group lending has been very mixed.

² Hossein (1988) reports that the Grameen Bank has a repayment rate in excess of 95%. Adams and Vogel (1986) and Braverman and Guasch (1984) suggest that repayment rates less than 25% are not uncommon in many government sponsored credit programs for the poor.

³ The farm credit program established by the Goodfaith Fund in rural Arkansas is one example.

This work should be contrasted with previous papers on group lending by Stiglitz (1990) and Varian (1990). These studies focus on the informational advantages of group lending, i.e., the fact that group members may have better information about individuals' efforts and/or abilities than does the bank. They then analyze how group lending affects the likelihood that borrowers will be *able* to repay, assuming that they will repay if they are able to.⁴ Our study looks instead at borrowers' *willingness* to repay, that is the problem of enforcing repayment after some set of project returns has been realized. We then focus on how peer pressure can help to increase such willingness.⁵

Our discussion of the ability of group lending to harness social collateral is also a contribution to the nascent literature on interactions between market and non-market institutions (see Arnott and Stiglitz (1991)). In the kinds of environments where group lending is used, banks typically have few sanctions against delinquent borrowers. However, such economies are typically comparatively rich in the ability to impose effective social sanctions against individuals who harm others in their social group.⁶ Group lending provides a way for credit markets to harness such non-market institutions to enforce loan repayment.

The remainder of the paper is organized as follows. In the next section we lay out the basic model of lending to a single borrower. Section 3 extends this to consider a group lending contract between two *ex ante* identical borrowers. Section 4 adds social penalties and explores how these affect repayment rates. Section 5 discusses some extensions and section 6 provides a brief conclusion.

2. The model and individual lending

We use the simplest possible model to make the main points of interest. A borrower has a project that requires one unit of capital. The project lasts for one period and yields θ units of income. Prior to undertaking the project, the borrower does not know θ . He does, however, know that θ is distributed on $[\underline{\theta}, \bar{\theta}]$ according to the distribution function $F(\theta)$. This distribution function is assumed to be continuous on $[\underline{\theta}, \bar{\theta}]$ and to satisfy $F(\underline{\theta}) = 0$. We assume throughout that the borrower is risk neutral.

⁴ In fact Varian focuses on general contracting problems rather than on group lending *per se*. Stiglitz, on the other hand, does look at group lending explicitly.

⁵ The distinction between ability and willingness to repay is often used in models of international lending. It also seems useful in studying problems of financial development. The studies of Adams and Vogel (1986) and Braverman and Guasch (1984) suggest that both are problems in the early phases of economic development when reliable forms of collateral are hard to come by.

⁶ In fact many informal institutions already exist to make use of social networks. One widespread example is the rotating savings and credit association, which also uses social sanctions to curb default, see Ardener (1964). Besley et al. (1993) examines the economics of these institutions.

A bank lends the borrower one unit of capital to undertake the project. The loan is due at the end of the period and the amount to be repaid, inclusive of interest, is $r > 1$. After the project return is realized, the borrower must decide whether or not to repay his loan.⁷ To keep things simple, we assume that repayment is an all or nothing decision; i.e., the borrower either repays r or nothing. The borrower's repayment decision will hinge on comparing the gain from consuming an extra r units of income with the consequences of default.

The bank is assumed to have some sanctions against delinquent borrowers. The penalty it can impose on the defaulting borrower is described by a function $p(\theta)$. This function is assumed to be continuous and increasing. The bank's penalties can be thought of as having two components. The first component is a monetary loss due to seizure of income or assets. This loss is likely to be higher the greater the project return; the more successful the project the more income the borrower has for the bank to get at. The second component is a non-pecuniary cost resulting from being 'hassled' by the bank, from loss of reputation, and so forth. It is less clear how this cost will vary with the project return. One could tell stories to suggest that it may be increasing or decreasing. Our assumption that $p(\cdot)$ is increasing implies that if the non-pecuniary cost decreases then it does so at a slower rate than the increase in the monetary loss.⁸

Since the gain from non-repayment is r and the penalty is $p(\theta)$, the borrower will repay the loan if and only if $r \leq p(\theta)$. The 'critical' project return at which the borrower is indifferent between repayment and default will be given by $\phi(r)$, where $\phi(\cdot) (\equiv p^{-1}(\cdot))$ is the inverse of the penalty function $p(\cdot)$. Since the penalty for non-repayment is increasing in θ , the borrower will repay if and only if his project return exceeds $\phi(r)$. Thus the probability that the loan will be repaid, or *repayment rate* when the amount to be repaid is r , is given by

$$\Pi_1(r) = 1 - F(\phi(r)). \quad (1)$$

Since the penalty function is increasing, its inverse $\phi(\cdot)$ must also be increasing. It follows that the repayment rate is decreasing in r .

To make the problem interesting, we will suppose that the bank's sanctions are *incomplete*. By this we mean that it is not possible for the bank to enforce repayment for every project return. This assumption is formalized as $\phi(1) > \underline{\theta}$. Thus even if the borrower could obtain a loan with a zero interest rate, he would

⁷ Throughout the paper we will focus solely on strategic default. Thus we ignore the possibility that a borrower has insufficient funds to repay his loan. The model can easily be extended to deal with default of this kind but this additional complication yields little extra insight.

⁸ An alternative, more theoretically satisfying, approach to exogenously specifying the bank's penalties is to derive them endogenously in the context of a dynamic model. Thus the penalty for non-repayment is exclusion from future access to credit. However, such a penalty only has bite when a borrower's credit needs are expanding. Even in a repeated version of our model, a borrower only needs to borrow one unit of capital at the outset. From then on he can self-finance his project.

fail to repay his loan were his project return very low. It follows that the repayment rate is less than 100% for all positive interest rates, i.e. for all $r > 1$.

3. Group lending

To examine group lending, we retain the same basic model structure. For simplicity, we consider a group composed of two ex ante identical borrowers referred to as borrowers '1' and '2', respectively. At the beginning of the period, the group is granted a loan of two units of capital, one for each borrower.⁹ Each invests this in a project whose returns are independent. The loan is due at the end of the period, and the amount to be repaid (inclusive of interest) is $2r$. Once again, we assume that repayment is an all or nothing decision; i.e., the group repays $2r$ or nothing. The bank has the same penalties available to it as in the previous section.¹⁰ Thus if the group defaults when the two borrowers receive returns θ_1 and θ_2 respectively, the bank imposes penalties $p(\theta_1)$ and $p(\theta_2)$.

The concern here is with whether grouping borrowers together, and making them jointly liable in this way, improves repayment rates. Clearly, it introduces interdependence between the two borrowers' decisions. Borrower 1, for example, may decide to repay the entire loan himself if he believes that borrower 2 will pay nothing. But if borrower 2 believes this is the case then he has no incentive to pay his share. To answer the question, we must model the *repayment game* to which group lending gives rise.

Consider the extensive form game depicted in Fig. 1. At the time the game is played, the returns from both borrowers' projects are assumed to have been realized. These returns are denoted by θ_1 and θ_2 and are assumed to be common knowledge. The game has two stages. At the first, each borrower decides simultaneously whether or not to contribute his share, r , of the total amount due (which is $2r$). We label these two options as c – 'contribute' and n – 'not contribute'. If the two borrowers make the same decisions, then the outcome is straightforward. If both contribute their share, then the loan is repaid and payoffs are $(\theta_1 - r, \theta_2 - r)$. Alternatively, if both borrowers decide not to contribute, then the loan is not repaid and the bank imposes its penalties. The payoffs are then given by the vector $(\theta_1 - p(\theta_1), \theta_2 - p(\theta_2))$.

If the borrowers choose different strategies at the first stage, then the borrower who has played c must decide whether or not to repay the whole loan himself.

⁹ One could equivalently think of each borrower being given a loan, but liability for both loans being joint.

¹⁰ This is an important assumption of our analysis. In certain environments, adopting group lending may increase the penalties that the bank can impose. This would be the case if there were (binding) legal restrictions on the amount the bank could sanction borrowers and these restrictions were lessened under group lending. Effectively, our analysis assumes either that the incompleteness of the bank's penalties stems from technological rather than legal constraints or that these legal constraints are the same under both types of lending.

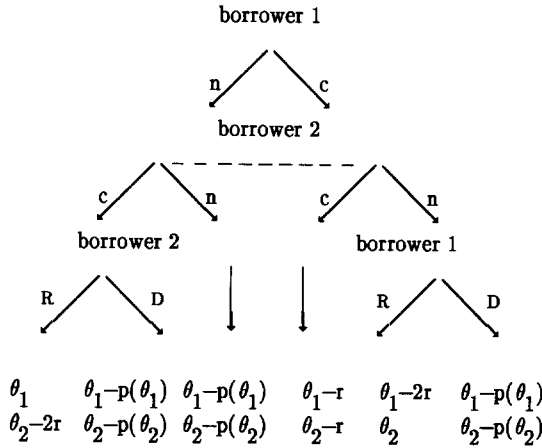


Fig. 1.

Thus at the second stage of the game, he faces a decision between *R* – ‘repay’ and *D* – ‘default’. If borrower 1, for example, chooses to repay when his partner plays *n* at the first stage, then the payoffs are $(\theta_1 - 2r, \theta_2)$. Alternatively, if he decides to default, then the payoffs are $(\theta_1 - p(\theta_1), \theta_2 - p(\theta_2))$. Clearly, borrower 2 would prefer his partner to repay, since then he incurs no penalties from the bank.

Our next task is to characterize repayment incentives under group lending by determining the equilibria of this extensive form game. We shall be particularly interested in what happens to individuals’ choices as the project returns (θ_1, θ_2) vary. Characteristically, the extensive form of Fig. 1 has many Nash equilibria, not all of which seem satisfactory.¹¹ We use sub-game perfection to refine these. This requires that strategies form a Nash equilibrium at every sub-game (see, for example, Kreps (1990)). The resulting equilibrium strategies are fully described in the appendix, to which the reader is referred for details. All that is necessary to understand the substance of our results is contained in the discussion that follows.

The main concern, given our interest in repayment rates, is to discern the values of the project return vectors (θ_1, θ_2) for which the group loan is repaid. These are described in

Proposition 1. Under group lending the loan will be repaid if at least one borrower receives a return in excess of $\phi(2r)$. It may be repaid if both borrowers have returns between $\phi(r)$ and $\phi(2r)$. It will not be repaid otherwise.

Proof: See appendix.

¹¹ For example, when both borrowers have returns in excess of $\phi(2r)$, $\{(c, D), (c, D)\}$ is a Nash equilibrium. However, it is implausible since it involves each borrower playing *D* at the second stage when each would prefer to play *R*.

The argument supporting this proposition is reasonably straightforward and can be understood with the aid of Fig. 1. Consider first what happens if both borrowers have returns in excess of $\phi(2r)$. There are two sub-game perfect equilibria in this case – $\{(c, R), n\}$ and $\{n, (c, R)\}$. In either case the bank gets repaid. Note that there is no symmetric equilibrium in this case. This is curious since both borrowers have lucrative projects, so lucrative in fact that either is prepared to repay the group loan unilaterally. But herein lies exactly the issue. Each borrower can rely on the other to repay the loan, but if he expects the other to repay then it is in his interest not to contribute his share.

The bank also gets repaid in the case where only one borrower has a project return above $\phi(2r)$. The equilibrium in this case has the fortunate borrower repaying the entire loan. The borrower with the lower return anticipates that the other will repay on his behalf (i.e. will play R at the second stage) and therefore ‘free rides’ on his partner’s good project in any sub-game perfect equilibrium.

Next consider the case where both borrowers have returns between $\phi(r)$ and $\phi(2r)$. There are now two symmetric sub-game perfect equilibria $\{(c, D), (c, D)\}$ and $\{n, n\}$. In the first the bank gets repaid, while in the second it does not. Hence the wording of the proposition which states that the bank *may* get repaid when project returns lie in this interval. In this case, neither borrower finds it worthwhile to repay the whole loan. Each borrower is willing to contribute his share if and only if his partner also does so. We will have more to say about this case presently.

In all other cases, the equilibrium involves the group defaulting on the loan. Neither borrower has the incentive to play R at the second stage. Moreover, at least one of the borrowers will not find it worthwhile to contribute his share at the first stage even if his partner chooses to.

The task now is to calculate the repayment rate under group lending and compare it to that under individual lending, as given by (1). This task is complicated by the ambiguity in equilibrium outcomes described in Proposition 1. If both group members’ returns lie between $\phi(r)$ and $\phi(2r)$, then there are two equilibria – mutual contribution ($\{(c, D), (c, D)\}$) and mutual non-contribution ($\{n, n\}$). In our calculations, we assume that the first of these is reached. While this equilibrium is Pareto superior, reaching it requires solving a coordination problem. If one individual believes that the other will contribute his share, then he will contribute too. However, pessimistic expectations of non-repayment by their partner will lead an individual to choose not to repay. Ending up in a situation of non-repayment thus represents a *coordination failure*. Whether this is a real issue in practice is moot. For example, permitting individuals to renegotiate after observing each other’s first-stage choices could help to eliminate the $\{n, n\}$ equilibrium. In general, however, this does illustrate the possible importance of expectations formation for the success of group lending. The fact that we are assuming mutual contribution for this case makes our calculation of the repayment rate only an upper bound on the performance of group lending.

Referring back to Proposition 1, we see that, assuming repayment in the ‘ambiguous’ case, the repayment rate under group lending is

$$\begin{aligned} \Pi_G(r) \equiv & [1 - F(\phi(2r))][1 + F(\phi(2r))] \\ & + [F(\phi(2r)) - F(\phi(r))]^2 \end{aligned} \quad (2)$$

The first term is the probability that at least one borrower has a project return above $\phi(2r)$, while the second represents the probability that both borrowers receive a return between $\phi(r)$ and $\phi(2r)$. We are interested in comparing this repayment rate with that obtained under individual lending. Subtracting (1) from (2) and rearranging yields

$$\begin{aligned} \Pi_G(r) - \Pi_I(r) = & F(\phi(r))[1 - F(\phi(2r))] \\ & - [F(\phi(2r)) - F(\phi(r))]F(\phi(r)). \end{aligned} \quad (3)$$

This expression crystalizes the trade-off faced by lenders who are considering the adoption of group lending to improve repayment rates. The first term is the probability that one borrower will have a return above $\phi(2r)$, when the other has a return below $\phi(r)$. This term favors group lending. Under individual lending, default would occur if a borrower had a return below $\phi(r)$. However, this is not the case under group lending if the other borrower has a return in excess of $\phi(2r)$. The borrower with the successful project will pay the share of his less fortunate partner.

The second term represents the probability that one borrower has a return between $\phi(r)$ and $\phi(2r)$ when the other has a return below $\phi(r)$. This term reduces the repayment rate under group lending relative to individual lending. Under individual lending, a borrower with a return between $\phi(r)$ and $\phi(2r)$ will repay, while under group lending repayment will not take place if the other borrower has a return below $\phi(r)$. Thus the loan is not repaid, even though one group member would have repaid if he had not been saddled with the weight of liability for his partner’s share.

One interesting question concerns how the advantage/disadvantage of group versus individual lending varies with the interest rate. This can be investigated by differentiating the right-hand side of (3) with respect to r . In general, the outcome is ambiguous. However, it is possible to say something about this in simple examples. Consider a uniform distribution of projects; $F(\theta) = (\theta - \underline{\theta})/(\bar{\theta} - \underline{\theta})$, and a linear penalty function; $p(\theta) = \theta/\beta$, where $\beta > \max\{\underline{\theta}, 1\}$. In this case, for $r \in (1, \bar{\theta}/2\beta)$ we may write (3) as

$$\begin{aligned} \Pi_G(r) - \Pi_I(r) = & (\beta r - \underline{\theta})[\bar{\theta} - \beta 2r]/(\bar{\theta} - \underline{\theta})^2 \\ & - [\beta 2r - \beta r](\beta r - \underline{\theta})/(\bar{\theta} - \underline{\theta})^2. \end{aligned} \quad (4)$$

It is now straightforward to see that group lending has a higher repayment rate than individual lending if and only if r is less than $\bar{\theta}/3\beta$. Thus group lending has

a higher repayment rate when interest rates are low. However, as they are allowed to increase, individual lending dominates in terms of repayment.

4. Social sanctions

The above analysis assumed that there was no cost to a borrower from not contributing his share of the group loan, except that which might be imposed by the bank in the event of group default. The object of this section is to consider what happens to the case for group lending when we allow for the possibility of social penalties where an individual is sanctioned for imposing costs on his group lending partner. The main idea is to demonstrate just how such sanctions can be ‘harnessed’ to improve the performance of group lending.¹²

Interdependence between individuals is an important and much analyzed feature of developing societies. In his influential study of village society, Scott (1976) describes this succinctly as “the intimate world of the peasantry where shared values and social controls combine to reinforce mutual assistance” (p. 27). Village organizations in developing countries serve both to provide certain welfare services and to manage common property (see Wade (1988)) and participation in village life typically involves restraining self-interest. A variety of enforcement mechanisms, formal and informal, are harnessed to ensure this. Notwithstanding that the strength of this kind of social fabric varies enormously between different places, it is a key feature of many developing countries and an appropriate backdrop against which to analyze group lending.

We motivate social sanctions in group lending from the observation that, unlike individual lending contracts, individuals can affect each others’ payoffs. For example, if an individual chooses not to contribute his share of a *group* loan (i.e. chooses strategy n), then he may adversely affect his partner’s payoff. The loss faced by an individual who contributes when his partner does not is r if he chooses to repay the group loan himself, and $p(\theta) - r$ if he decides to default. In either case, assuming that $p(\theta) \geq r$, he is worse off than he would have been if his partner had contributed his share. It is the fact that he suffers this loss that may lead a borrower to sanction his partner if the latter does not pay his share.

In light of this, we shall suppose that a contributing group member imposes penalties on a partner who does not contribute his share. There are a number of potential forms that such penalties might take, two of which come immediately to mind. First, the contributing member may admonish his partner for causing him or

¹² This idea is not new. Thus World Bank (1989) makes reference to a Latin American scheme where bank employees formed groups from lines of borrowers at their windows. This scheme proved unsuccessful and they comment that “such arbitrary selection is unlikely to achieve group accountability” (p. 117). In similar vein Adams and Landman (1979) have argued that group lending “appears to work well where village organizations are strong...” (p. 87). We know of no other attempt to capture these ideas formally.

her discomfort and material loss. He might also report this behavior to others in the village (such as members of the village ruling council), thus augmenting the admonishment felt. Such behavior is typical of the close-knit communities in some LDCs (see, for example, Udry (1990)). A second penalty mechanism, which seems reasonable for the context of group lending, is that a contributing member reduces cooperation with his borrowing partner in future. This is particularly pertinent if there is some form of exchange between them that occurs outside of the lending group. They may, for example, rely on each other in productive activities. Alternatively, they may help each other out in times of trouble as in the model of Coate and Ravallion (1993). The social penalties in this case would be consistent with the approach to reputation taken in the theory of repeated games.

For the purposes of this paper it is unnecessary to be specific about the penalty mechanism to make our main point. We shall simply postulate the existence of such penalties. Our approach to social sanctions thus parallels Akerlof (1980) or Kandell and Lazear (1992), seeking implications of social phenomena rather than explaining them. The *social penalty function*, denoted by $s(\cdot)$, is assumed to have two key properties. First, penalties depend upon the extent of harm inflicted by the non-contributing member on his partner and second, they depend upon the reasonableness of the decision not to contribute. The latter just says that if a non-contributor has a very unprofitable project, then the social penalty should be small. Define $L(\theta, r) \equiv \min\{p(\theta) - r, r\}$ as the loss suffered by a contributing individual with project return θ , due to a decision by his partner not to contribute.¹³ If the non-contributing group member's project had a return of θ' , the social penalty that he faces would be given by $s(L(\theta, r), \theta')$. The function $s(\cdot)$ is assumed to be smooth and to satisfy:¹⁴

- Assumption 1:* (i) For all $\theta' \in [\underline{\theta}, \bar{\theta}]$, $s(L, \theta') = 0$ for all $L \leq 0$.
(ii) For all $L \geq 0$, $s(L, \underline{\theta}) = 0$.
(iii) For all $(L, \theta') \in \mathbb{R}_{++} \times (\underline{\theta}, \bar{\theta})$, $s_1(L, \theta') > 0$ and $s_2(L, \theta') > 0$.

Part (i) of this assumption says that there will be no social sanctions if an individual's decision not to contribute imposes no loss on his partner. Part (ii) implies that an individual will not be sanctioned if he fails to contribute when he receives the lowest possible return. The final part of the assumption implies that the social penalty is increasing in the loss imposed on the contributor and in the return on the non-contributor's project.

The repayment game with social penalties is illustrated in Fig. 2. Once again we will characterize repayment incentives by determining the equilibria of this

¹³ It is the minimum because the contributing individual can choose to do the least costly thing at the second stage of the game.

¹⁴ A subscript i here denotes the partial derivative of the penalty function with respect to its i th argument.

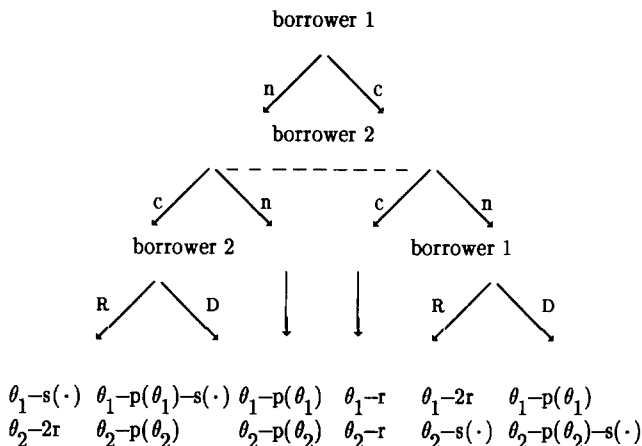


Fig. 2. Note: When the strategy pair is $\{n, (c, R)\}$, $s(\cdot) = s(r, \theta_1)$; when it is $\{(c, R), n\}$, $s(\cdot) = s(r, \theta_2)$; when it is $\{(c, D), n\}$, $s(\cdot) = s(p(\theta_1) - r, \theta_2)$, and when it is $\{n, (c, D)\}$, $s(\cdot) = s(p(\theta_2) - r, \theta_1)$.

game. We will show how the severity of social sanctions can affect the performance of group lending in a favorable way. This can be seen most clearly by parameterizing the severity of penalties by a shift parameter μ , such that $s(L, \theta) = \mu\lambda(L, \theta)$. One can then show that increasing μ tends to reduce the negative effects of group lending on the repayment rate without damaging its positive aspects. Before this can be done, however, we need to describe the project returns for which the group loan is repaid in the presence of social sanctions.

Proposition 2. With social sanctions the loan will be repaid if at least one borrower receives a return in excess of $\phi(2r)$. It may be repaid if both borrowers have returns between $\phi(r)$ and $\phi(2r)$. It may also be repaid if one borrower receives a return θ' between $\phi(r)$ and $\phi(2r)$ and the other borrower receives a return θ that is less than $\phi(r)$ but is such that $p(\theta) + s(p(\theta') - r, \theta) > r$. It will not be repaid otherwise.

Proof. See appendix.

Comparing Propositions 1 and 2, we find that the only difference in repayment rates is in the case where one borrower receives a return between $\phi(r)$ and $\phi(2r)$ while the other receives a return less than $\phi(r)$. This does, however, belie some more subtle changes in the underlying equilibria of the repayment game. Consider, for instance, the case where both borrowers have project returns above $\phi(2r)$. As we noted for the case without social sanctions in the discussion following Proposition 1, there are only asymmetric equilibria where one borrower repays the

entire loan. If social penalties are sufficiently severe, however, the only equilibrium in this case will be one where both borrowers contribute their shares. This makes good sense. An individual who ‘free rides’ on the good fortune of his partner now incurs a social penalty. Thus both may now contribute their shares if the penalty is severe enough. Similarly, when one individual has a project with a return above $\phi(2r)$ and the other has one below $\phi(2r)$, the existence of social penalties makes it less likely that an individual with the good project will have to repay the entire group’s loan.¹⁵

From the perspective of repayment rates, however, the only case that matters is that where there was default without social penalties. Referring to Fig. 2, imagine that we are in a case where one borrower, say borrower 1, has a return between $\phi(r)$ and $\phi(2r)$, while the other borrower has a return less than $\phi(r)$. Suppose also that borrower 2 expects borrower 1 to contribute his share (i.e. play c) at the first stage. Borrower 2 must now compare payoffs of $\theta_2 - r$ and $\theta_2 - p(\theta_2) - s(p(\theta_1) - r, \theta_2)$. He will evidently prefer to contribute his share if r is less than $p(\theta_2) + s(p(\theta_1) - r, \theta_2)$, the sum of the social penalties and those that will be inflicted by the bank. Thus $\{(c, D), (c, D)\}$ is a possible equilibrium in these circumstances. Notice, however, that it is not the only sub-game perfect equilibrium. The strategy pair $\{n, n\}$ is also an equilibrium.

Comparing the repayment rate under group lending with that under individual lending, again requires us to deal with the ambiguity of certain equilibrium outcomes. In our calculations we will again assume that repayment occurs in the ambiguous cases. Under this assumption, we can show that if social penalties are large enough, the superiority of group to individual lending in terms of repayment rates is guaranteed. This is stated as

Proposition 3. Consider a social penalty function of the form $s(L, \theta) = \mu\lambda(L, \theta)$, where $\lambda(\cdot)$ satisfies Assumption 1. Then if $\phi(2r) < \bar{\theta}$, the repayment rate under group lending exceeds that under individual lending for sufficiently large μ .

Proof. For all $\mu > 0$, define the function $\theta_\mu: (\phi(r), \phi(2r)) \rightarrow (\underline{\theta}, \phi(r))$ implicitly from the equation

$$p(\theta_\mu(\theta')) + \mu\lambda(p(\theta') - r, \theta_\mu(\theta')) = r.$$

For social sanctions of ‘strength’ μ , it should be clear that if one borrower has a return $\theta' \in (\phi(r), \phi(2r))$ and the other has a return $\theta < \phi(r)$, then repayment will occur if and only if $\theta > \theta_\mu(\theta')$. The probability of the latter event is

¹⁵ This is either Case 2 or 3 in the appendix. Suppose that we are in case 2 (case 3 is symmetric) where individual 1 has a return $\theta_1 > \phi(2r)$ and individual 2 has a return $\theta_2 < \phi(2r)$, then whether individual 1 repays everything depends upon whether $s(r, \theta_2) \geq r$, i.e. whether individual 2 finds incurring the social penalty worse than repaying the loan.

$F(\phi(r)) - F(\theta_\mu(\theta'))$. It follows that we may write the repayment rate under group lending as

$$\begin{aligned} \Pi_G(r, \mu) &\equiv [1 - F(\phi(2r))][1 + F(\phi(2r))] \\ &\quad + [F(\phi(2r)) - F(\phi(r))]^2 \\ &\quad + 2 \int_{\phi(r)}^{\phi(2r)} [F(\phi(r)) - F(\theta_\mu(\theta'))] dF(\theta'). \end{aligned} \tag{5}$$

The first two terms are just as in (2) above, while the final term represents the probability that one borrower has a return between $\phi(r)$ and $\phi(2r)$, and the other has a return lower than $\phi(r)$, but sufficient for repayment to occur.

Subtracting (1) from (5) and simplifying, yields

$$\begin{aligned} \Pi_G(r, \mu) - \Pi_I(r) &= F(\phi(r))[1 - F(\phi(r))] \\ &\quad - 2 \int_{\phi(r)}^{\phi(2r)} F(\theta_\mu(\theta')) dF(\theta'). \end{aligned} \tag{6}$$

The first term in this expression, that favors group lending, is positive. The second, that favors individual lending, is negative. We claim, however, that as μ gets large this second term goes to zero. To see this, note first that for all $\theta' \in (\phi(r), \phi(2r))$, $\lim_{\mu \rightarrow \infty} \theta_\mu(\theta') = \underline{\theta}$; that is, as social sanctions get increasingly severe the critical project return necessary to induce repayment gets nearer and nearer to the minimal return. This follows from part (iii) of Assumption 1. Since F is continuous, it follows that for all $\theta' \in (\phi(r), \phi(2r))$, $\lim_{\mu \rightarrow \infty} F(\theta_\mu(\theta')) = F(\underline{\theta})$. Moreover, since F is a distribution function, the sequence of functions $\langle F(\theta_\mu(\theta')) \rangle_{\mu=1}^\infty$ is bounded. Thus we may conclude from the *Bounded Convergence Theorem* that

$$\begin{aligned} \lim_{\mu \rightarrow \infty} \int_{\phi(r)}^{\phi(2r)} F(\theta_\mu(\theta')) dF(\theta') &= \int_{\phi(r)}^{\phi(2r)} \lim_{\mu \rightarrow \infty} F(\theta_\mu(\theta')) dF(\theta') \\ &= \int_{\phi(r)}^{\phi(2r)} F(\underline{\theta}) dF(\theta') = 0. \end{aligned}$$

This completes the proof. \square

Thus if social penalties are severe enough, group lending will result in a higher repayment rate than individual lending.¹⁶ This confirms the view that social collateral in the form of sanctions available to community members to discipline poor behavior is a resource that can usefully be harnessed by group lending. Thus

¹⁶ This result may seem obvious. However, the reader may note that we use the form of the penalties specified in Assumption 1 in essential ways in the proof of Proposition 3. In particular, Proposition 3 may not hold if there exist a range of project returns for which social penalties are zero when losses are positive. Parts (ii) and (iii) of Assumption 1 rule this out.

as we claimed above, this may explain why group lending is often advocated for rural lending in developing countries, where social connectedness among communities is typically high.

5. Discussion

The previous two sections analyzed the performance of group lending with and without social sanctions. The analysis assumed a specific form of the 'repayment game' and focused solely on the effect of group lending on repayment incentives. This section broadens the discussion somewhat. We begin by discussing an alternative approach to modelling the repayment game. We then comment on relaxing some of our other assumptions. Finally, we address the question of whether group lending leads to a higher level of social welfare than individual lending.

We believe that our specification of the repayment game is a plausible representation of the interaction to which group lending might give rise. However, it is not the only possible way of modelling the repayment decision and it would be useful to know how sensitive the results are to the specification chosen. One feature of our model is that group members either pay nothing, pay their contractual share of the loan, or pay for the entire loan. This does not permit intermediate solutions in which borrowers agree *ex post* to share the burden of loan repayment in a way that is not proportional to their contractual shares. One might be concerned that not allowing this degree of flexibility would bias the results against group lending.

To investigate this, we specify a model of the repayment game which allows for greater flexibility in sharing the burden of repayment. Suppose that first, each group member i announces an amount r_i that he will contribute to the repayment of the loan. If $r_1 + r_2 \geq 2r$, the loan is repaid and group members split the surplus $r_1 + r_2 - 2r$ evenly. If, on the other hand, $r_1 + r_2 < 2r$, the loan is not repaid and no contributions are made. In the former case, group member i 's payoff would be $\theta_i - r_i + (r_1 + r_2 - 2r)/2$. In the latter case, it would be $\theta_i - p(\theta_i)$.¹⁷

The reader will find it straightforward to verify that the Nash equilibria of this game result in repayment decisions as follows: the loan will be repaid if at least one borrower receives a return in excess of $\phi(2r)$; it *may* be repaid if both borrowers have returns less than $\phi(2r)$ but the sum of the bank's penalties ($p(\theta_1) + p(\theta_2)$) exceed $2r$; it will not be repaid otherwise. The ambiguity in the case when borrowers have returns less than $\phi(2r)$ but $p(\theta_1) + p(\theta_2) \geq 2r$ reflects the existence of multiple equilibria. Both members announcing that they will contribute nothing is an equilibrium in this case. Thus this game, as with our original specification, also exhibits a co-ordination failure.

¹⁷ Perhaps one drawback with this type of formulation is that the rules specifying what happens if the contributions exceed or fall short of $2r$ are somewhat *ad hoc*.

Comparing these results with Proposition 1, we see that repayment is somewhat more likely since the condition that $p(\theta_1) + p(\theta_2) \geq 2r$ is weaker than the condition that $\theta_i \geq \phi(r)$ for each member. However, the same basic trade off identified in Section 3 remains.¹⁸ The advantage of group lending is that an extra r will be repaid when $p(\theta_i) < r$ for one of the members but $p(\theta_1) + p(\theta_2) \geq 2r$. The disadvantage is that r will be lost when $p(\theta_i) > r$ for one of the members but $p(\theta_1) + p(\theta_2) < 2r$. Whether the advantage outweighs the disadvantage will depend on the precise properties of the distribution function $F(\cdot)$. Again, adding social penalties to the game for imposing costs on other group members will improve the relative performance of group lending in terms of repayment rates. Thus the results we have derived appear robust to allowing greater flexibility in the sharing of the burden of repayment.

Two further extensions of the model are worth commenting on. First, we could introduce positively correlated project returns, as would seem natural for agricultural lending. This would introduce correlated default under individual lending. Under group lending, it would reduce the probability that individuals would have very different returns and hence diminish the ‘risk sharing’ advantage of group lending where one individual repays the loan of another. Hence on balance it is unclear how the *relative* returns to the two types of lending would be affected. Second, one could consider the effect of expanding the group size. The basic ideas of the analysis would remain. One difference might be to increase the chance of the kind of coordination failure that lead to the bad outcome in the ‘ambiguous’ case discussed above.

The existing literature on group lending has focused primarily on repayment rates and here we have continued in this tradition. Ultimately, however, we are interested in the welfare effects of different lending schemes. Unfortunately, the relationship between repayment rates and welfare is by no means clear. The implicit assumption in the literature seems to be that higher repayment rates will increase the profitability of rural lending and will therefore improve the price and availability of rural credit. This, in turn, is supposed to improve access to credit and will more than compensate rural borrowers for having to repay more loans.

This argument seems plausible, but investigating it rigorously requires a richer framework than that provided by the model of this paper. In particular, since the argument assumes that a high interest rate prevents certain wealth enhancing projects from being undertaken, it is necessary to model individuals’ decisions to obtain loans. It would also be necessary to be more explicit about the form of the bank’s penalties and social sanctions. To the extent that they are not simply

¹⁸ It is also worth noting that, ignoring the possible coordination failure, this flexible repayment game gives rise to the same repayment decisions as one would expect if the borrowers behaved cooperatively and could make transfers to each other. In this case, they would behave in such a way as to maximize their joint surplus and hence would repay whenever $p(\theta_1) + p(\theta_2) \geq 2r$. Thus the trade off identified in Section 3 remains when borrowers behave cooperatively.

transfers between agents, these penalties must be accounted for in the welfare analysis. Knowing how to treat social sanctions poses some particularly interesting conceptual difficulties. The results of this paper, therefore, should not be taken as implying that group lending is better or worse than individual lending in any broader sense than repayment rates. Providing a more comprehensive analysis of the differences between the two lending schemes is an interesting subject for further research.¹⁹

6. Conclusion

This paper has investigated repayment incentives under group lending, a widely heralded financial innovation for developing economies. Its main contribution is to formulate the ‘repayment game’ between borrowers which group lending gives rise to and to derive expressions that allow comparisons of repayment rates. Our analysis shows that there are both positive and negative aspects to introducing group lending. The positive effect results from the possibility that successful borrowers may repay the loans of partners who obtain sufficiently poor returns to make repayment profitable. The negative effect arises if the entire group defaults, when at least some members would have repaid had they not been saddled with the weight of liability for their partners’ loans.

We have also shown how group lending may allow a bank to harness ‘social collateral’. Under an individual lending contract, all the borrower has to fear if he defaults is the penalties the bank can impose. Under group lending, he may also incur the wrath of other group members. If the group is formed from communities with a high degree of social connectedness, then this may constitute a powerful incentive device and hence may serve to mitigate any negative effects from group lending. The idea of drawing on the punishment capability of some agents to improve upon outcomes, may be of wider significance in contract design in situations where market and non-market institutions interact. It also complements the analysis of non-market institutions by Arnott and Stiglitz (1991). Whether there exist other examples of situations where such interactions are also important is an interesting avenue for further research.

Appendix

The purpose of this appendix is first to describe the subgame perfect equilibria of the repayment game and then to prove Propositions 1 and 2. In our characterization of equilibria, we shall consider only the repayment game with social

¹⁹ Such an analysis should also consider the incentive effects on effort and on the character of projects chosen.

sanctions. The game without sanctions is a special case of this with $s(\cdot) \equiv 0$. We will consider only pure strategy equilibria.

In describing the equilibria of the repayment game, we distinguish seven different cases. In each case we will simply state what the subgame perfect equilibria are. The reader can easily validate these claims using Fig. 2.

Case 1. If $\theta_i \geq \phi(2r)$, $i = 1, 2$, then there are three sub-cases:

- (a) If $s(r, \theta_i) > r$ for $i = 1, 2$, then $\{(c, R), (c, R)\}$ is an equilibrium.
- (b) If $s(r, \theta_1) < r$ then $\{n, (c, R)\}$ is an equilibrium.
- (c) If $s(r, \theta_2) < r$ then $\{(c, R), n\}$ is an equilibrium.

Case 2. If $\theta_1 > \phi(2r)$ and $\theta_2 < \phi(2r)$, then there are two sub-cases:

- (a) If $s(r, \theta_2) < r$, then $\{(c, R), n\}$ is an equilibrium.
- (b) If $s(r, \theta_2) > r$, then $\{(c, D), (c, R)\}$ is an equilibrium.

Case 3. If $\theta_2 > \phi(2r)$ and $\theta_1 < \phi(2r)$. This is symmetric to Case 2.

Case 4. If $\theta_i \in (\phi(r), \phi(2r))$, $i = 1, 2$, then $\{(c, D), (c, D)\}$ and $\{n, n\}$ are both equilibria.

Case 5. If $\theta_i < \phi(r)$, $i = 1, 2$, then $\{n, n\}$ is the only equilibrium.

Case 6. If $\theta_1 \in (\phi(r), \phi(2r))$ and $\theta_2 < \phi(r)$, then there are two subcases:

- (a) If $p(\theta_2) + s(p(\theta_1) - r, \theta_2) > r$, then $\{(c, D), (c, D)\}$ is an equilibrium.
- (b) If $p(\theta_2) + s(p(\theta_1) - r, \theta_2) < r$, then $\{n, n\}$ is an equilibrium.

Case 7. If $\theta_1 < \phi(r)$ and $\theta_2 \in (\phi(r), \phi(2r))$. This is symmetric to Case 6.

The two propositions now follow easily:

Proof of Proposition 1. If at least one borrower has a return bigger than $\phi(2r)$, we are in either Case 1, 2 or 3. In either Case the loan is repaid. If both borrowers have returns between $\phi(r)$ and $\phi(2r)$, we are in Case 4 and since $\{(c, D), (c, D)\}$ is an equilibrium the bank's loan may be repaid. In the remaining Cases (5, 6 and 7), the bank's loan will not be repaid if $s(\cdot) \equiv 0$. Hence the result. \square

Proof of Proposition 2. The only difference from this and Proposition 1, is in the case when one borrower receives a return θ' between $\phi(r)$ and $\phi(2r)$ and the other borrower receives a return θ smaller than $\phi(r)$ but such that $p(\theta) +$

$s(p(\theta') - r, \theta) > r$. This corresponds to Cases 6(a) and 7(a). In both cases $((c, D), (c, D))$ is an equilibrium and hence the bank's loan may be repaid. \square

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