Borrower Empowerment and Savings: A Two-stage Micro-finance Scheme

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Abstract: We consider group-lending with joint liability where the *provision* of loans is conditional on prior savings. In a dynamic model with moral hazard and endogenous group-formation, we examine the effect of such schemes on the allocation of loans between strongly and weakly empowered borrowers. We find that he savings requirement may help to screen out weak borrowers. Further, as long as the borrowers are not too similar, it increases the incentive for "positive assortative matching (PAM)." For intermediate interest rates, group-lending leads to "PAM" with a screening out of weak borrowers. It is thus feasible, whereas individual lending, which does not allow for such screening, is not. Interestingly, for relatively high interest rates, individual lending may dominate group-lending.

Key words: Assortative matching; empowered borrowers; joint liability lending; savings.

JEL Classification: G2, O1, O2.

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1 Introduction

In this paper we focus on two aspects of micro-finance that have, perhaps, received less attention in the theoretical literature than they deserve. The first involves the linkage between micro-finance and borrower (women) empowerment. The second involves the role of savings in micro-finance. In particular we examine a lending scheme where the *provision* of credit is conditional on prior savings, and examine the impact of such a scheme on the allocation of loans between strongly and weakly empowered borrowers.

Many of the micro-finance programs are built around women. In fact, for many people, "micro-finance is all about banking for women" (Aghion and Morduch, 2005).[1] In this context, there are two issues of critical interest. While the literature is largely concerned with whether micro-finance helps in empowerment of women (Aghion and Morduch, 2005, chapter7), a related and perhaps logically prior question is the issue of loan allocation: In a heterogenous population consisting of both the strongly and the weakly empowered borrowers, who obtain these micro-finance loans, the strong or the weak? In this paper we make a beginning in analyzing this issue.

In recent years there has been a growing debate as to the role of savings in micro-finance. This is part of a larger debate as to which offers a better way out of poverty, savings or borrowing. We take the view, as do Aghion and Morduch (2005), that "the two (approaches) are complementary." We thus examine a two-stage micro-finance program with joint liability, where the provision of credit is tied to prior savings by the borrowers.

While many micro-finance organizations, including Grameen, have a compulsory savings scheme, these savings are locked in until the loan is re-

[1] Mody (2000) found that women make up 80% of the clients of the 34 largest micro-lenders. Yunus (2001) found that 95% of the clientele of the Grameen Bank comprises women. For various reasons, e.g. selection of safer investments, lesser mobility, greater amenability to peer pressure, etc., women have a better repayment rate in case of micro-finance loans (Aghion and Morduch, 2005).

paid, so that they primarily act as guarantee for the loans taken. In contrast we consider a scheme where the savings are not locked in, but invested in the project itself. This scheme, therefore, provides a direct channel through which savings can be converted into assets,[2] and provides a conceptual middle ground between compulsory and voluntary savings. In particular, we are interested in the effect of the prior savings requirement on the group-formation process, as well as the allocation of loans.

An analysis of such a two-stage scheme is motivated by the self help group (SHG) linkage program in India.[3] Under this program borrowers endogenously form into SHGs, with initially the members saving regularly for a certain period of time. This process is usually facilitated by some NGO. Once a group manages to meet its savings target, it is linked to some bank,[4] which lends it a further sum, usually up to four times the amount saved, on a joint liability basis.

Our analysis suggests that the prior savings requirement serves two purposes. First, as long as the borrowers are not too similar with respect to their level of empowerment, an increase in the prior savings requirement increases the incentive for homogenous group-formation. Second, the savings requirement can be used as a screening tool to weed out weak borrowers. The analysis also sheds some light on the relative efficacy of group-lending vis-a-vis individual lending. We find that, for intermediate values of the rate of interest, group-lending is feasible, while individual lending is not.

[2] It is possible of course to consider a scheme which have elements of both, in the sense that a part is locked in, and the rest is not. The fact that compulsory savings can act as collateral is, however, well understood, and for focus we mostly abstract from this aspect.

[3] In fact, the SHG linkage program is rapidly turning into the dominant micro-finance paradigm in India (Basu and Srivastava, 2005). The number of self help groups linked to banks has increased from 500 in the early 1990s, to over 8,00,000 by 2004. Between 1999 and 2003, the amount of loans disbursed through this program increased by 3487%. Even under this scheme, women constitute the bulk of the borrowers.

[4] Rural branches of state owned commercial banks, regional rural banks, cooperative banks, etc.

Whereas if the rate of interest is relatively high, then individual lending may dominate group-lending.

The first conceptual challenge is to formalize the notion of an empowered borrower. In doing so, we move away from the traditional unitary approach to modeling household decisions pioneered by Becker (see, e.g. Becker, 1993), and follow the more recent approach that explicitly allows for conflicts among various members.[5] Moreover, we take a purely economic view of empowerment and interpret it as the ability to control household income. While, as pointed out by Basu (2006) and others, empowerment is a multi-dimensional concept, in this paper for the most part we will not be concerned with these.[6]

We assume that there are two classes of (women) borrowers, strong (S type) and weak (W type). Compared to weak borrowers, strong borrowers have a greater chance of being empowered, i.e. being in control of household finances. Our formulation is consistent with Goetz and Sengupta (1996) who argue that only 60% of the women in their survey on micro-finance had partial or full control of their investment activities, whereas the rest had no control at all. Further, in case a borrower is not in control, the household income is allocated in a manner that yields no utility to the borrower. This is consistent with the evidence that the same flow of income going to a household can have very different impact depending on the whether the man, or the woman is the recipient.[7]

[5] See, among others, Bourguignon and Chiappori (1994).

[6] For example, we completely abstract from the issue of violence, as well as the choice of activities under micro-finance (whether traditional or not), two of the key concerns in the literature. Further, unlike in Basu (2006), we shall take the level of empowerment to be exogenously given. This issue is considered in somewhat greater details in section 6.

[7] Ten dollars given to the male head and the same amount given to his wife can have very different implications not only for the amount of tobacco and alcohol purchased, but also on child labor, education and health (Kanbur and Haddad, 1995). In the micro-finance context, similar results were obtained by Khandker (2003).

We consider a two period dynamic model with *moral hazard* and *endogenous group-formation*. There are many borrowers. In any given period, the S-types have a greater chance of being empowered. All borrowers have access to a project that requires an initial setup cost. The borrowers initial income is less than the setup cost, so that starting a project requires outside funding from a bank. The bank decides on a saving requirement for the borrowers, and lends the difference (between the setup cost and the amount saved) to some selected borrower or SHG. The project returns depend on whether the borrowers work, or shirk. The moral hazard problem arises since the effort levels are non-verifiable.

Even under individual lending we find that there are several screening mechanisms at play. First, some W-type borrowers, i.e. those who are not empowered in period 1, will be screened out.[8] Second, by manipulating the savings requirement, s, appropriately, the W-types can be screened out. This is possible since for any given s the expected payoff is higher for the S-types.

We then consider joint liability lending (JLL). There is endogenous group formation whereby the borrowers who manage to save, form SHGs of size two among themselves. The key issue here is whether there will be SS-type group formation or not. In case the bank decides to lend, it randomly selects one of the SHGs and lends it the balance amount required to start a project. The members of the selected SHG then endogenously decide on how much effort to put into the projects.

We find that under joint liability lending there is SS-type group formation. The intuition is simple. Because of joint liability, having an S type partner is preferable to having an W type partner. This contribution, however, is more valuable to an S-type borrower since she is more likely to be empowered herself. Hence an S-type has a greater incentive to match up

[8] While some S-types will also be screened out, the screening mechanism is stronger for the W-types.

with an S-type. Interestingly, the incentive to form SS-type groups may be non-monotonic in the savings requirement, s. It is increasing in the savings requirement as long as the two types are not too similar. Otherwise, however, the incentive to form SS-type groups may be decreasing in s.[9] Further, under some realistic assumptions the level of s chosen by the bank is sub-optimal.

We then compare group-lending with individual lending. Interestingly, for intermediate values of the rate of interest, individual lending is not feasible, while group-lending is. This result provides a *raison d'etre* for group-lending in this context. For relatively high rates of interest, however, individual lending may dominate group-lending.

Interestingly, both these results hinge on a negative aspect of joint liability lending, something that we call the *contagion effect*. Because of joint liability, the incentive to work is lower under group-lending. In case one borrower shirks, the other one has no incentive to work since she will be incurring the disutility from working without getting any monetary benefits. Hence, ceteris paribus, the payoff of any borrower is higher under individual lending, compared to that under group-lending. Thus, for intermediate values of the rate of interest, it is possible to screen out weak types (i.e. WW-type groups) under group lending, but not under individual lending. This improves the pool of borrowers under joint liability lending, hence the result.

If the rate of interest is relatively large however, then weak types will be screened out under both institutional forms. There are two effects at play here. Because of the contagion effect, the bank is likely to prefer individual lending. On the other hand, screening out requires a higher savings prerequisite, which may make the bank prefer group-lending. In case the weak

[9]Of course, the idea that JLL may affect the nature of group-formation is not new. Ghatak (1999, 2000) and Tassel (1999) demonstrate that joint liability lending leads to *positive assortative matching* so that borrowers of the same type club together.

types are extremely dis-empowered however, the first effect dominates so that the bank prefers individual lending over group-lending.

Finally, we argue that our framework can be used to analyze some of rich social complexities associated with the group-lending process, e.g. the endogenous determination of the level of empowerment.

We then relate our paper to the literature. Aniket (2007) is another paper that considers a micro-finance model with savings. His paper is not concerned with the issue of borrower empowerment though. In a model with intra-group competition for loans, he finds that there could be negative assortative matching in terms of wealth levels. He then examines the implications of his model with respect to borrower outreach. Clearly, apart from the commonality in terms of the focus on savings, the two papers are very different as regards the issues addressed, the modeling and the results. There is of course a vast and growing literature dealing with various aspects of group-lending. Relatively recent surveys of this literature include Aghion and Morduch (2005), Ghatak and Guinanne (1999) and Morduch (1999).

The next section describes the economic environment. In section 3, we analyze the outcome under individual lending, whereas joint liability lending is taken up in section 4. Section 5 compares and contrasts individual lending with joint liability lending. Section 6 discusses some robustness issues. Finally, section 7 concludes.

2 The Economic Environment

We consider a dynamic two period game with one bank and a continuum of borrowers. Each borrower has access to one identical project. The opportunity cost of capital is normalized to zero, thus all agents have a discount factor of 1.

2.1 The Borrowers

The borrowers are risk neutral, have no assets and there is limited liability. At the start of period 1, every borrower household has an income of $\overline{s} < 1$. The borrowers are of two types, strong (S type) and weak (W type). Let λ_i^j denote the probability that a type j borrower, $j \in \{W, S\}$, is in charge of allocating household income in period i, $i \in \{1, 2\}$. We assume that $\lambda_1^S = \lambda_2^S = \lambda_S$ and $\lambda_1^W = \lambda_2^W = \lambda_W$, where $0 < \lambda_W < \lambda_S \leq 1$. Thus, in any given period, a strong (respectively weak) borrower controls household income, i.e. is *empowered*, with probability λ_S (respectively λ_W). For simplicity we assume that half the borrowers are strong, and half are weak.

In period i, a borrower who is in charge of household income will be denoted an $E(i)$-borrower, where E is an obvious mnemonic for empowered.

2.2 The Bank

There is a single risk neutral bank, that can observe the actual project returns. Under individual lending the bank lends, if at all, to *two* individual borrowers, whereas under group-lending it lends, if at all, to *one* SHG.[10] Let $(1-s)$ (respectively $2(1-s)$) denote the amount the bank is willing to lend to any one individual (respectively SHG) in period 1, where $1 - s \leq 1 - \overline{s}$. The amount s, where $s \in [0, 1]$, is a policy variable for the bank. Lending is contingent on the savings requirement being met. The bank maximizes its profit subject to a break-even constraint.

For every dollar loaned, the amount to be repaid is r (≥ 1), where r is exogenously given.[11] Such rigidities in the rate of interest arise naturally if it

[10] This assumption is a simplifying one, and allows us to abstract from the issue that by reducing $(1-s)$, the bank can serve a greater number of villagers. Since this trade-off, while undoubtedly important, is not our focus in this paper, we have chosen to abstract from it.

[11] 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

is exogenously fixed by the government, perhaps on political grounds. In the context of the SHG-linkage program in India, for example, this assumption is not too implausible given that the National Bank for Agricultural and Rural Development (NABARD), a governmental organization, plays a leading role in the program.[12]

2.3 Individual and Joint Liability Lending

We examine two alternative forms of lending, individual and joint liability. Consider period 1. Under *individual lending* the bank randomly selects one of the $E(1)$-borrowers who have managed to save s, and makes her an advance of $(1-s)$. Whereas under *joint liability lending*, the $E(1)$-borrowers endogenously form self-help groups of size two, with each member saving s. The bank randomly selects one of these groups, and makes it an advance of $2(1-s)$. Thus the group has a total fund of 2, which is divided equally among the two borrowers.[13] Further, there is joint liability in the sense that if one of the borrowers have a payoff of X whereas the other one has zero, then the first borrower will have to repay on behalf of both of them (to the extent possible).

2.4 The Projects

Every borrower has access to a project that requires a startup capital of 1. Any borrower that wants to start a project can borrow at most $1-s$ from the bank (provided the bank is willing to lend to her), and has to save the rest, i.e. s. Project returns are verifiable and depends on the effort level

interest to be endogenous.

[12] In a case-study of an SHG-linkage program in Haryana, India, Aniket (2006) finds that the rate of interest is often set by government lending agencies, e.g. the Rastriya Mahila Kosh and National Minorities Development Finance Corporation.

[13] The sequence of actions under individual (respectively joint liability) lending will be described in greater details in section 3 (respectively section 4).

put in by the borrower. For all projects, the return equals X in case the borrower works, and equals zero in case the borrower shirks. In case the borrower works, the monetized value of the disutility from working equals e, where $X > e > 0$.[14] There is no such disutility in case the borrower shirks, of course.

For simplicity we assume that the project return X is neither too large, nor too small.

Assumption 1. $2r(1-\overline{s}) > X > X - e > r$.

We shall later find that, A1 implies that for an empowered borrower it is optimal to work rather than to shirk under individual lending. Similarly, under group-lending, A1 implies that in case one of the borrowers work, then it is optimal for the other borrower to work as well if she is empowered, whereas in case one of the borrowers shirk, then it is optimal for the other borrower to shirk as well.

2.5 Allocation of Household Income

In period 1, an $E(1)$-borrower can allocate the household income, $\overline{s}$, among savings, or expenditure for productive purposes. This savings will be invested in her project in case she receives a further loan, of $(1-s)$, from the bank. Otherwise, this too will be spent for productive purposes.

Next consider period 2. If she had invested in her project earlier, and is $E(2)$, then she spends the income from the project, if any, productively.

In either period, if the borrower is not in charge, the household income is spent unproductively, and the borrower derives no utility from it. A borrower derives utility from expenditure if and only if it is used for productive

[14] We have examined a variation of this model where the effort levels vary continuously and the effort cost function is convex. We find that our results are qualitatively robust to this alternative formulation.

purposes.[15]

3 Individual Lending

Individual lending is of interest in itself, specially since many micro-finance organizations, in particular the Bank Rakyat Indonesia (BRI), are using individual lending schemes. Further, the analysis for this case provides a benchmark for group-lending.

3.1 The Sequence of Actions

In period 1, the bank chooses some $s \leq \overline{s}$, and lends $(1-s)$ to some borrower who is randomly selected among those who manage to save s. In period 2, the selected borrower chooses her effort level. A more formal description follows:

Period 1.

Stage 1. The bank selects some s, where $0 \leq s \leq \overline{s}$. Further, the borrowers get to know whether they are in charge in this period or not. All borrowers who are in charge save s, and spend the remaining $(\overline{s} - s)$ productively.

Stage 2. In case the bank decides to offer the loans, it then randomly selects two of the borrowers who have managed to save s, and lends them another $(1 - s)$ each. The selected borrowers invest the sum of the amount saved and borrowed, i.e. 1, in their own projects. The borrowers who are not selected, spend the amount saved in stage 1, i.e. s, productively.

Period 2.

[15] The utility functions will be formally specified later on.

Stage 1. The borrowers get to know whether they are in control of household income in this period or not.

Stage 2. The selected borrowers, if any, decides on their effort levels.[16] In case the borrowers work, the payoff of both in period two alone (net of effort costs) is $X - (1-s)r - e$, and the bank gets back $2(1-s)r$. Otherwise, the bank does not obtain anything and the borrowers have a period two payoff of zero.

3.2 The Analysis

For ease of exposition let us denote

$$Z(s) = X - (1-s)r - e. \tag{1}$$

We then solve this game through *backwards induction.*

Period 2. Stage 2. Consider a borrower who has invested in her project. If she is $E(2)$, then, given that $X - e > r > (1-s)r$ (Assumption 1), her period two payoff from working, i.e. $X - (1-s)r - e$, exceeds that from shirking, which is 0. Thus, it is optimal to work. If she is not in charge, then working is sub-optimal since she incurs the effort cost e without getting any monetary returns.

Let $v_i(r)$ denote the payoff, aggregated over the two periods, of a type i borrower who obtains the bank loan, given that the decision to work or shirk is taken optimally. Thus,

$$\begin{aligned} v_S(s) &= \lambda_S Z(s) + \bar{s} - s, & (2)\\ \text{and,}\ v_W(s) &= \lambda_W Z(s) + \bar{s} - s. & (3) \end{aligned}$$

We need some notations.

[16] We have examined a variation of the model where the borrowers make their effort choices before getting to know whether they are in control in this period or not. We find that this does not affect the results qualitatively.

Definition. $s_i = \begin{cases} s_i', & \text{if } s_i', \text{ solving } v_i(s) = \overline{s}, \text{ is well defined,} \\ 1, & \text{otherwise,} \end{cases}$

where note that

$$s_i' = \frac{\lambda_i(X - r - e)}{1 - \lambda_i r}. \tag{4}$$

Clearly, s_i is such that if s_i' is well defined, then at $s = s_i$, in period 1 an $E(1)$-borrower of type i has the same payoff from obtaining a loan and not obtaining one (when she has a payoff of $\overline{s}$).

Given that $v_i(0) = \lambda_i(X - r - e) + \overline{s} > \overline{s}$ and $v_i(s)$ is monotonic in s, it is clear that s_i' is well defined whenever $v_i(\overline{s}) < \overline{s}$. Observation 1 below summarizes a few properties of s_i. It follows from the fact that $\lambda_S > \lambda_W$ (see Figure 1).

Observation 1. *(i)* $s_S > s_W$*, whenever* $s_W < 1$*. Further,* $s_S = 1$*.*

(ii) $\forall i \in \{W, S\}$*,* $v_i(s) \geq \overline{s}$*, i.e. taking a loan is individually rational for a borrower, if and only if* $s \leq s_i$*.*

(iii) If $s_S > s \geq s_W$*, then the S-type alone will find it individually rational to take a loan.*

Observation 1(iii) is central to the analysis in this section and shows that for intermediate values of s, the W-types may be completely screened out of the market.[17] It is interesting that, in contrast to most of the literature, in our framework W types can be screened out by using only one instrument, i.e. s.[18] Clearly such screening improves the pool of potential borrowers, so that the bank is more likely to break even.

We then assume that r is neither too large, nor too small. While this

[17] We adopt the tie-breaking rule that in case the payoff from taking a loan equals that from not taking one, a borrower prefers not to take a loan. This is for ease of exposition alone.

[18] In Ghatak (2000), for example, screening requires two instruments, the rate of interest and the extent of joint liability.

assumption is not critical for the analysis, it simplifies the exposition.

Assumption 2. (i) $\lambda_S^2 r - 1 > 0$.
(ii) $r(\lambda_S^2 + \lambda_W^2) - (\lambda_S + \lambda_W) < 0$.

Assumption 2(i) implies that if W-type borrowers can be screened out, then individual and group lending are both feasible. Whereas A2(ii) ensures that in case the W-types cannot be screened out, then neither individual, nor group-lending is feasible.

Period 1. Stage 2. Consider the bank's payoff. There are two cases.

(i) In case $s_W \leq s < s_S$, only the S type borrowers will find it optimal to take a loan, and the bank's net payoff is

$$B'(s) = 2(1 - s)(\lambda_S r - 1). \tag{5}$$

(ii) If $s < s_W$, then all borrowers will find it optimal to take a loan. Since $\frac{\lambda_W}{2}$ (respectively $\frac{\lambda_S}{2}$) of the weak (respectively strong) borrowers can save s, the bank's net payoff in this case is

$$B''(s) = 2(1 - s)[r\frac{\lambda_S^2 + \lambda_W^2}{\lambda_S + \lambda_W} - 1]. \tag{6}$$

Observe that $B'(s) > B''(s)$, which reflects the fact that the bank faces a safer pool of borrowers in case (i) as the weak types are screened out.

Period 1. Stage 1. We then solve for the optimal s set by the bank. Suppose $s_W = 1$. Then for any $s \leq \bar{s}$, $s < 1 = s_W$, so that the W-types cannot be screened out (Observation 1(ii)), and the bank's payoff is $B''(s)$. Given A2(ii), lending is not feasible and the bank sets some $s > \bar{s}$ so that it can avoid lending. Whereas if $s_W \leq \bar{s}$, then the W-types can be screened out (Observation 1(ii)), so that the bank's payoff is $B'(s)$. From (5) and A2(i), $B'(s)$ is positive for all $s \leq \bar{s}$. Moreover, from (5) the bank's payoff is decreasing in s, so that it sets s at the lowest possible level that allows for screening out of W-types. Hence optimally the bank sets $s = s_W$.

Formally, we have

Proposition 1. *Suppose Assumptions 1 and 2 hold. Individual lending is feasible if and only if W-type borrowers can be screened out, i.e.* $v_W(\bar{s}) = \lambda_W(X + (1-\bar{s})r - e) \leq \bar{s}$*. In case individual lending is feasible, the optimal* s *set by the bank equals* s_W*.*

The analysis in this section shows that even under individual lending, there are two kinds of screening mechanisms at play. First, since loans are only given to borrowers who have managed to save in period 1, W types will be screened out unless they are empowered. Of course, some S-types are also screened out, but to a lesser extent compared to the W-types. Further, under certain parameter conditions, *all* W types can be screened out of the market through an appropriate choice of s.

4 Joint Liability Lending

We then turn to the main focus of this paper, group-lending with joint liability. We endogenously solve for the group-formation process, and also examine the impact of a change in the savings pre-requisite, s, on group-formation. Further, we characterize conditions for JLL to be feasible, and solve for the optimal s in case JLL is feasible.

4.1 The Sequence of Actions

In period 1, the bank chooses some $s \leq \bar{s}$, and lends $2(1-s)$ to some SHG that is randomly selected among those that manage to save $2s$. In period 2, members of the selected SHG choose their effort level.

Period 1.

Stage 1. The bank selects some s such that $0 \leq s \leq \bar{s}$. Further, the borrowers get to know whether they are in charge in this period or not.

Stage 2. The $E(1)$ borrowers all save s, and spend $(\bar{s} - s)$ productively. There is endogenous group formation whereby, the $E(1)$ borrowers organize themselves into groups of two. Depending on the type of borrowers comprising the groups, these can be of three types, SS, WW and SW. Of course, the borrowers have the option of not forming a group at all. It is possible, for example, that all S type borrowers form SS type groups, whereas the W type borrowers remain single.

Stage 3. The bank decides on whether to make a loan or not. In case the bank decides to make a loan, it randomly selects one of the SHGs, and lends the SHG another $2(1 - s)$. The selected SHG thus has a total of 2 dollars, out of which each member obtains 1 dollar which they invest in their respective projects. Members of other SHGs spend their savings productively.

Period 2.

Stage 1. The borrowers get to know whether they are in charge in this period or not.

Stage 2. The members of the selected SHG, say borrowers 1 and 2, simultaneously decide on how much effort to put into their own projects. In case both the borrowers work, each borrower has a net payoff of $X - (1 - s)r - e$ in this period, and the bank is repaid $2(1 - s)r$. If both the borrowers shirk, then the bank does not obtain anything and both the borrowers have a period two payoff of zero. Whereas if borrower 1 (say) works and borrower 2 shirks, then, *given joint liability*, the bank gets back X (since, from A1, $X < 2(1 - s)r$), borrower 1 has a period two payoff of $-e$ and borrower 2 has a period two payoff of zero.

4.2 The Solution Concept

The solution concept is as follows:

- We first solve for the *renegotiation-proof Nash equilibrium* of the game in period 2. Clearly the notion of renegotiation-proofness (as well as the optimal sorting principle) allows for coordination among the agents. In the context of lending to rural communities with close interactions, allowing for such coordination may not be too unreasonable.[19]

- In stage 3 of period 1, the bank's decision as to whether to make a loan or not, is solved using backwards induction.

- The group-formation process in stage 2 of period 1 is solved using the *optimal sorting principle*, which says that borrowers cannot form a new group without making some member of the new group worse off.[20]

- Finally, we use backwards induction to solve for the optimal s in stage 1 of period 1.

We need some further definitions.

Definition. There is *positive assortative matching* (henceforth PAM) if group formation is homogenous, i.e. S types match up with S types, and W types match up with W types.

Definition. There is *negative assortative matching* (henceforth NAM) if group formation is heterogenous, i.e all groups are of type SW.

Definition. There is *positive assortative matching of type* ii, $i \in \{S, W\}$, (henceforth PAM-ii) if i types match-up with i-types, and j-types, $j \neq i$,

[19] In the present context, this is of course equivalent to solving for the set of Nash equilibria and then using the Pareto criterion on this set.

[20] In this context the optimal sorting principle was first used by Ghatak (1999, 2000). The formal definition follows shortly.

remain single.

For ease of exposition we shall sometimes write "positive assortative matching" (henceforth "PAM") to denote PAM *and* PAM-SS.

Let v_{ij} denote the expected equilibrium payoff, aggregated over the two periods, of a type i borrower at stage 3 of period 1, if she forms a group with a type j borrower, $i, j \in \{S, W\}$, and the group receives the bank loan. We shall later find that this subgame has a unique equilibrium so that v_{ij} is well defined.

Optimal Sorting Principle. We shall later argue that

$$v_{SS} > v_{SW} = v_{WS} > v_{WW}. \tag{7}$$

Given this, the optimal sorting principle, assuming that side payments are possible, yields the following:

- Suppose that $v_{WW} > \bar{s}$, so that for any borrower of type i, group formation (with any borrower of type j) dominates remaining single (when she has a payoff of $\bar{s}$). There will be PAM whenever

  $$v_{SS} - v_{SW} > v_{WS} - v_{WW}. \tag{8}$$

  Otherwise, there will be NAM.

  Equation (8) states that the maximum a type W 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 W partner.

- Suppose that $v_{WW} \leq \bar{s} < v_{SW}$, so that for any W type borrower remaining single is preferable to forming a group with another W type borrower. Then there will be PAM-SS whenever

  $$v_{SS} + \bar{s} > v_{SW} + v_{WS}. \tag{9}$$

  Otherwise, there will be NAM.

- Finally, suppose that $v_{SW} \leq \overline{s} < v_{SS}$. Then group-formation can only involve PAM-SS.

4.3 The Analysis

We next turn to solving this game.

Stage 2. Period 2. We first solve for the equilibrium effort levels of the two borrowers. Depending on how many of the borrowers are empowered in period 2, there are two cases to consider.

Case (i). First consider the case where both the borrowers are empowered. There are two possible *Nash equilibria* of this game. One involves both the borrowers working, and the other involves both of them shirking. First, consider the candidate Nash equilibrium where both work. Given that the other borrower is working, the period 2 payoff of a borrower from working herself is $X - e - (1-s)r$. From A1, $X - e - (1-s)r > 0$, so that it is optimal to work rather than to shirk. Next consider the candidate Nash equilibrium where both shirk. Given that the other borrower is shirking, A1, and the fact that there is joint liability, the period two payoff of a borrower from working herself is $-e$. Therefore, it is optimal to shirk rather than to work.

Under the Nash equilibrium where both work, the borrowers' period 2 payoff equals $X - e - (1 - s)r$, whereas it equals zero in case both shirk. From A1, $X - e - (1 - s)r > 0$, so that the *renegotiation-proof equilibrium* involves both of them working.

Case (ii). We then consider the case where at most one of the borrowers is empowered. The borrower who is out of control will clearly shirk. Further, given joint liability, and the fact that $X - 2(1 - s)r < 0$ (A1), the other borrower will shirk irrespective of whether she is in control or not.

Given the above discussion we have the following expressions for v_{ij}:

$$\begin{aligned} v_{SS}(s) &= \lambda_S^2 Z(s) + \overline{s} - s, && (10) \\ v_{WW}(s) &= \lambda_W^2 Z(s) + \overline{s} - s, && (11) \\ \text{and, } v_{SW}(s) = v_{WS}(s) &= \lambda_W \lambda_S Z(s) + \overline{s} - s. && (12) \end{aligned}$$

From equations (10), (11) and (12), observe that $v_{SS} > v_{SW} = v_{WS} > v_{WW}$, so that equation (7) earlier holds.

Definition. $s_{ij} = \begin{cases} s'_{ij}, & \text{if } s'_{ij}, \text{ solving } v_{ij}(s) = \overline{s}, \text{ is well defined,} \\ 1, & \text{otherwise,} \end{cases}$

where note that

$$s'_{ij} = \frac{\lambda_i \lambda_j (X - r - e)}{1 - \lambda_i \lambda_j r}. \qquad (13)$$

Thus s_{ij} such that, whenever s'_{ij} is well defined, at $s = s_{ij}$, an $E(1)$-borrower of type i is indifferent between forming a group with a type j borrower and obtaining a loan, and not obtaining one.

Note that s'_{ij} is well defined whenever $v_{ij}(\overline{s}) < \overline{s}$. Observation 2 below follows from equation (7) and the fact that $v_{ij}(s)$ is monotonic in s (see Figure 2).

Observation 2. *(i) $s_{SS} > s_{SW} = s_{WS} > s_{WW}$, whenever $s_{SW} < 1$. Further, $s_{SS} = 1$.*

(ii) For all $i, j \in \{S, W\}$, $v_{ij}(s) \geq \overline{s}$, i.e. for a type i $E(1)$-borrower, forming an SHG with a type j $E(1)$-borrower is individually rational if and only if $s \leq s_{ij}$.

(iii) If $s_{SS} > s \geq s_{WW}$, then taking a loan is (strictly) individually rational for an SS-type group, but not a WW-type group.

Observation 2(iii) shows that for intermediate values of s, WW-type groups have no incentive to form.

Stage 3. Period 1. The bank makes the loan if and only if its expected payoff from making a loan is non-negative. We shall later argue that endogenous group-formation will lead to "PAM". We thus derive the expected payoff of the bank in case there is PAM, or PAM-SS.

Case (i). Suppose that there is PAM-SS (implying that $s_{WW} \leq s < s_{SS}$). Then only the SS-type groups will obtain the loan, and the expected payoff for the bank is

$$\overline{B}(s) = 2(1-s)(\lambda_S^2 r - 1). \tag{14}$$

Case (ii). Whereas if there is PAM (implying that $s < s_{WW}$), so that both types of groups will be interested in the loan, the expected payoff for the bank is

$$\overline{\overline{B}}(s) = 2(1-s)[r\frac{\lambda_S^3 + \lambda_W^3}{\lambda_S + \lambda_W} - 1]. \tag{15}$$

Note that $\overline{\overline{B}}(s) < \overline{B}(s)$, reflecting the fact that the bank faces a safer pool of borrowers in the first case.

Period 1. Stage 2. We then consider the endogenous group formation phase. The results are summarized in Proposition 2 below.

Proposition 2. *Let Assumptions 1 and 2 hold. Endogenous group-formation leads to PAM in case $s_{WW} > s$, and PAM-SS if $s_{SS} > s \geq s_{WW}$.*

Proof. There are three cases to consider.

(i) First suppose $s_{WW} > s$. From equations (10) - (12), there is PAM if and only if $v_{SS} + v_{WW} > v_{SW} + v_{WS}$, i.e. $(\lambda_S - \lambda_W)^2 Z > 0$. This is satisfied since, from A1, $Z = X - (1-s)r - e > 0$.

(ii) Next let $s_{WW} \leq s < s_{SW}$. There is PAM-SS provided $v_{SS} + \overline{s} > v_{SW} + v_{WS}$. This is satisfied since

$$v_{SS} + \overline{s} > v_{SS} + v_{WW} > v_{SW} + v_{WS},$$

where the last inequality follows from A1.

(iii) Finally, let $s_{SS} > s \geq s_{SW}$. In this case, the only feasible group-formation involves PAM-SS. ■

The intuition is as follows. It is sufficient to consider the case where $s_{WW} > s$. Clearly, for any borrower, having an S type partner is preferable to having an W type partner. This follows since, because of joint liability, an S-type borrower inflicts a lower cost on her partner in case she is not in control in the second period. Note, however, that this marginal contribution is valuable if and only if the borrower is herself empowered. Since an S-type borrower is more likely to be empowered herself, the marginal contribution is relatively more valuable to her. Hence the maximum a type W 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 W partner.

Stage 1. Period 1. We then solve for the optimal s set by the bank. To begin with, note that whenever $s_{WW} = 1$, screening out WW types groups is not possible (since $s \leq \overline{s} < 1$), so that the bank's payoff is $\overline{\overline{B}}(s)$. From A2(ii) and (15), group-lending is not feasible and the bank sets $s > \overline{s}$, so as to avoid making a loan. Whereas if $s_{WW} \leq \overline{s}$, then the WW-type groups can be screened out, so that the payoff of the bank is $\overline{B}(s)$. From (14) and A2(i), $\overline{B}(s) > 0$ for all $s \leq \overline{s}$. Moreover, since the bank's payoff is decreasing in s, it optimally sets s at the smallest possible level that allows for screening, i.e. s_{WW}. Thus the bank has a payoff of $\overline{B}(s_{WW}) > 0$.

We can now write down our next proposition.

Proposition 3. *Suppose Assumptions 1 and 2 hold. Joint liability lending leads to "PAM". Further, it is feasible if and only if WW-type groups can be screened out, i.e.* $v_{WW}(\overline{s}) = \lambda_W^2[X - (1-\overline{s})r - e] \leq \overline{s}$. *In case joint liability lending is feasible, the optimal s set by the bank equals s_{WW}.*

Thus joint liability lending leads to "positive assortative matching" among empowered borrowers. Further, for some parameter configurations, groups consisting of weak borrowers can be screened out using an appropriate level of s, viz. s_{WW}.

4.4 Incentive for "Positive Assortative Matching"

As the preceding analysis shows, the nature of group-formation, in particular the formation of SS-type groups, is critical to the success of JLL. In this sub-section we therefore examine the effect of a change in the savings pre-requisite, s, on the incentive for "PAM" vis-a-vis NAM.

Let $I(s)$ denote the incentive for "PAM". Clearly, $I(s)$ is the difference between the aggregate payoffs of one S-type and one W-type borrower under two alternative scenarios, namely "PAM" and NAM.

We then turn to providing a formal definition of $I(s)$. Clearly, if $s_{WW} > s$, then the choice is between PAM and NAM. Whereas if $s_{SW} > s \geq s_{WW}$, then the choice is between PAM-SS and NAM. Finally, if $s_{SS} > s \geq s_{SW}$ then the choice is between PAM-SS and not forming any group. Hence we have the following

Definition. Let

$$I(s) = \begin{cases} v_{SS}(s) + v_{WW}(s) - v_{SW}(s) - v_{WS}(s), & \text{if } s_{WW} > s, \\ v_{SS}(s) + \overline{s} - v_{SW}(s) - v_{WS}(s), & \text{if } s_{SW} > s \geq s_{WW}, \\ v_{SS} - \overline{s}, & \text{if } s_{SS} > s \geq s_{SW}. \end{cases}$$

It is easy to see that $v_{SS}(s) + v_{WW}(s) - v_{SW}(s) - v_{WS}(s) = (\lambda_S - \lambda_W)^2 Z(s)$, which is increasing in s. Next observe that $v_{SS}(s) + \overline{s} - v_{SW}(s) - v_{WS}(s) = (\lambda_S^2 - 2\lambda_W \lambda_S) Z(s) + \overline{s}$. This is increasing in s if and only if $\lambda_S > 2\lambda_W$.

Proposition 4 shows that the incentive for SS-type group formation may be non-monotonic in s. It is increasing in s as long as the two types are not too similar in terms of their levels of empowerment. If, however, the empowerment levels are sufficiently close, and s is at an intermediate level, then an increase in s may *reduce* the incentive for "PAM".

Proposition 4. *Let Assumptions 1 and 2 hold.*

(i) Suppose $s < s_{WW}$. *Then* $I(s)$ *is increasing in* s.

(ii) Suppose $s_{WS} > s \geq s_{WW}$. *Then* $I(s)$ *is decreasing in* s *if* $\lambda_S < 2\lambda_W$, *and increasing in* s *if* $\lambda_S > 2\lambda_W$.

(iii) Suppose $s_{SS} > s \geq s_{WS}$. *Then* $I(s)$ *is increasing in* s.

Proof. (i) In this case forming all three types of groups, SS, WW and SW, are individually rational.

(ii) In this case forming SS and SW type groups are individually rational, but not WW type groups.

(iii) In this case only SS-type groups are individually rational. ■

Consider Proposition 4(i). With an increase in s, the borrowers have to invest more of their own money in the projects and thus have a greater incentive to ensure that they are not affected by their partner's failure. Thus, having an S type partner becomes even more important. While this is true for both kinds of borrowers, given that S-types have a higher probability of being empowered, it is even more so for S type borrowers.

We then consider Proposition 4(ii). In this case the alternatives involve PAM-SS and NAM. Recall that under PAM-SS, the W-type borrowers remain single, so that their payoff, $\bar{s}$, is independent of s. Thus the aggregate payoff under PAM-SS is not that sensitive to an increase in s, hence the result. If, however, the S-types are relatively much more empowered compared to the S-types (formally $\frac{\lambda_S}{\lambda_W} > 2$), then the aggregate payoff under PAM-SS, i.e. $v_{SS} + v_{WW}$, still increases sufficiently fast compared to that under NAM, i.e. $2v_{SW}$, so that $I(s)$ is increasing in s.

Proposition 4 has some important policy implications. While, in the present framework, "PAM" is going to take place even if $s = 0$, one can conceive of situations where other factors, e.g. social and kinship ties, may threaten to turn the balance in favor of NAM. In such cases, if $\lambda_S < 2\lambda_W$ and s is at an intermediate level, then an increase in s may lead to NAM. This suggests that, from a policy perspective, the savings requirement, s, needs to be used to with care.

5 Comparing Individual and Group-lending

In this section we argue that for a large range of parameter values group-lending dominates individual lending as far as the payoff of the bank is concerned. This provides a rationale for group-lending under such two stage lending procedures. Interestingly, we also find that under certain conditions individual lending may dominate group-lending.

For ease of exposition we first consider a *hypothetical* situation where the extent of screening is the same under both institutional forms. Thus, under both forms, either there is complete screening out of W-type borrowers, or there is no screening out of W-types except to the extent that those who cannot save in period 1 are screened out. In that case, Proposition 5 shows that individual lending dominates JLL, in the sense that all agents, the borrowers, as well as the bank, prefer the former.[21]

Proposition 5. *Let Assumptions 1 and 2 hold.*
(i) $v_S(r) > v_{SS}(r)$.
(ii) $v_W(r) > v_{WW}(r)$.
(iii) $B'(r) > \overline{B}(r)$*, and* $B''(r) > \overline{\overline{B}}(r)$.

[21] It should be recognized though, that our framework abstracts from some of the positive effects of group-lending recognized in the literature, namely peer monitoring (see, e.g. Banerji et al., 1994) and social capital (see, e.g. Besley and Coate, 1995).

While the proof of Proposition 5 is trivial,[22] the intuition is interesting and follows from what we term the *contagion effect*. Under JLL, the borrowers are liable to pay for their partner's default. Knowing this, an $E(2)$-borrower who knows that her partner is going to shirk, has no incentive to work herself. Such contagion effects are absent under individual lending, so that the incentive to work is greater in this case.[23]

Further, Proposition 5(iii) demonstrates that the bank also prefers individual lending. Again the logic follows from the contagion effect. In case both lending mechanisms have the same degree of screening, the only reason the bank may prefer JLL is that there may be cross-subsidization in the sense that a successful borrower may repay on behalf of an unsuccessful one. The contagion effect, however, ensures that if one borrower shirks, then so necessarily will the other one. Thus cross-subsidization cannot take place in this framework.

Strikingly enough, despite Proposition 5, JLL may dominate individual lending as far as feasibility is concerned. The argument turns on the fact that while screening out bad borrowers is possible under both forms of lending, under JLL such screening takes place for a lower value of r. Thus, for intermediate values of r, while such screening can take place under JLL, it cannot under individual lending. This provides a rationale for JLL, even though, the effort levels under JLL is lower compared to that under individual lending because of the contagion effect.

We need some more notations. Let

[22] The proof follows from a straightforward comparison of equations (2), (3), (5), (6), (10), (11), (12), (14) and (15).

[23] While the contagion effect discussed above is reminiscent of the negative effect of JLL identified by Besley and Coate (1995), unlike them we consider a scenario where project returns are observable. The group aspect of JLL has some other negative aspects, e.g. borrowers may collude against the bank. Further, the extreme punishments used under JLL may create frictions between the borrowers and the loan officers (see, Aghion and Morduch, 2005).

$$r_W(\overline{s}) = \begin{cases} r'_W(\overline{s}), & \text{if } r'_W(\overline{s}), \text{ solving } v_W(\overline{s}, r) = \overline{s}, \text{ is well defined,} \\ 0, & \text{otherwise,} \end{cases}$$

where note that $r'_W(\overline{s}) = \frac{\lambda_W(X-e)-\overline{s}}{\lambda_W(1-\overline{s})}$ is well defined if $v_W(\overline{s}, r)|_{r=0} = \lambda_W(X-e) > \overline{s}$.

Similarly, let

$$r_{WW}(\overline{s}) = \begin{cases} r'_{WW}(\overline{s}), & \text{if } r'_{WW}(\overline{s}), \text{ solving } v_{WW}(\overline{s}, r) = \overline{s}, \text{ is well defined,} \\ 0, & \text{otherwise,} \end{cases}$$

where note that $r'_{WW}(\overline{s}) = \frac{\lambda_W^2(X-e)-\overline{s}}{\lambda_W^2(1-\overline{s})}$ is well defined if $v_{WW}(\overline{s}, r)|_{r=0} = \lambda_W^2(X-e) > \overline{s}$.

The following observation is central to our analysis. Observations 3(i) and (ii) follow from the fact that $v_W(\overline{s}, r)$ and $v_{WW}(\overline{s}, r)$ are both decreasing in r. Observation 3(iii) follows from Proposition 5(ii) (see Figure 3).

Observation 3. *(i) Consider individual lending.* $v_W(\overline{s}, r) \geq \overline{s}$, *i.e., for a W type borrower, taking a loan is individually rational, if and only if* $r \leq r_W(\overline{s})$.

(ii) Consider group-lending. $v_{WW}(\overline{s}, r) \geq \overline{s}$, *i.e., for a W type borrower, taking a loan under PAM is individually rational, if and only if* $r \leq r_{WW}(\overline{s})$.

(iii) $r_W(\overline{s}) > r_{WW}(\overline{s})$, *whenever* $r_W(\overline{s}) > 0$.

Suppose $r_{WW}(\overline{s}) \leq r < r_W(\overline{s})$. Then, from Observation 3(i), for any $s \leq \overline{s}$, W type borrowers cannot be screened out under individual lending. Thus from A2(ii), individual lending is not feasible. Whereas under group-lending, there is assortative matching (PAM-SS to be precise), and moreover, WW type groups can be screened out for an appropriate choice of s (Observation 3(ii)). Thus the bank's payoff in this case is $\overline{B}(s_{WW}) > 0$.

Next suppose that r is relatively high, i.e. $r > r_{WW}(\overline{s})$. From Observation 3, W-type borrowers can be screened out under both both forms of lending. Thus under individual lending the bank has a payoff of $B'(s_W) =$

$2(1-s_W)(\lambda_S r-1)$, whereas under group-lending it has a payoff of $\overline{B}(s_{WW}) = 2(1-s_{WW})(\lambda_S^2 r-1)$. While from A2(i) both are feasible, whether $B'(s_W)$ is greater or less than $B(s_{WW})$, is ambiguous.

There are two effects at play here. While the contagion effect suggests that $B'(s_W)$ is likely to be greater, the fact that screening requires a higher level of s under individual lending, i.e. $s_W > s_{WW}$ ((4) and (13)), suggests that $\overline{B}(s_{WW})$ is likely to be greater. Suppose, for example, that λ_S is large. Then the contagion is effect is negligible and $\overline{B}(s_{WW}) > B'(s_W)$. Whereas if λ_W is small, then s_W is close to s_{WW}, so that $B'(s_W) > \overline{B}(s_{WW})$.

Finally, suppose $r < r_{WW}(\overline{s})$. Then weak borrowers cannot be screened out under either individual, or joint liability lending. From A2(ii), neither is feasible.

Summarizing the above discussion we obtain Proposition 6, which is the main result of this section.

Proposition 6. *Let Assumptions 1 and 2 hold.*

(i) If $r_{WW}(\overline{s}) \leq r < r_W(\overline{s})$, then group-lending is feasible while individual lending is not, i.e. $\overline{B}(s_{WW}) > 0 > B''(s)$, $\forall s \leq \overline{s}$.

(ii) If $r_W(\overline{s}) < r$, then both group-lending and individual lending are feasible. Whether the bank prefers individual or group-lending is, however, ambiguous. Individual lending is preferred if λ_W is small, whereas group-lending is preferred if λ_S is large.

The following example demonstrates that Proposition 6 is not vacuous.

Example. (i) Consider the case where $X = 2$, $e = 0.5$, $\overline{s} = 1/8$, $r = 81/70$, $\lambda_S = 1$ and $\lambda_W = 1/2$. It is clear that Assumptions 1 and 2 are satisfied. Further, in this case $r_W(\overline{s}) = 10/7 > r > 8/7 = r_{WW}(\overline{s})$. Thus the hypothesis of Proposition 6(i) is satisfied.

(ii) Consider the case where $X = 2$, $e = 0.5$, $\overline{s} = 1/8$, $r = 138/119$, $\lambda_S = 1$ and $\lambda_W = 1/4$. Assumptions 1 and 2 are satisfied. Further, in this case $r > r_W(\overline{s}) = 8/7$. Thus the hypothesis of Proposition 6(ii) is satisfied.

While the Grameen bank, and the innumerable Grameen replicators, all adopt a group-lending methodology, there are many micro-finance organizations who do not. In particular, the Bank Rakyat Indonesia (BRI), the largest micro-finance organization in the world, uses individual lending. It is therefore important to identify conditions under which one or the other lending mechanism may be preferable. Our results suggest that the choice of institutional forms may be related to the rate of interest, with an intermediate interest rate favoring a group-lending scheme, whereas a higher level may favor individual lending.

5.1 Optimal Choice of the Savings Pre-requisite

We then examine if the level of s chosen in Proposition 6 is the socially optimal one. It is easy to see that the aggregate payoff of the bank and the two recipient borrowers is independent of s. Consider Proposition 6(i). Under group-lending the loan is made to an SS-type group so that the aggregate payoff equals

$$2v_{SS}(s) + \overline{B}(s) = 2[\lambda_S^2(X - e) - 1 + \overline{s}],$$

which is independent of s. A similar argument can be made in the other cases also.[24] The intuition is simple. Both the bank, as well as the borrowers can transform one unit of capital into one unit of output. Thus it does not matter whether a project is funded by the bank, or the borrowers. This suggests that the level of s chosen in equilibrium is socially optimal.

[24]Consider Proposition 6(i). Under individual lending the loan is made to two borrowers who are randomly picked out of those saving s. The expected aggregate payoff in this case equals: $2[\frac{\lambda_S v_S(s)}{\lambda_S+\lambda_W} + \frac{\lambda_W v_W(s)}{\lambda_S+\lambda_W}] + B''(s) = 2[\frac{\lambda_S^2+\lambda_W^2}{\lambda_S+\lambda_W}(X-e) - 1 + \overline{s}]$, which is independent of s. Next consider Proposition 6(ii). Under individual lending the loan is advanced to two S-type borrowers, when the aggregate payoff equals $2v_S(s) + B'(s) = 2[\lambda_S(X-e) - 1 + \overline{s}]$, which is independent of s.

In the present context, however, it may be equally reasonable to assume that the borrowers cannot necessarily transform one unit of savings into one unit of output. Even if the borrowers are empowered, opportunities for productive consumption and safe voluntary savings instruments may be limited. Thus a borrower may be able to transform only a fraction $0 < \mu < 1$ of her period 1 savings into output. In that case it is easy to see that the optimal s equals $\overline{s}$.[25] Since in this case the bank is more efficient in transforming capital into output, it is optimal to use as little of the bank money in the project as possible. Consequently, the equilibrium level of s chosen by the bank is sub-optimal.

Remark. Let us briefly analyze the effect of introducing voluntary savings instruments, as well as compulsory savings in such a scenario. Consider voluntary savings first. The effect of such a scheme would be to increase μ to $\mu' > \mu$, so that borrower payoffs increase. Suppose that the equilibrium involves group-lending with the WW-types being screened out. Since $v_{WW}(s, \mu') > v_{WW}(s, \mu)$, the savings pre-requisite needed to screen-out WW-types groups also increases, i.e. $s_{WW}(\mu') > s_{WW}(\mu)$. Thus the equilibrium level of s also increases to $s_{WW}(\mu')$, so that it is closer to the socially optimal level $\overline{s}$. Thus, in addition to the direct effect which is captured by an increase in μ, introduction of voluntary savings instruments leads to an increase in the equilibrium level of s, which is socially optimal.

We then consider the effect of introducing a compulsory savings component. Clearly, this does not affect the borrower's payoff when she works, but reduces it when she shirks. Thus, for the same level of s, the borrower payoff is reduced. Suppose that the equilibrium involves group-lending with the WW-types being screened out. Since $v_{WW}(s)$ decreases, the savings pre-

[25] Consider the case where under group-lending the loan is made to an SS-type group. In this case, $v_{SS}(s) = \lambda_S[X-(1-r)s-e]+\mu(\overline{s}-s)$. Consequently, the aggregate payoff of the bank and the two SHG members equals $2v_{SS}(s)+\overline{B}(s) = 2[\lambda_S^2(X-e)-1+\mu\overline{s}+s(1-\mu)]$, which is increasing in s. A similar argument holds for the other cases.

requisite needed to screen-out WW-types groups, i.e. s_{WW} also decreases, so that it is moves away from the socially optimal level $\bar{s}$. Thus introducing compulsory savings instruments yields a negative fallout in our framework in that it leads to an decrease in the equilibrium level of s.

A full analysis of the effects of introducing compulsory and voluntary savings is beyond the scope of the present paper though, and must await future work.

5.2 Endogeneity of λ_i

Thus far the level of borrower empowerment is taken to be exogenous, in particular we assume that getting a loan in period 1 does not affect the empowerment level in the next period. It may be argued though, that a borrower who obtains a loan will have a greater say in the household allocation process in the second period.[26] As pointed out by Basu (2006), though, this process is likely to take some time. For analytical simplicity, we considered an extreme form of this assumption where there is no change in the level of empowerment within the time-frame considered.

It is clearly of interest to allow for such endogeneity though. It is often argued, for example, that group-lending, because of interaction among the borrowers, generates a high level of social capital. This, in turn, leads to empowerment, so that empowerment levels are higher under group-lending compared to that under individual lending. Let us formalize this by assuming that under group-lending the empowerment level of a type i borrower is λ_i' in period two, whereas that under individual lending is still λ_i, where

[26]This is explicitly acknowledged in the literature on household decision making. Bourguignon and Chiappori (1994) and Moehling (1995), for example, assume that the level of empowerment depends on the female wage rate. Basu (2006), on the other hand, argues that this depends not just on the wage rate, but on what the women actually earn. There is some ambiguity in the micro-finance literature on this point though, see Aghion and Morduch (2005).

$\lambda_i' > \lambda_i$. As long as the contagion effect dominates the social capital effect, in the sense that $\lambda_W'^2 < \lambda_W$, then $v_{WW} < v_W$, so that $r_{WW} < r_W$. Hence a version of Proposition 6(i) still goes through. If the social capital effect is very strong though, in the sense that $\lambda_W'^2 > \lambda_W$, then $v_{WW} > v_W$, so that $r_{WW} > r_W$. Hence, for intermediate values of r, it may be possible that weak types are screened out under individual lending, but not under group-lending.

Next let us consider a scenario where, in period 2, the borrower is no longer in control of household income. Our paper makes the not too unrealistic assumption that in this case the borrower has the option of not working on her project. We can conceive of situations, however, where this is not an option open to the borrower, and she has to obey the dominant male in the household. In that case the effort level put in by the borrower is likely to be higher (compared to the case where the borrower is in control), since the dominant male may not internalize the effort cost of the borrower. Thus, somewhat perversely, this may improve feasibility. Of course, in that case the borrower may not be willing to take a loan in the first place.

Another issue relates to the effect of such endogeneity on the *average* level of empowerment in the community. In case the strong borrowers get even stronger, the bank would have a greater incentive to make repeat loans to the same SHG. Further, it is easy to see that the incentive for "PAM", i.e. $I(s)$, would also increase. It is possible that strong borrowers are also borrowers with greater social capital, and it is this social capital that is part of their strength. If that indeed is the case, then provision of loans to strong borrowers may have the largest impact on the community, since the recipients are also the potential leaders, being those with the largest social capital. Otherwise, the impact may be limited, with the initial recipients alone continuing to flourish.

Clearly a complete analysis of these issues is beyond the scope of this paper. Our purpose in discussing them, however briefly, is to suggest that our framework may be of use in understanding some of the rich complexities associated with the group-lending process.

6 Discussion

In this section we discuss some robustness issues, as well as relate the analysis to some relevant issues.

To begin with we discuss the roles played by Assumptions 1 and 2. The first part of A1, that $2r(1-\overline{s}) > X$, implies that in case one borrower works and the other one shirks, then the whole of X is taken away by the bank under joint liability. While this simplifies the exposition, by making the contagion effect more stark,[27] the basic point, that joint liability reduces the incentive to work, would still go through in its absence. The last part of A1, that $X - e > r$, ensures that working is optimal under individual lending (as well as under group-lending if the other member of the SHG also works). Clearly in the absence of such an assumption the problem is not interesting.

A2 ensures that lending, either individual or group, is feasible if and only if the W-types can be screened out. A2 clearly simplifies the exposition, in particular that of Proposition 6(i). Even in its absence, however, it can be argued that for intermediate value of r, screening out weak borrowers is possible under group-lending, but not under individual lending. Hence the bank may still prefer joint liability lending to individual lending, so that the central economic intuition behind Proposition 6(i) still goes through.

In the group-lending literature solving for the group size constitutes an unresolved issue. While a full resolution of this question is beyond the scope of the present paper, our analysis identifies some of the costs and benefits associated with a larger group-size. On the negative side, a larger group-size increases the contagion effect. On the positive side though, a larger group-

[27] In fact, the analysis goes through under the weaker assumption that $X - 2(1-\overline{s})r < e$.

size may, because of the same contagion effect, reduce the rate of interest required to screen out weaker groups.

In the Indian SHG-linkage program, lending may also be contingent on other aspects of borrower discipline, in particular repayment of internal loans. While we abstract from this issue in this paper, our analysis is of some relevance here. It may be argued that the repayment of internal loans, like the savings pre-requisite, provides a signal about borrower discipline, i.e the level of borrower empowerment, and helps to weed out weak borrowers.[28]

Finally, note that the Indian SHG-linkage program also has other features in common with Grameen, e.g. sequential lending, dynamic incentives, etc. Most of these, however, are reasonably well understood. Sequential lending has been analyzed by Aniket (2007) and Roy Chowdhury (2005, 2007). Ghatak and Guinanne (1998) and Roy Chowdhury (2007) analyze some aspects of dynamic incentives. This literature, however, is mostly in the context of Grameen like schemes. It may be of interest to examine if the intuitions gleaned from them go through in the context of the SHG-linkage program.

7 Conclusion

This paper examines the role of savings and borrower empowerment in micro-finance. We consider a micro-finance scheme where the provision of loans is conditional on prior savings. The savings scheme is different from compulsory savings in that the savings are not locked in, and provides a direct channel whereby savings can be transformed into assets. In a dynamic group-lending model with moral hazard, endogenous group-formation and joint liability, we examine the effect of such schemes on the allocation of loans between empowered and weak borrowers. We demonstrate that group-

[28] We refer the readers to Aniket (2006, 2007) for a different, though complementary, justification of this requirement.

formation leads to "positive assortative matching." Our analysis suggests that the savings requirement, s, performs two roles. First, it affects the incentive for SS-type group formation. As long as the borrower groups are not too similar in terms of empowerment, an increase in s increases the incentive for "PAM". Otherwise, however, an increase in s may adversely affect the incentive for "PAM". Second, under some parameter configurations, s can be used to screen out the weak types.

We then compare group-lending with individual lending. We find that the analysis hinges on the contagion effect, that, because of joint liability, incentive to work is greater under individual lending. For intermediate values of the rate of interest, group-lending allows for screening out of weak borrowers and is thus feasible, while individual lending, which does not allow for such screening out, is not. Whereas for relatively high rates of interest, while weak types will be screened out under both institutional forms, because of the contagion effect, the bank may prefer individual lending over group-lending.

Finally, our analysis allows us to draw some tentative policy conclusions:

1. In case the rate of interest is at an intermediate level, then group-lending with joint liability is more likely to be feasible compared to individual lending.

2. Whereas if the rate of interest is relatively large, and the weak types are extremely dis-empowered, then individual lending is more likely to be feasible compared to group-lending.

3. As a policy tool, the savings pre-requisite needs to be used with care since an increase in the savings requisite may lead to negative assortative matching.

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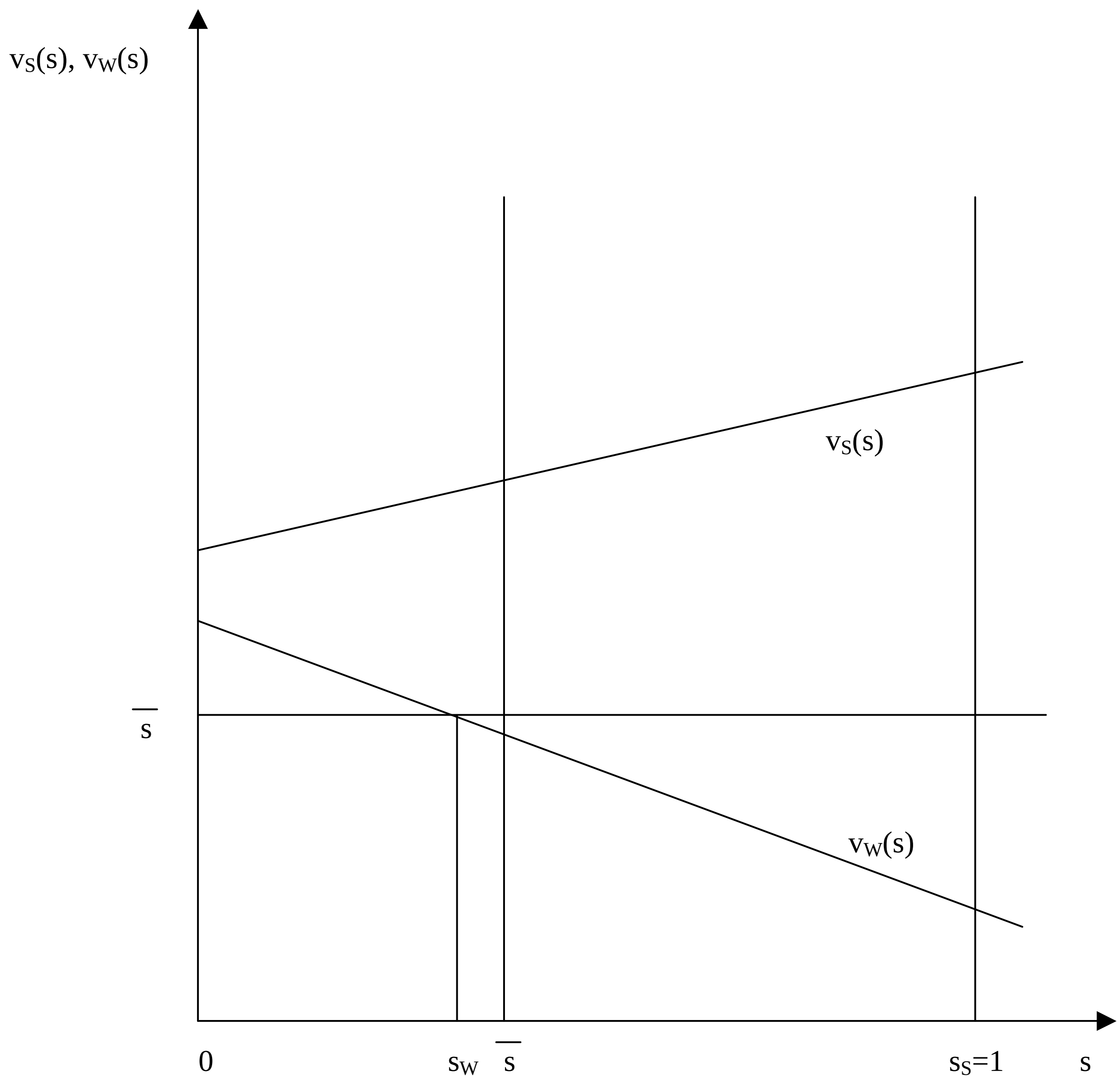

Figure 1

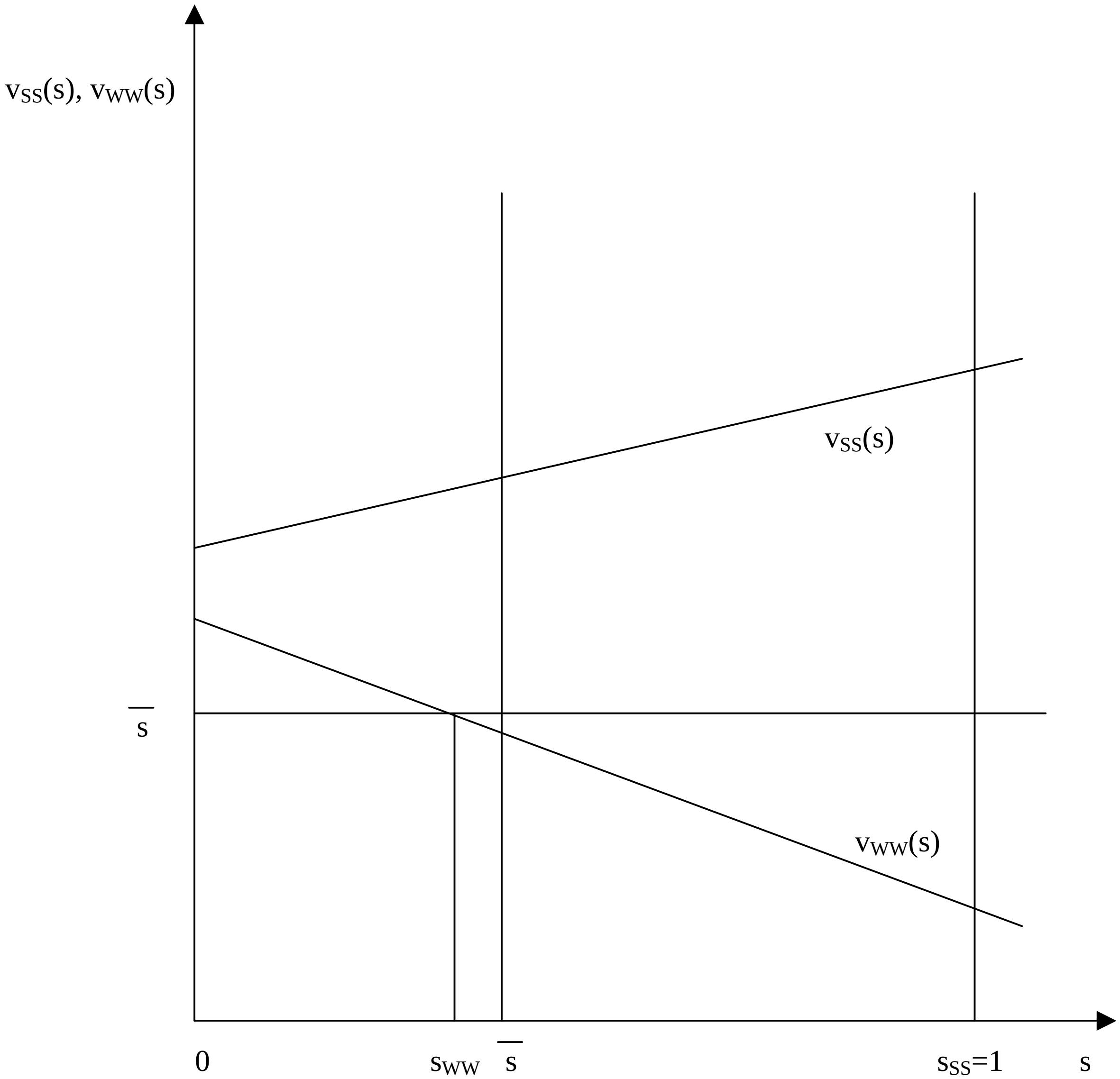

Figure 2

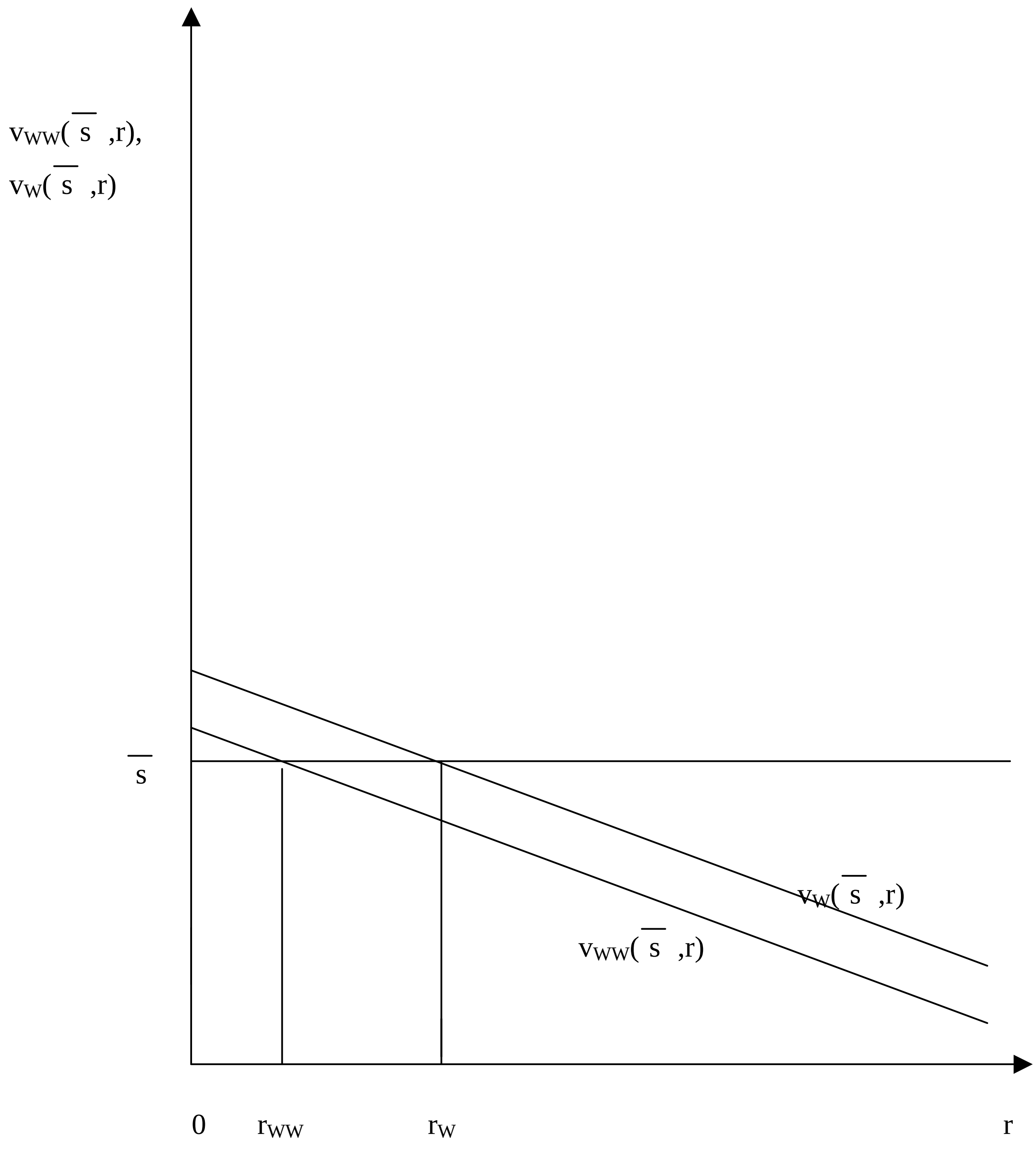

Figure 3