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Abstract

We examine group-lending under sequential financing. In a model with moral hazard, social capital and endogenous group formation, we identify conditions such that sequential financing with joint liability leads to positive assortative matching between borrowers with and without social capital and, moreover, 'bad' borrowers are partially screened out, thus resolving the moral hazard problem to some extent. Further, if the later loans are not too delayed, then under these conditions the expected payoff of the bank is greater compared to that under joint liability lending. Positive assortative matching or sequential financing (specially in the absence of joint liability) are no panacea though.

Key words: Group-lending; sequential financing; joint liability; social capital; assortative matching; endogenous group formation.
JEL Classification Number: G2, O1, O2.

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1 Introduction

The recent success of micro-lending institutions, in particular those involving group-lending,[1] has raised hopes that such schemes could be used to channel credit to the poor people.[2] Not only have such institutions captured the public imagination, but have also attracted a lot of interest from economists.

The literature has made significant progress in understanding the incentive structure of such schemes.[3] Some of the recent contributions focus on two aspects of such schemes, *endogenous group-formation* and the presence of *social capital*.[4] Ghatak (1999, 2000) and Tassel (1999) analyze the problem of endogenous group formation in the presence of *joint liability*, so that in case of default by some member, the other members have to make up the deficit. They demonstrate that there will be *positive assortative matching* in the sense that borrowers of the same type will club together. Ghatak (2000) and Tassel (1999) then go on to show that the lender can use an appropriate set of loan contracts to screen out the 'bad' borrowers.[5] Ghatak (1999), on the other hand, argues that positive assortative matching improves the mix of borrowers by attracting safe borrowers.

In the context of group-lending, the importance of social capital was first

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[1] According to Hossein (1988), the Grameen Bank in Bangladesh has a repayment rate in excess of 95 percent. Christen, Rhyne and Vogel (1994) and Morduch (1999) all report similar figures. Many other group-lending schemes, including the ACCION-affiliated ones in Latin America have similar repayment rates (see Hossain (1988)).

[2] Worldwide there are 8-10 million people under similar programs (Ghatak (2000)). In fact, Grameen Bank's success has prompted other countries to try out similar schemes.

[3] Among relatively recent surveys of the literature one can mention Ghatak and Guinnane (1999) and Morduch (1999).

[4] Among other papers one can mention Banerjee et al. (1994), Stiglitz (1990) and Varian (1990), all of whom emphasize the importance of peer monitoring in group-lending. Conning (1996) and Ghatak and Guinnane (1999), on the other hand, examine how joint liability can influence peer-monitoring activity and thus help resolve some moral hazard problems. In a model of strategic default, Rai and Sjostrom (2004) study a mechanism design problem with limited side contracting.

[5] *Bad* borrowers are more risky in Ghatak (2000), and less able in Tassel (1999).

highlighted by Besley and Coate (1995) and Floro and Yotopolous (1991). However, while Floro and Yotopolous (1991) emphasize the importance of social ties, Besley and Coate (1995) focus on social penalties. In a strategic repayment game with both joint liability and social penalty, Besley and Coate (1995) demonstrate how joint liability lending may harness social collateral, thus mitigating the negative effects of group-lending to some extent.

Clearly the theoretical discussion has mostly centered around joint liability, to, perhaps, the relative neglect of some of the other features of group-lending. In this paper we focus on one such feature, that of *sequential financing*. In the Grameen Bank, for example, the groups have five members each. Loans are initially given to only two of the members (to be repaid over a period of one year). If they manage to pay the initial instalments then, after a month or so, another two borrowers receive loans and so on.[6]

While there are some recent works on sequential financing, in particular Ray (1999) and Roy Chowdhury (2004), sequential financing remain poorly understood. In particular the effect of sequential financing on group-formation, as well as its interaction with social capital and joint liability deserve careful scrutiny.

Moreover, recall that Ghatak (1999, 2000) and Tassel (1999) show that joint liability leads to positive assortative matching between 'good' and 'bad' borrowers. Given Besley and Coate (1995), it is natural to ask if joint liability causes borrowers with and without social capital to club together. Further, what are the incentive implications of such matchings? Do they necessarily improve the rate of repayment?

In an effort to build a framework capable of addressing these issues, we build a simple model of group-lending based on social capital, *moral hazard* and endogenous group-formation.

Social capital may take the form of mutual help in times of distress (see Coate and Ravallion (1993)), mutual reliance in productive activities, status

[6]See Morduch (1999). As an example of a group-lending scheme that does not involve sequential financing, one can mention the BancoSol program in urban Bolivia.

in the local community, etc. Under joint liability, default by one borrower may harm the other borrowers and thus be penalized through a loss of this social capital. Such social penalties may take the form of a reduced level of cooperation, or even admonishment.[7] In fact, in a study of group-lending in Guatemala, Wydick (1999) finds that for groups located in rural areas, group pressures play an important role in ensuring loan repayment. We assume that the borrowers are heterogenous, so that a fraction (denoted the S type) have access to social capital, while the other borrowers (denoted the N type) do not.

The moral hazard problem is modelled as follows. Every borrower has access to two projects where one of the projects has a verifiable income and no non-verifiable private benefit, while the other one has a non-verifiable private benefit and no verifiable income. The bank prefers the first project (when it can recoup its initial investment), while at least the N type borrowers prefer the second one. Hence the bank may be unwilling to lend at all.[8]

There is endogenous group formation whereby prior to the actual lending, the borrowers endogenously form groups of size two among themselves.[9] The key issue is whether there will be positive assortative matching or not.

We then briefly describe our results. To begin with let us consider joint liability lending without sequential financing. We demonstrate that there is positive assortative matching. The impact of positive assortative matching on repayment is, however, rather complex. In our model positive assortative matching works by improving the incentives for loan repayment. In case the social capital is not too large, positive assortative matching ensures that S type borrowers invest in their first project, rather than the second one.

[7]According to Rahman (1998) women are specially sensitive to such admonishments, especially if administered publicly.

[8]Ghatak and Guinnane (1999), in fact, identify moral hazard as one of the four central problems besieging joint liability lending.

[9]Ghatak (2000) provides evidence to suggest that endogenous group-formation is a key component behind the success of many group-lending schemes.

However, in case the social capital is relatively large, the expected payoff of the bank would be higher in the absence of positive assortative matching.

We then consider group-lending schemes involving sequential financing, as well as joint liability. We find that if the moral hazard problem is either rather large, or rather small, then there will be positive assortative matching. Moreover, N type borrowers will be partially screened out, thus resolving the moral hazard problem to some extent. Hence while group-lending by itself fails to screen out 'bad' borrowers, a combination of joint liability lending and sequential financing may lead to a partial screening out of such borrowers. Moreover, if loans to later borrowers are not too delayed, then sequential financing with joint liability leads to a greater payoff for the bank compared to joint liability lending.

If, however, the moral hazard problem is at an intermediate level, then sequential financing with joint liability would lead to negative assortative matching. While under negative assortative matching, S type, rather than N type borrowers may be screened out, it does, however, have certain advantages. First, if the loan goes to an SN type group, then there might be cross-subsidization in the sense that S type borrowers may partially repay in case of default by the N types. Moreover, in case the loan goes to an NN type group, the partial screening effect will also come into play.

We then use two examples to show that a combination of sequential financing and joint liability might solve the moral hazard problem, while joint liability by itself may fail to do so. This, however, is not possible if the lending scheme involves sequential financing, but not joint liability.

We then examine the case where the group-formation process does not involve side-payments, and moreover, the S type borrowers take the lead in group-formation. In that case there is necessarily positive assortative matching.

We then relate our paper to the literature. While the presence of social capital is central to our analysis, our paper differs from Besley and Coate

(1995) in several respects. First, the basic problem analyzed in this paper is one of moral hazard, rather than strategic repayment. Second, in contrast to Besley and Coate (1995), we assume that group formation is endogenous and that different borrowers may have different levels of social capital. Our model also differs from Ghatak (1999, 2000) and Tassel (1999). First, in our model the central problem is one of moral hazard, rather than asymmetric information. Second, the heterogeneity arises not because one group of borrowers is safer, or more able, but because one group has more social capital compared to the other. Most importantly, in contrast to all the above papers, we focus on the issue of sequential financing, and its interaction with joint liability, rather than on joint liability itself.

Finally, consider the literature on sequential financing. Ray (1999) provides an explanation based on coordination failures in case of voluntary default. In a model with moral hazard, Roy Chowdhury (2004) argues that sequential financing enhances the incentive for peer monitoring and may, even in the absence of joint liability, solve the moral hazard problem. Roy Chowdhury (2004), however, does not allow for either social capital, or endogenous group-formation.

The rest of the paper is organized as follows. In sections 2 and 3 we set up the basic model and analyze two benchmark cases, that of individual lending, and joint liability lending without sequential financing. Sequential financing with joint liability is analyzed in section 4, while section 5 analyzes sequential financing without joint liability. In section 6 we analyze the case where group-formation does not involve side-payments. Section 7 discusses some modelling assumptions, while section 8 concludes.

2 The Economic Environment

The market consists of a large number of borrowers, where their number is normalized to 1. Borrower i can invest in one of two projects, P_i^1 or P_i^2. For every i, P_i^1 has a verifiable income of H, and no non-verifiable income, whereas 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.

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. This can be done either individually, or as a group. For every dollar loaned, the amount to be repaid is r (≥ 1), where r is exogenously given.[10]

Thus there are significant rigidities in the rate of interest. In fact, we later assume that the extent of joint liability is also exogenously given. This is likely to be the case whenever these variables are exogenously fixed by the government, perhaps on political grounds. This is especially plausible if the lending bank is government controlled. Even if, say, the bank is run by an NGO, the government may have some control over its activities, specially if the NGO is funded (at least partially) by the government. (Later, in section 7, we examine the implications of relaxing this assumption.)

For the project to be profitable for the borrowers it must be that $H > r$. For simplicity we assume that $H \leq 2r$, so that $r < H \leq 2r$. (Later, in remark 1 of section 3 and footnote 18, we further discuss this assumption.)

A fraction $0 \leq \theta \leq 1$ of the borrowers have a social capital of s (> 0), whereas the other borrowers have no social capital.[11] 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.[12]

[10]We follow Besley and Coate (1995) in assuming that the rate of interest is exogenous. However, some authors e.g. Ghatak (1999, 2000), Tassel (1999) etc. do take the rate of interest to be endogenous.

[11]For ease of exposition we assume that the number of both types of borrowers are even.

[12]Note that the social penalty is imposed only in case it affects the other borrower. Thus it satisfies Assumption 1(i) in Besley and Coate (1995). Moreover, it is non-decreasing in the degree of loss. Thus it also satisfies Assumption 1(iii), though in a weak sense.

We assume that the magnitude of the moral hazard problem, quantified by b, is not too small.

Assumption 1. $H - r < b$.

Suppose that a borrower has taken a loan of 1 dollar. If the borrower is of type N, then, given Assumption 1, she will prefer to invest in her second project. Moreover, we assume that the social capital s is not too small.

Assumption 2. $H - r > b - s$.

Suppose some borrower of type S has taken a loan and that she will lose her social capital in case of default. In case she invests in her second project, she obtains a non-verifiable income of b, but loses her social capital, so that her net payoff is $b - s$. Given Assumption 2, the borrower will prefer to invest in her first project.

3 Individual and Joint Liability Lending

In this section we analyze two benchmark models, that of individual lending and joint liability lending without sequential financing.

3.1 Individual Lending

Under individual lending there are two stages.

Stage 1. The bank decides whether to lend 1 dollar to an individual borrower or not. In case the bank decides to do so, it randomly selects one of the borrowers as the recipient and the game goes to the next stage.

Stage 2. The selected borrower then invests the 1 dollar loaned earlier into one of the two projects available to her. In case the first project is chosen, the bank gets back r, and the borrower obtains $H - r$. In case the

Assumption 1(iii) is, of course, not applicable in our framework.

second project is chosen, the borrower obtains a private benefit of b and the bank obtains nothing.

We solve for the renegotiation-proof equilibrium of this game. In this case this simplifies to a backwards induction argument.

Stage 2. Given Assumption 1, borrowers of both types will invest in their second project.

Stage 1. Consider the case where the bank has already lent 1 dollar to the borrower. Clearly, the expected payoff of the bank is -1.

We can now write down our first proposition.

Proposition 1. *Individual lending is not feasible.*

3.2 Joint Liability Lending Without Sequential Financing

In this sub-section we examine a group-lending game with joint liability, but without sequential financing. The sequence of events is as follows.

Stage 1. There is endogenous group formation whereby the borrowers organize themselves into groups of two. Depending on the type of borrowers comprising these groups, these can be of three types, SS, NN and SN. We assume that the group-formation process follows the *optimal sorting principle*,[13] in the sense that borrowers from different groups cannot form a new group without making some member of the new group worse off.[14]

Stage 2. The bank decides whether to lend 2 dollars to some group or not. In case it does, the bank randomly selects one of the groups as the recipient and the two dollars is divided equally among the two members of the selected group. There is joint liability, i.e. in case one of the borrowers fails to meet her obligation, then the other borrower has to repay for both

[13] Ghatak (1999, 2000) were the first papers to use the optimal sorting principle in this context. Ghatak (1999), in turn, traces this idea to Becker (1993).

[14] It is clear that the optimal sorting principle is closely related to the core, as well as the idea of stability developed by Gale and Shapley (1962).

of them (provided she had invested in her first project earlier).

Stage 3. Both the borrowers then simultaneously invest 1 dollar into one of the two projects. Joint liability implies that if the $i-$th borrower invests in P_i^1 and the $j-$th borrower invests in P_j^2, then the $j-$th borrower obtains either b (if she is of type N) or $b-s$ (if she is of type S), the other borrower obtains nothing and the bank obtains H. In case both the borrowers invest in the first project, then they both obtain $H-r$ and the bank gets back $2r$. Whereas if both the borrowers invest in their second project, then the bank does not obtain any payoff.

We need some more definitions before we can proceed further.

Definition. There is *positive assortative matching* if there are $\frac{\theta}{2}$ groups of type SS, and $\frac{1-\theta}{2}$ groups of type NN.

Definition. There is *negative assortative matching* if 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.

We then describe our solution concept. We begin by solving for the renegotiation-proof equilibria of all sub-games in stage 2. Finally, the stage 1 game is solved using the optimal sorting principle.

Let V_{ij} denote the expected equilibrium payoff of a type i borrower in stage 3 if she forms a group with a type j borrower and the group receives the bank loan.

Hence, assuming that side payments are possible,[15] there will be positive

[15]Ghatak (2000) appeals to non-pecuinary forms of transfers, e.g. providing free labour services and the use of agricultural implements, to justify side-payments. However, given that in our model the returns from the second project is non-verifiable, Ghatak's (2000) other justification, that borrowers can promise to pay their partners out of the returns from the project, is not applicable to our case. Thus it may be argued that allowing for side-payments during the group-formation process may be somewhat problematic. However, our analysis in section 6 suggests that most of our results go through even if the group-formation process does not involve side-payments.

assortative matching if and only if the maximum a type N borrower is willing to pay to a type S borrower, is strictly less than the minimum a type S borrower will need as compensation for having a type N partner i.e.

$$V_{SS} - V_{SN} > V_{NS} - V_{NN}. \tag{1}$$

Clearly, there will be negative assortative matching whenever $V_{SS} + V_{NN} < V_{SN} + V_{NS}$. In case $V_{SS} + V_{NN} = V_{SN} + V_{NS}$, there is no strong justification for either positive, or negative assortative matching. In general we can expect that there will be x groups of type SN, where $x \leq \min\{\theta, 1 - \theta\}$, and the remaining borrowers will form groups with their own types. However, for ease of exposition we assume that in this case there will be negative assortative matching, i.e. $x = \min\{\theta, 1 - \theta\}$.

Note that both the optimal sorting principle, as well as the notion of renegotiation-proofness allows for coordination among the agents. In the context of lending to small rural communities with close interactions, allowing for such coordination may not be too unreasonable though.

We then turn to the solution of this game.

Stage 3: We begin by solving for the equilibrium project choice for groups of the form SS. The payoff matrix is as follows:

	Project 1	Project 2
Project 1	$H - r,\ H - r$	$0,\ b - s$
Project 2	$b - s,\ 0$	$b - s,\ b - s$

where the strategies of borrower 1 (of type S) are written vertically and those of borrower 2 (of type S) are written horizontally. For every payoff vector the first entry represents the payoff of borrower 1, and the second entry represents the payoff of borrower 2.

There are two cases to consider. If $s > b$, then the unique Nash (and hence renegotiation-proof) equilibrium involves both the borrowers investing in their first project. Whereas if $s \leq b$, then there are two Nash equilibria.

One involves both the borrowers investing in their first project, while the other one involves both the borrowers investing in their second project. However, given Assumption 2, the unique renegotiation-proof equilibrium involves both the borrowers investing in their respective first project. Hence

$$V_{SS} = H - r. \tag{2}$$

Next consider groups of the form NN. The payoff matrix is as follows:

	Project 1	Project 2
Project 1	$H-r,\ H-r$	$0,\ b$
Project 2	$b,\ 0$	$b,\ b$

where the strategies of borrower 1 (of type N) are written vertically and those of borrower 2 (of type N) are written horizontally. Given Assumption 1, it is easy to see that the unique Nash equilibrium involves both the borrowers selecting their second project. Thus

$$V_{NN} = b. \tag{3}$$

Finally consider groups of the form SN. The payoff matrix is as follows:

	Project 1	Project 2
Project 1	$H-r,\ H-r$	$0,\ b$
Project 2	$b-s,\ 0$	$b-s,\ b$

where the strategies of borrower 1 of type S are written vertically, and those of borrower 2 of type N are written horizontally.

Again there are two cases to consider. In case $b > s$, the unique equilibrium involves both the borrowers investing in their second project. Whereas if $b \leq s$, then the unique equilibrium involves borrower S investing in her first project, and borrower N investing in her second project.[16] Thus

$$V_{SN}|_{b>s} \quad = \quad b - s, \tag{4}$$

[16] For ease of exposition we adopt the following tie-breaking rule: If a borrower has the same expected payoff from investing in her first and second projects, then she invests in her

$$V_{NS}|_{b>s} = V_{NS}|_{b\leq s} \;=\; b, \tag{5}$$

$$V_{SN}|_{b\leq s} \;=\; 0. \tag{6}$$

Stage 2. We then calculate the expected payoff of the bank in case it decides to make a loan. Under positive assortative matching the bank's payoff is

$$2[\theta r - 1]. \tag{7}$$

Next consider the case of negative assortative matching. In case $\theta < 1-\theta$, there would be θ groups of type SN, and $\frac{1-2\theta}{2}$ groups of type NN. Thus the expected payoff of the bank in case it decides to make a loan is

$$2\theta(H-2) + (1-2\theta)(-2) = 2(\theta H - 1), \tag{8}$$

if $s \geq b$, and -2 otherwise.

Whereas if $\theta \geq 1-\theta$, then there would be $1-\theta$ groups of type SN, and $\frac{2\theta-1}{2}$ groups of type SS. Hence the expected payoff of the bank is

$$2(1-\theta)(H-2) + (2\theta-1)(2r-2) = 2[(1-\theta)H + r(2\theta-1) - 1], \tag{9}$$

if $s \geq b$, and $2(2\theta r - r - 1)$ otherwise.

From equations (7), (8) and (9) observe that for $s \geq b$ the payoff of the bank is higher under negative assortative matching, compared to that under positive assortative matching.[17] While apparently counter-intuitive, this is easy to explain. Given that the bank cannot screen among various groups, the probability of the loan going to a type S borrower is independent of whether the matching process involves positive, or negative assortative matching. Moreover, under both positive and negative assortative matching, the type N borrowers invest in their second project whereas, for $s \geq b$, the type S borrowers invest in their first project. Thus the probability that the first project will be selected is the same under positive and negative

first project. Note that for the case where $b = s$, uniqueness follows from the tie-breaking rule.

[17]For $b > s$, the payoff of the bank is higher under positive assortative matching.

assortative matching. However, under negative assortative matching the bank's expected payoff is higher since, in case a group of the form SN is selected, the S type borrower will partially repay the N type's loan.

Thus our analysis uncovers one potential problem with positive assortative matching; for $s \geq b$, it would lead to greater repayment rates compared to positive assortative matching.

Stage 1. We then solve for the endogenous group-formation problem.

Case 1. $s \geq b$. From equations (2), (3), (5) and (6), the positive assortative matching condition, i.e. equation (1), is clearly satisfied.

Case 2. $s < b$. From equations (2), (3), (4) and (5), the positive assortative matching property reduces to $H - r > b - s$, which, given Assumption 2, is satisfied.

The intuition behind positive assortative matching is simple. An N type borrower is indifferent between having a safe and a risky partner, since her payoff is b in both the cases. Whereas, given joint liability, an S type borrower strictly prefers to have a safe partner. Hence the result follows.

Thus our analysis extends the results in Ghatak (1999, 2000) and Tassel (1999) to show that joint liability lending induces positive assortative matching between borrowers with and without social capital (and not just between safe and risky borrowers as in Ghatak (1999, 2000), or between borrowers with different abilities as in Tassel (1999)).

Morduch (1999) argues that one of the most important issues for empirical research is to test if endogenous group-formation does indeed lead to positive assortative matching. Our analysis suggests that any such empirical study should also consider positive assortative matching between borrowers with and without social capital.

Summarizing the above discussion we obtain our next proposition.

Proposition 2. *(i) Group lending leads to positive assortative matching.*

(ii) Group-lending is feasible if and only if $\theta r - 1 \geq 0$.

Thus group lending may be feasible if there are a large number of borrowers of type S. The result, however, is driven by a somewhat different set of factors than those in Ghatak (1999, 2000) and Tassel (2000). Since, unlike in Ghatak (2000) and Tassel (1999), the rate of interest and the extent of joint liability are exogenously given, positive assortative matching cannot be used to screen out the N type borrowers. Moreover, unlike in Ghatak (1999), positive assortative matching does not lead to an improvement in the pool of borrowers. This is because with $H > r$, all borrowers want to take the loan anyway.

The result depends on the interplay of several factors. Because of joint liability, social capital is brought into play. In particular, if social capital is small i.e. $s \geq b$, then, irrespective of the nature of the matching process, type S borrowers invest in their first project. However, if $s < b$, then joint liability by itself is not sufficient to ensure that S type borrowers invest in their first project. In this case, the S type borrowers invest in their first project if there is positive assortative matching, but not if there is negative assortative matching. Thus in this case positive assortative matching improves the incentives for the S type borrowers. On the other hand, if $s \geq b$, then positive assortative matching is less profitable for the banks compared to negative assortative matching. For $\theta r - 1 \geq 0$, however, the positive effects dominate. Hence the result.

Note that the result is critically dependent on joint liability. In the absence of joint liability, default by any group-member does not affect the other members. Hence it is natural to assume that in this case default would not attract the social penalty. In this case, irrespective of the matching process, both types of borrowers will default and group-lending is not feasible.

Remark 1. We then examine if our analysis goes through if $H > 2r$, i.e. if we relax the assumption that $H \leq 2r$. Consider the stage 3 game for the SS group. It is straightforward to check that $V_{SS} = H - r$, $V_{NN} = b$, $V_{SN}|_{H-2r \geq b-s} = H - 2r$, $V_{NS}|_{H-2r \geq b-s} = b$, $V_{SN}|_{H-2r < b-s} = b - s$ and

$V_{NS}|_{H-2r<b-s} = b$. Hence the condition for positive assortative matching, i.e. equation (1), is necessarily satisfied. The intuition is the same as for the case where $H \leq 2r$. Moreover, the expected payoff of the bank is $2(\theta r - 1)$. Thus Proposition 2 goes through in this case also.

Remark 2. Note that in equilibrium the types of borrowers are revealed to the bank. Thus even though bad borrowers cannot be screened out initially, over a period of time they can be. This observation also provides some additional rationale for some of the other dynamic elements observed under group-lending, namely that of repeat lending in case of repayment, and withholding of future loans in case of default.

4 Sequential Financing With Joint Liability

In this section we consider a group-lending scheme that involves both sequential financing and joint liability. In case the bank decides to make a loan, initially only one of the group members receive a loan. Depending on whether this loan is repaid or not, the bank decides on whether to make further advances. Let $\tilde{r} \geq 1$ denote the opportunity cost of 1 dollar.

We consider a two period model with the following sequence of actions:

Period 1. There are three stages.

Stage 1. There is endogenous group formation whereby the borrowers organize themselves into groups of two according to the optimal sorting principle.

Stage 2. The bank decides on whether to lend to some group or not. In case it does, the bank randomly selects a group, lends the selected group 1 dollar and puts another dollar to its alternative use, which yields $\widetilde{r}$ dollars in the next period.

Stage 3. One of the borrowers is randomly selected (with probability half) by the group 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_i^1 or P_i^2.

If B_i invests in P_i^2, then, depending on its type, B_i obtains either b, or $b - s$, and this is the end of the game. Neither B_j, nor the bank receives any payoff and there is no further lending in period 2.

Whereas if B_i invests in P_i^1, then there is a verifiable return of H, out of which the bank is repaid r, and the remaining $H - r$ yields $(H - r)\tilde{r}$ in period 2. We assume that $(H-r)\tilde{r} < 1$, so that this amount is not sufficient to finance the investment in the next period.[18] Since we are interested in analyzing the implications of sequential financing, this assumption is a natural one to make.

Period 2. This stage arises only if B_i had invested in P_i^1 in stage 3 of period 1. 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 P_j^1, or P_j^2. If this amount is invested in P_j^2, then, depending on her type, B_j obtains either b or $b - s$, and the bank obtains $(H - r)\tilde{r}$. If its invested in P_j^1, then the bank obtains r, and the surplus $(H-r)(1+\tilde{r})$ is distributed between the two borrowers, so that B_j obtains $H-r$ and B_i obtains $(H-r)\tilde{r}$. Note that this sharing rule corresponds to that followed by the Grameen Bank where the borrowers get to keep the surplus in case all the borrowers manage to repay successfully.

The solution concept is similar to that used in the earlier section. We first solve for the renegotiation-proof equilibrium of the subgames starting in stage 2 of period 1. We then solve for the stage 1 game in period 1 using the optimal sorting principle.

Let $\tilde{V}_{ij}$ denote the expected equilibrium payoff of a type i borrower in stage 3 of period 1 in case it forms a group with a type j borrower and this group obtains the loan. Clearly, there will be positive assortative matching if and only if

$$\tilde{V}_{SS} + \tilde{V}_{NN} > \tilde{V}_{SN} + \tilde{V}_{NS}. \tag{10}$$

[18]Since $r, \tilde{r} \geq 1$, the condition that $(H - r)\tilde{r} < 1$ implies that $H < 2r$. Thus the assumption that $H < 2r$ plays a role in this section as well.

We then turn to solving this game.

Period 2. In case the game reaches this stage then a type S borrower would invest in her first project, whereas a type N borrower would invest in her second project.

Period 1. Stage 3. First consider a group of type SS. If the selected borrower, say B_i, invests in her first project then the game goes to the second period, when the other borrower invests in her first project. Then B_i obtains $(H-r)\tilde{r}$ in period 2, which has a present discounted value of $H-r$. Whereas if B_i invests in her second project then she has a payoff of $b-S$. Given Assumption 2, she invests in her first project, obtaining $H-r$. Thus

$$\tilde{V}_{SS} = \frac{(H-r)(1+\tilde{r})}{2\tilde{r}}. \tag{11}$$

Next consider a group of type NN. If the selected borrower, say B_i, invests in her first project, then in the second period the other borrower would invest in her second project. In that case B_i has a payoff of zero. Thus B_i would prefer to invest in her second project, obtaining a payoff of b (>0). Thus

$$\tilde{V}_{NN} = \frac{b}{2}. \tag{12}$$

Finally, consider a group of type SN. Let the selected borrower be B_i. In case B_i is of type S, then her payoff from investing in her first project is zero (since in the second period the other borrower, who is of type N, would invest in her second project). Whereas her payoff from investing in her second project is $b-s$. Thus she invests in her first project if $s \geq b$ (for $s=b$, we invoke the tie-breaking rule), and in her second project if $b>s$. In case B_i is of type N, she invests in her second project when she has a payoff of b (in case she invests in her first project, her payoff is $H-r<b$). Thus

$$\tilde{V}_{SN}|_{s\geq b} = 0, \tag{13}$$

$$\tilde{V}_{NS}|_{s\geq b} = \frac{b(1+\tilde{r})}{2\tilde{r}}, \tag{14}$$

$$\tilde{V}_{SN}|_{s<b} = \frac{b-s}{2}, \tag{15}$$

$$\text{and,}\quad \tilde{\mathrm{V}}_{\mathrm{NS}}|_{\mathrm{s<b}} = \frac{b}{2}. \tag{16}$$

Period 1. Stage 2. The outcome depends on whether there was positive assortative matching in stage 1 or not. The expected payoff of the bank in case there is positive assortative matching is

$$\frac{\theta r(1+\tilde{r})}{\tilde{r}} - \frac{\theta}{\tilde{r}} - 1. \tag{17}$$

Under negative assortative matching, there are two cases to consider.

Case 1. $\theta < 1-\theta$. Under negative assortative matching there would be θ groups of type SN, and $\frac{1-2\theta}{2}$ groups of type NN. Thus the expected payoff of the bank in case it decides to make a loan is

$$(1-2\theta)(-1)+2\theta[\frac{1}{2}(-1)+\frac{1}{2}\{r-2+\frac{(H-r)\tilde{r}+\tilde{r}-1}{\tilde{r}}\}] = \theta H - 1 - \frac{\theta}{\tilde{r}}. \tag{18}$$

Case 2. $\theta \geq 1-\theta$. In this case under negative assortative matching there would be $1-\theta$ groups of type SN, and $\frac{2\theta-1}{2}$ groups of type SS. Hence the expected payoff of the bank in case of a loan is

$$\begin{aligned} & (2\theta-1)(\frac{r(1+\tilde{r})-1}{\tilde{r}} - 1) + 2(1-\theta)[\frac{1}{2}(-1) + \frac{1}{2}\{r-2+\frac{(H-r)\tilde{r}+\tilde{r}-1}{\tilde{r}}\}] \\ = \ & \theta(\frac{2r(1+\tilde{r})}{\tilde{r}} - H - \frac{1}{\tilde{r}}) + H - 1 - \frac{r(1+\tilde{r})}{\tilde{r}}. \end{aligned} \tag{19}$$

Period 1. Stage 1. There are two cases to consider.

Case 1. $s \geq b$. From equations (10), (11), (12), (13) and (14) it follows that there is positive assortative matching if and only if $(H-r)(1+\tilde{r}) > b$.

Case 2. $b > s$. From equations (10), (11), (12), (15) and (16) we have that there is positive assortative matching provided $(H-r)(1+\frac{1}{\tilde{r}}) > b-s$. Given Assumption 2, this is always satisfied.

Summarizing the above discussion we obtain Proposition 3.

Proposition 3. *(i) There is positive assortative matching if and only if either $b > s$, or $s \geq b$ and $(H-r)(1+\tilde{r}) > b$.*

(ii) In case there is positive assortative matching, joint liability lending with sequential financing is feasible if and only if $\frac{\theta r(1+\tilde{r})}{\tilde{r}} - \frac{\theta}{\tilde{r}} - 1 \geq 0$. *Moreover, if* $\tilde{r} = 1$, *then the expected payoff of the bank is greater than that under joint liability lending without sequential financing.*

(iii) Suppose there is negative assortative matching.

(a) In case $\theta < 1 - \theta$, *joint liability lending with sequential financing is feasible if and only if* $\theta H - 1 - \frac{\theta}{\tilde{r}} \geq 0$.

(b) In case $\theta \geq 1 - \theta$, *joint liability lending with sequential financing is feasible if and only if* $\theta[\frac{2r(1+\tilde{r})}{\tilde{r}} - H - \frac{1}{\tilde{r}}] + H - 1 - \frac{r(1+\tilde{r})}{\tilde{r}} \geq 0$.

Note that Proposition 3(i) states that there is positive assortative matching if the moral hazard problem is either very large, or very small. The intuition is as follows. Suppose that the moral hazard problem is large in the sense that $b > s$. In that case, for a group of the type SN, both the borrowers will invest in their second project, and the game ends in the first period itself. Thus neither of the borrowers obtain a loan in the second period, making groups of the form SN rather unattractive. Next suppose that the moral hazard problem is small. Since $b \leq s$, for groups of the type SN, the S type borrower will invest in her first project in case she obtains the loan. In that case the other borrower will obtain the loan in the second period, so that the aggregate payoff is $\frac{b(1+\tilde{r})}{2\tilde{r}}$. Given that $b < (H - r)(1 + \tilde{r})$, i.e. b is small, the aggregate payoff for SN type groups is not very large, leading to positive assortative matching.

We then provide an example to show that it is possible that while ordinary group-lending is not feasible, sequential financing leading to positive assortative matching is feasible.

Example 1. (i) Let $H = 2$, $b = 1.2$, $s = 0.8$, $r = \tilde{r} = 1.5$ and $\theta = 0.6$. Note that Assumptions 1 and 2 are satisfied. Moreover, $\theta r - 1 = -0.1$, so that joint liability lending without sequential financing is not feasible. Moreover, $b > s$, so that under sequential financing there will be positive assortative matching (Proposition 3(i)). In this case the expected payoff of the bank $\frac{\theta r(1+\tilde{r})}{\tilde{r}} - \frac{\theta}{\tilde{r}} - 1 = 0.2$, so that from Proposition 3(ii) sequential financing is feasible.

(ii) Let $H = 2$, $b = 1.2$, $s = 3$, $r = \tilde{r} = 1.5$ and $\theta = 0.6$. As before, Assumptions 1 and 2 are satisfied and joint liability lending without sequential financing is not feasible. Next note that $s > b$ and $(H - r)(1 + \tilde{r}) > b$, so that under sequential financing there will be positive assortative matching (Proposition 3(i)).[19] Since $\frac{\theta r(1+\tilde{r})}{\tilde{r}} - \frac{\theta}{\tilde{r}} - 1 = 0.2$, from Proposition 3(ii) it follows that sequential financing is feasible.

The intuition behind Proposition 3(ii) and Example 1 is as follows. Note that for the parameter values described in Proposition 3(i), there is positive assortative matching. Moreover, *sequential financing acts as a partial screening mechanism*, in the sense that if the bank makes a loan to a group of type NN, then, in period 1, there is default and the other N type borrower does not get a loan in the next period.[20] Of course, sequential financing involves a cost, for the bank as well as the borrowers, in that some of the borrowers with social capital gets the loan a period later. As Example 1 and the second part of Proposition 3(ii) show, under some conditions the screening effect would outweigh the delayed loan effect.

Under negative assortative matching there are several effects at play. First, note that the loan goes to a type SN group with probability $\min\{\theta, 1-\theta\}$. One the one hand this implies that there might be cross-subsidization. In case the first recipient of the loan is type S, she will (partially) repay the loan that the N type will get in the next period. On the other hand, if the first recipient of the loan is of the N type, then she will default, so that the S type borrower does not get the loan in the second period. Moreover, in

[19] For both examples 1(i) and 1(ii) note that $(H - r)\tilde{r} = 0.75 < 1$.

[20] Note that in reality groups have more than two members. Hence, in case sequential financing with joint liability leads to positive assortative matching, the partial screening effect will assume a greater significance.

case $\theta < 1-\theta$, there will be $\frac{1-2\theta}{2}$ NN groups, so that the partial screening effect will also come into play. Depending on the strength of these various effects, several possibilities emerge.

We first argue that if $\theta < 1-\theta$ and joint liability lending by itself is not feasible, then neither is sequential financing if it leads to negative assortative matching. Since group-lending without sequential financing is not feasible, it follows that $\theta r - 1 < 0$, i.e. $\theta < \frac{1}{r}$. Hence if group-lending with sequential financing is feasible, then

$$\frac{1}{r}(H - \frac{1}{\tilde{r}}) - 1 > \theta(H - \frac{1}{\tilde{r}}) - 1 \geq 0. \tag{20}$$

This implies that $(H-r)\tilde{r} > 1$, which is a contradiction.

Thus sequential financing is no panacea.

However, for $\theta \geq 1-\theta$, the result is different.

Example 2. Let $H = \frac{5}{3}$, $b = 1.2$, $s = 1.3$, $r = \frac{10}{9}$, $\tilde{r} = 1$ and $\theta = 0.9 - \epsilon$. Clearly, Assumptions 1 and 2 are satisfied and joint liability lending without sequential financing is not feasible. Next note that $s > b$ and $(H-r)(1+\tilde{r}) < b$, so that under sequential financing there will be negative assortative matching (Proposition 3(i)).[21] Since $\theta[\frac{2r(1+\tilde{r})}{\tilde{r}} - H - \frac{1}{\tilde{r}}] + H - 1 - \frac{r(1+\tilde{r})}{\tilde{r}} > 0$, from Proposition 3(iii)(b) it follows that sequential financing is feasible.

5 Sequential Financing Without Joint Liability

In this section we consider a group-lending scheme with sequential financing, but without joint liability. The objective is to examine if sequential financing can succeed even in the absence of joint liability lending.

The sequence of actions is very similar to that in Section 4. However, there are the following differences. Consider the stage 3 game in period 1. Suppose the loan goes to B_i. In that case if B_i invests in P_i^1, then there is a verifiable return of H, out of which the bank is repaid r, and B_i obtains

[21] Note that $(H-r)\tilde{r} < 1$.

$H - r$. Moreover, if in period 2, B_j invests in P_j^2, then B_j obtains b, and the bank obtains no payoff.

Note that in this case default by B_j does not affect the payoff of B_i, the group-member who had received the loan earlier. Default by B_i would, however, affect B_j's payoff. Thus it seems natural to assume that default by B_j does not attract the social penalty, whereas default by B_i does. The implication of this assumption is that in period 2 borrowers of both kinds will default.

Let $\hat{V}_{ij}$ denote the expected equilibrium payoff of a type i borrower in stage 3 of period 1 in case it forms a group with a type j borrower and this group obtains the loan. We next turn to solving this game.

Period 2. Both types of borrower would invest in their second projects.

Period 1. Stage 3. Given that borrowers of both types default in period 2, in stage 3 of period 1 S type borrowers will invest in their first project, and N type borrowers will invest in their second project. Hence

$$\hat{V}_{SS} = \hat{V}_{SN} = \frac{H - r}{2}, \tag{21}$$

$$\text{and, } \hat{\mathrm{V}}_{\mathrm{NN}} = \hat{V}_{NS} = \frac{b}{2}. \tag{22}$$

Period 1. Stage 2. Straightforward calculations show that, irrespective of the nature of the matching process, the expected payoff of the bank is

$$\theta r - 1 - \frac{\theta}{\tilde{r}}. \tag{23}$$

This follows because the investment decision of a borrower does not depend on the nature of the group, but only on whether the borrower is the first recipient of the loan or not.

Period 1. Stage 1. Given equations (21) and (22), it is easy to see that group-formation would lead to negative assortative matching.

Summarizing the above discussion we obtain our next proposition.

Proposition 4. *(i) Under sequential financing without joint liability there is negative assortative matching.*

(ii) Sequential financing without joint liability is feasible if and only if $\theta r - 1 - \frac{\theta}{\tilde{r}} \geq 0$.

Next suppose that joint liability lending by itself is not feasible. Note that the expected payoff of the bank under sequential financing without joint liability

$$\theta r - 1 - \frac{\theta}{\tilde{r}} < \theta r - 1 < 0, \tag{24}$$

where the last inequality follows from the fact that group-lending without sequential financing is not feasible.

Thus in case joint liability lending by itself is not feasible, neither is sequential financing without joint liability. Since joint liability is absent, the social penalty mechanism is weaker. Therefore the later recipient of the loan has no incentive to invest in her first project. Hence the presence of joint liability is critical for the success of sequential financing schemes.

6 Group-formation as a Non-cooperative Process

In this section we examine the case where the group-formation process follows some non-cooperative bargaining protocol and side-payments are not allowed.

To begin with we examine the case where the S type borrowers take the initiative in group-formation. This assumption may not be too unreasonable if a part of the social capital can be attributed to the fact that the S type borrowers are better networked. In order to formalize this idea we assume that the group formation process follows what we call the *S protocol.*

S Protocol. Under all forms of group-lending, the group formation stage is now modelled as follows: This stage is divided into two phases.

Phase 1 consists of at most $n\theta$ stages (n will be defined shortly), where, at every stage, nature randomly selects an S type borrower out of the pool of remaining S type borrowers. The selected S type borrower, say B_i, makes an offer to some other borrower (who could be of either type), say B_j, to form a group with her. In case B_j agrees, the group forms and the two borrowers leave the group formation process. In case this group receives the loan, the expected payoffs of the borrowers are given by the dynamics of the subsequent game (e.g. in case of joint liability without sequential financing borrower i's payoff is V_{ij} and that of borrower j is V_{ji}).[22] In case B_j refuses, both the borrowers return to the group formation process. We assume that once a borrower has been refused n (≥ 1) times, she is out of the bargaining process.[23] In either case in the next stage nature again randomly selects one of the remaining S type borrowers to make an offer. This phase goes on until all S type borrowers are either matched, or are out of the bargaining process.

In **phase 2**, at every stage nature randomly selects an N type borrower to make an offer and so on.

For tractability we make the following assumption.

Assumption 3. If a borrower's payoff from accepting an offer is at least as much as her maximum possible payoff from rejecting it, then she accepts the offer.

We next solve for the renegotiation-proof equilibria of the various group-lending games.

Proposition 5. *Consider two lending mechanisms, joint liability lending without sequential financing, and sequential financing with joint liability. Under the S protocol, all equilibria of both the lending mechanisms involve positive assortative matching.*

[22]Thus an offer is simply regarding whether to form a group or not, and not about payoffs. This captures the idea that side payments are not possible.

[23]This assumption ensures that the game does not go on forever.

Proof. (i) First consider joint liability lending without sequential financing. From equations (2), (4) and (6) we have that $V_{SS} > V_{SN}$.[24] Thus, invoking Assumption 3, an S type borrower always accepts an offer from another S type borrower.

Now suppose to the contrary there is an equilibrium outcome that does not involve positive assortative matching. This implies that at some stage some S type borrower must have made an offer to an N type borrower even though another S type borrower was available, which was either accepted, or it was rejected and the S type borrower went out of the bargaining process (this being her n-th offer). This is a contradiction.

(ii) Next consider the group-lending game with both sequential financing and joint liability. Note that in this case $\tilde{V}_{SS} > \tilde{V}_{SN}$. In case $s \geq b$, from equations (11) and (13), this simplifies to the condition that $H > r$. Whereas if $b > s$, from equations (11) and (15), this simplifies to the condition that $(H - r)(1 + \frac{1}{\bar{r}}) > b - s$. Given Assumption 2, this is satisfied. Hence S type borrowers always accepts offers from other S type borrowers. We can then argue as before that any equilibrium outcome must involve positive assortative matching.

Finally, observe that for both the lending mechanisms, the following strategies constitute an equilibrium: All S type borrowers make offers to S type borrowers if available, otherwise they make offers to N type borrowers. All N type borrowers make offers to N type borrowers. Moreover, S type borrowers only accepts offers from S type borrowers as long as there are other S type borrowers in the pool. Otherwise, they accept all offers. N type borrowers accepts all offers. ■

We next consider group-lending schemes with sequential financing, but without joint liability. From equations (21) and (22) we have that $\hat{V}_{SS} = \hat{V}_{SN}$ and $\hat{V}_{NN} = \hat{V}_{NS}$. Hence there is an equilibrium leading to positive

[24] Since *ex ante*, every group has an equal probability of obtaining the loan, it is sufficient to consider the payoffs conditional on getting the loan.

assortative matching where S type (respectively N type) borrowers always make offers to and accepts offers from other S type (respectively N type) borrowers. Of course, in this case the expected payoff of the bank is independent of whether there is positive or negative assortative matching.

Finally, we briefly consider an alternative bargaining protocol where borrowers of type S and N are treated symmetrically.

Random Protocol. The random protocol differs from the S protocol in that the game is not divided into two phases. At every stage nature randomly selects a borrower, out of the pool of *all* borrowers remaining till that stage, to make an offer. The rest of the game is similar to the S protocol discussed above.

Proposition 6. *Suppose that there is either joint liability lending without sequential financing, or sequential financing with joint liability and, moreover, $b > s$. Under the random protocol, for both the lending mechanisms there ia an equilibrium that leads to positive assortative matching.*

Proof. For both the lending mechanisms consider the same set of strategies as described in Proposition 5.

(i) Under joint liability lending without sequential financing we have that $V_{SS} > V_{SN}$ and $V_{NS} = V_{NN}$ (see equations (3) and (5)). Hence the above strategies do constitute an equilibrium.

(ii) Consider joint-liability lending with sequential financing. Given that $\tilde{V}_{SS} > \tilde{V}_{SN}$ and, for $b > s$, $\tilde{V}_{NS} = \tilde{V}_{NN}$ (see equations (12) and (16)), the above strategies do constitute an equilibrium. ∎

Thus in case the S type borrowers take the initiative in group-formation, positive assortative matching is more likely compared to the case where side payments are possible.

7 Discussion

In this section we discuss the robustness of our analysis with respect to some modelling assumptions.

We first consider the assumption that the rate of interest and the extent of joint liability are exogenous. We briefly examine the possible implications if these two variables are, instead, endogenously determined by the bank. In particular, would such flexibility allow the bank to improve the pool of potential borrowers, either by screening out 'bad' borrowers (as in Ghatak (2000) and Tassel (1999)), or by inducing more 'good' borrowers to join the pool of potential applicants (as in Ghatak (1999))?

For simplicity we focus on the case where $b > H - r > b - s$ and $H > r$. This may be justified as follows. If $b \leq H - r$, then the rate of interest may be too low for the bank to break even. Whereas if $b - s \geq H - r$ then borrowers of both types will default. Finally if $H \leq r$, then not only do N type borrowers default, S type borrowers either default, or are not willing to take the loan at all.

We first examine if it is possible to screen out 'bad' (i.e. N type) borrowers. Recall that under joint liability without sequential financing, $V_{SS} = H - r$, whereas $V_{NN} = b$. Given that $V_{SS} = H - r < b = V_{NN}$, any contract that is profitable for the S types, will be profitable for the N types also, so that screening out N type borrowers is not possible. Next consider joint liability lending with sequential financing. In this case, while it is possible that $\tilde{V}_{SS} > \tilde{V}_{NN}$, note that $\tilde{V}_{NN}$ is independent of the rate of interest, as well as the extent of joint liability (equation (12)). Thus, in contrast to Ghatak (2000) and Tassel (1999), the rate of interest and the extent of joint liability cannot be used to screen out 'bad' borrowers.

We then observe that since $H - r > 0$, all borrowers find it profitable to borrow. Thus in this framework all 'good' borrowers are already in the pool of potential applicants. Hence, unlike in Ghatak (1999), it is not possible to improve the pool any further by attracting more 'good' borrowers.

We then discuss the social penalty function. In this paper we assume that the social penalty is imposed only if default harms the other group-members. A natural alternative may be to assume that the social penalty is imposed whenever there is default, irrespective of whether the other group-members are affected or not. Such an assumption can be justified as follows. Suppose that the bank's *future* loans to the other villagers, including the members of the defaulting group, depend on the repayment record of the existing groups.[25] In such a scenario default might affect the future loan prospects of the other villagers, leading to social sanctions.

What are the implications of adopting this alternative formulation? Note that under joint liability lending, both with and without sequential financing, default always adversely affects the other group-members. Thus, under the alternative formulation, the analysis in sections 3 and 4 will not be affected. The analysis in section 5 (sequential financing without joint liability) will be significantly affected though. Given that there is no joint liability, default by the later recipient of the loan would not attract the social penalty. Our analysis, not reported here, shows that in that case there will be negative assortative matching. Moreover, sequential financing without joint liability may solve the moral hazard problem, even though joint liability by itself may fail to do so.

These two formulations of the social penalty are not mutually exclusive though. In fact, one can think of a general formulation where the social penalty is imposed whenever a borrower defaults, but is higher in case such default also affects the other group-members. Our formulation can be considered to be a special case of this.

Finally we consider the linkage between social capital and social penalty. As mentioned in the introduction, while Floro and Yotopolous (1991) em-

[25]In the Grameen Bank, for example, loan officers at the center level (a center being a collection of 5 to 8 groups) sometimes suspend all loan disbursements until debts of all the groups under this center are up-to-date (see Schreiner (2003)). Moreover, in case a group manages to repay a loan, it often receives another (often larger) loan.

phasize the importance of social capital, Besley and Coate (1995) put more emphasis on social penalties.[26] Under our framework, however, the two are complementary, rather than competitive. While the mere presence of social capital does not affect repayment rates, the presence of social capital is a necessary condition for the imposition of social penalties.

8 Conclusion

Given the widespread adoption of group-lending schemes by many NGOs and governments, we need a clear understanding of the various aspects of such micro-finance schemes. In this paper we examine group-lending schemes with sequential financing, an aspect of such schemes that has been relatively neglected in the literature.

We identify conditions such that sequential financing with joint liability leads to positive assortative matching between borrowers with and without social capital and, moreover, 'bad' borrowers are partially screened out, thus resolving the moral hazard problem to some extent. Hence in social setups where the 'bad' borrowers cannot be screened out under joint liability lending, sequential financing can still achieve some degree of screening. Further, if the later loans are not too delayed, then sequential financing with joint liability leads to greater repayment compared to joint liability lending. *Inter alia,* we show that joint liability lending leads to positive assortative matching, which, in turn, may help resolve the moral hazard problem. Positive assortative matching or sequential financing (specially in the absence of joint liability) are no panacea though.

Finally, we try to draw some tentative policy conclusions:

1. Group-lending schemes should necessarily involve joint liability lending, either with, or without sequential financing.

[26]In fact, Wydick (1999) estimates the relative importance of social ties vis-a-vis group pressure in ensuring borrowing group performance. He finds that while group-pressure is important, at least in the rural context, social ties *per se* are not.

2. In addition to joint liability, group-lending schemes should also involve sequential financing if either the moral hazard problem is relatively large, or the group-formation process does not involve side-payments and borrowers with social capital take the initiative in group-formation.

Let us compare the policy prescriptions in this paper with those in Roy Chowdhury (2004). In a model with peer monitoring, but no social capital, Roy Chowdhury (2004) finds that sequential financing increases the incentives for peer monitoring. Hence Roy Chowdhury (2004) recommends that group-lending schemes should always involve sequential financing, either with, or without joint liability.

Taken together, the two papers suggest that the design of group-lending mechanisms should be sensitive to the relative efficacy of social penalties vis-a-vis peer monitoring. If peer monitoring is efficient (in the sense that the cost of such peer monitoring is low), then the lending mechanism should necessarily involve sequential financing. Whereas in case it is not very efficient, sequential financing needs to be used with care. Moreover, sequential financing should only be used in conjunction with joint liability lending. However, under the appropriate conditions, a combination of sequential financing and joint liability can solve the moral hazard problem, even though joint liability lending by itself may fail to do so.

9 References

Banerjee, A., Besley, T., Guinnane, T.W., 1994. Thy neighbor's keeper: The design of a credit cooperative with theory and a test. Quarterly Journal of Economics 109, 491-515.

Becker, G., 1993. A Treatise on the Family. Harvard University Press.

Besley, T., Coate, S., 1995. Group lending, repayment schemes and social collateral. Journal of Development Economics 46, 1-18.

Christen, R.P., Rhyne, E., Vogel, R., 1994. Maximizing the outreach of micro-enterprise finance: The emerging lessons of successful programs. International Management and Communications Corporation Paper, Washington, D.C.

Coate, S., Ravallion, M., 1993. Reciprocity without commitment: Characterization and performance of informal credit markets. Journal of Development Economics 40, 1-24.

Conning, J., 1996. Group-lending, moral hazard and the creation of social collateral. Working Paper, Williams College.

Floro, S.L., Yotopolous, P.A., 1991. Informal Credit Markets and the New Institutional Economics: The Case of Philippine Agriculture. Westview Press, Boulder.

Gale, D., Shapley, L.S., 1962. College admissions and the stability of marriage. American Mathematical Monthly 69, 9-15.

Ghatak, M., 1999. Group lending, local information and peer selection. Journal of Development Economics 60, 27-50.

Ghatak, M., 2000. Screening by the company you keep: Joint liability lending and the peer selection effect. Economic Journal 110, 601-631.

Ghatak, M., Guinnane, T.W., 1999. The economics of lending with joint liability: Theory and practice. Journal of Development Economics 60, 195-228.

Hossein, M., 1998. Credit for the alleviation of rural poverty: The Grameen Bank in Bangladesh. Research Report 65, IFPRI, February.

Morduch, J., 1999. The micro-finance promise. Journal of Economic Literature 37, 1564-1614.

Rahman, A., 1999. Micro-credit initiatives for equitable and sustainable development: Who pays? World Development 27, 67-82.

Rai, A., Sjostrom, T., 2004. Is Grameen lending efficient? Repayment incentives and insurance in village economies. Review of Economic Studies 71, 217-34.

Ray, D., 1999. Development Economics. Oxford University Press, New Delhi.

Roy Chowdhury, P., 2004. Group-lending: Sequential financing, lender monitoring and joint liability. Forthcoming, Journal of Development Economics.

Schreiner, M., 2003. A cost-effectiveness analysis of the Grameen Bank of Bangladesh. Development Policy Review 21, 357-382.

Stiglitz, J., 1990. Peer monitoring and credit markets. World Bank Economic Review 4, 351-366.

Tassel, E.V., 1999. Group-lending under asymmetric information. Journal of Development Economics 60, 3-25.

Varian, H., 1990. Monitoring agents with other agents. Journal of Institutional and Theoretical Economics 146, 153-174.

Wenner, M., 1995. Group credit: A means to improve information transfer and loan repayment performance. Journal of Development Studies 32, 263-281.

Wydick, B., 1999. Can social cohesion be harnessed to repair market failures? Evidence from group-lending in Guatemala. Economic Journal 109, 463-475.