

# Group Lending Without Joint Liability

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## Abstract

This paper contrasts individual liability lending with and without groups to joint liability lending. By doing so, we shed light on an apparent shift away from joint liability lending towards individual liability lending by some microfinance institutions. First we show that individual lending with or without groups may constitute a welfare improvement so long as borrowers have sufficient social capital to sustain mutual insurance. Second, we explore how a purely mechanical argument in favor of the use of groups - namely lower transaction costs - may actually be used explicitly by lenders to encourage the creation of social capital. We also carry out some simulations to evaluate quantitatively the welfare impact of alternative forms of lending, and how they relate to social capital.

**Keywords:** micro finance; group lending; joint liability; mutual insurance

## 1 Introduction

While joint liability lending by microfinance institutions (MFIs) continues to attract attention as a key vehicle of lending to the poor, recently some MFIs have moved away from explicit joint liability towards individual lending. The most prominent such

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institutions are Grameen Bank of Bangladesh and BancoSol of Bolivia.<sup>1</sup> However, interestingly, Grameen and others have chosen to retain the regular group meetings that traditionally went hand-in-hand with joint liability lending.

Now it should be pointed out that in the absence of good panel data on lending methods it cannot be conclusively said that there has been a significant overall decline in joint liability among MFIs worldwide just on the basis of various anecdotes about a handful of high-profile MFIs. Indeed, existing evidence suggests that joint liability continues to be widely used. For example, de Quidt et al. (2012) use a sample of 715 MFIs from the MIX Market (Microfinance Information Exchange) database for 2009, and estimate that 54% of loans are made under “solidarity group” lending as opposed to “individual” lending.<sup>2</sup>

Nevertheless, these phenomena raise the question of the costs and benefits of using joint liability, and the choice between group loans with and without (explicit) joint liability. Besley and Coate (1995) is one of the first papers to point out both benefits and costs of joint liability: joint liability can increase repayment rates by inducing borrowers to repay on behalf of their unsuccessful partners but there are also states of the world where an individual borrower may default because of this burden, even if she was willing to pay back her own loan. Using a limited enforcement or “ex-post moral hazard” framework introduced by Besley and Coate (1995) in the group lending context, in this paper we study two issues raised by this apparent shift.

First, we analyze how by leveraging the borrowers social capital, individual liability lending (henceforth, IL) can mimic or even improve on the repayment performance and borrower welfare of explicit joint liability (EJ). When this occurs, we term it “implicit joint liability” (IJ). For this argument to work, there is no need for group lending per se - borrowers can, in theory, sustain this without any explicit effort on the part of the lender. Second, to understand better the logic of group lending,

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<sup>1</sup>For a discussion of the reasons for the shift in Grameen Bank’s lending strategy, see Muhammad Yunus’s article “Grameen Bank II: Lessons Learnt Over Quarter of A Century,” at [http://www.grameen.com/index.php?option=com\\_content&task=view&id=30&Itemid=0](http://www.grameen.com/index.php?option=com_content&task=view&id=30&Itemid=0), accessed 18 December 2012.

<sup>2</sup>An earlier study Cull et al. (2009) puts this number at 51% using 2002/04 data involving 315 institutions. The year 2009 is one for which the largest cross-section of lending methodologies is available. Solidarity group loans defined by MIX as those for which “some aspect of loan consideration depends on the group, including credit analysis, liability, guarantee, collateral, and loan size and conditions.” Individual loans are “made to individuals, and any guarantee or collateral required comes from that individual.” We excluded 154 “village banks” for which lending methodology is unclear. See <http://www.mixmarket.org/about/faqs/glossary>.

we introduce a purely operational argument for its use under IL, namely, it simply reduce the lender's transactions costs, shifting the burden to the borrowers. This is valuable because lower interest rates relax the borrowers' repayment incentive constraints, increasing repayment and welfare. We then show how this related to first issue: group lending may contribute to the creation of social capital, and therefore, may induce IJ.<sup>3</sup>

Next we carry out some simple simulation exercises using empirically estimated parameters. The goal is to complement the theoretical analysis and to get a quantitative sense of the welfare effects as well as the relevant parameter thresholds that determine which lending method is preferred. Our key findings are as follows. First, in low social capital environments, EJ does quite well compared to IJ. For example, when the standard deviation of project returns of 0.5, for social capital worth 10% of the loan size, the welfare attainable under IJ is 32.4% lower compared to the welfare under EJ. However, with social capital worth 50% of the loan size, the welfare attainable under EJ is 5% lower to the one attainable under IJ. Second, we find that the interest rate, repayment rate and borrower welfare are all rather insensitive to social capital under EJ, whereas in the case of IJ, they are all highly sensitive. This is what we would expect, since the only sanction available under IJ is coming through social capital. Third, when project returns are high variance, the welfare gains from higher social capital are quite large under IJ, which is not the case under EJ. To illustrate consider the case where project returns have a standard deviation of 0.5. If borrowers share social capital worth 10% of the loan size, borrower welfare under IJ is 35.9% lower than that of borrowers who share social capital worth 50% of the loan size.

Our analysis is motivated by two influential recent empirical studies. Giné and Karlan (2011) found that removing the joint liability clause, but retaining the group meetings, of a random subset of borrowing groups of Green Bank in the Philippines had no meaningful effect on repayment rates. In our model, this outcome arises when the newly individually liable groups have sufficient social capital to continue to assist one another with repayments, as under EJ. Secondly, Feigenberg et al. (2011) randomly varied the meeting frequency of individually liable borrowing groups

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<sup>3</sup>It could even be that without the group, borrowers would be less able to interact. Indeed, in some conservative societies, social norms may prevent women from attending social gatherings (for instance under the Purdah customs in some parts of India and the Middle East). Then externally mandated borrowing groups can be a valuable vehicle for social interaction. See, for instance Sanyal (2009), Anderson et al. (2002), Kabeer (2005).

of the Village Welfare Society in India. They found that groups who met more frequently had subsequently higher repayment rates. In particular, they present evidence suggesting that this is due to improved informal insurance among these groups due to higher social capital. Both Giné and Karlan (2011) and Feigenberg et al. (2011) find evidence for intra-group transfers to help a borrower repay her loan even without explicit joint liability.<sup>4</sup> We argue that more frequent group meetings give borrowers a stronger incentive to build social capital, and that this is then leveraged to generate IJ. Grameen Bank states that Grameen II is designed to “lean on solidarity groups: small informal groups consisting of co-opted members coming from the same background and trusting each other.”<sup>5</sup> The emphasis on trust suggests that the group continues to play an important role in Grameen’s lending methodology beyond simply moderating the lender’s transaction costs.

The main conclusion of our analysis is that it is premature to write off EJ as a valuable contractual tool and group lending without (explicit) joint liability may still harness some of the benefits of joint liability via implicit joint liability. Thus far we have one high quality randomized study of contractual form (Giné and Karlan (2011)) in which EJ seems not to play an important role. However in our theoretical analysis there are always parameter regions over which EJ is the most efficient of the simple contracts we analyze. A recent randomized control trial by Attanasio et al. (2011) finds stronger consumption and business creation impacts under EJ (albeit no significant difference in repayment rates - note that in their context mandatory group meetings are not used under either IL or EJ). Carpena et al. (2010) analyze an episode in which a lender switched from IL to EJ and found a significant improvement in repayment performance. For the same reasons, Banerjee (2012) stresses the need for more empirical work in the vein of Giné and Karlan (2011) before concluding that EJ is no longer relevant.

It is instructive to briefly look at the types of contracts currently used by MFIs. As mentioned, from the MIX dataset, 54% of borrowers were borrowing under what

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<sup>4</sup>In table IX of Giné and Karlan (2011) we see that conversion to individual liability caused a decrease, significant at 10%, in side-loans between borrowers, although no significant effect on borrowers “voluntarily [helping others] repay loans”. Note that one challenge of interpreting these results in the light of our analysis is that group composition changed in Giné and Karlan (2011)’s experiment, while our model analyzes contract choice for a given level of social capital. Converted centers tended to take in members that were less well-known by existing members, presumably because individual liability made doing so less risky.

<sup>5</sup>See [http://www.grameen-info.org/index.php?option=com\\_content&task=view&id=33&Itemid=107](http://www.grameen-info.org/index.php?option=com_content&task=view&id=33&Itemid=107), accessed 28th September, 2012.

are classified as solidarity group loans. Although the solidarity group loans might not correspond exactly to pure EJ, this is the best measure we have. Our concept of IJ is most relevant to the “individual” category; the MIX Market notes that “loans based on consideration of the sole borrower, but disbursed through and recollected from group mechanisms, are still considered individual loans.” A notable example is the Indian MFI Bandhan, which is one of the top MFIs in India, and is listed as having 3.6m outstanding loans in 2011, all classified as “individual”. Bandhan does not use joint liability but disburses the majority of its loans through borrowing groups. Unfortunately, we do not have data on the method of disbursement of the full sample of loans classified as individual, but it seems likely that many institutions are indeed using groups to disburse individual loans. This paper highlights how this may improve welfare through two channels: first of all, borrowers with sufficient social capital can mutually insure one another and secondly, attending costly group meetings may give borrowers incentives to invest in social capital.

Much of the existing theoretical work has sought to show how explicit joint liability improves repayment rates (see Ghatak and Guinnane (1999) for a review). In the model of Besley and Coate (1995), joint liability gives borrowers an incentive to repay on behalf of their partner when the partner is unable to repay her own loan. If borrowers can threaten social sanctions against one another, this effect is strengthened further. However, there are two problems with EJ. Firstly, since repaying on behalf of a partner will be costly, incentive compatibility requires the lender to use large sanctions and/or charge lower interest rates, relative to individual liability.<sup>6</sup> Secondly, when a borrower is unsuccessful, sometimes EJ induces the successful partner to bail them out, but sometimes it has a perverse effect, inducing them to default completely, while under IL they would have repaid. Rai and Sjöström (2004) and Bhole and Ogden (2010) approach these issues from a mechanism design perspective - designing cross-reporting mechanisms or stochastic dynamic incentives that minimize the sanctions used by the lender. Baland et al. (2010) provide an alternative explanation of the apparent trend away from what we call EJ towards IL, based on loan size. They find that the largest loan offered under IL cannot be supported under joint liability and that the benefits of the latter are increasing in borrower wealth. We do not focus on this angle but briefly touch on the issue of loan

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<sup>6</sup>This issue is the focus of the analysis in Rai and Sjöström (2010). Because of this, de Quidt et al. (2012) show that with a for-profit monopolist lender borrowers are better off under EJ than IL lending, because the lender must typically charge lower interest rates under EJ.

size in section 2. Allen (2012) shows how partial EJ, whereby borrowers are liable only for a fraction of their partner's repayment, can improve repayment performance by optimally trading off risk-sharing with the perverse effect on strategic default. In contrast, we focus on how simple group lending with no joint liability can achieve some of these effects, as side-contracting by the borrowers can substitute for the lender's enforcement mechanism.

Our model is also related to Rai and Sjöström (2010). In that paper, borrowers are assumed to have sufficient social capital to support incentive-compatible loan guarantees through a side-contract between borrowers, provided they have sufficient information to enforce such side contracts. The role of groups is to provide publicly observable repayment so as to enable efficient side-contracting. In contrast, in our setting, repayment behavior is common knowledge among the borrowers, and it is the amount of social capital that is key. Groups play a role that depends on meeting costs introduced in the next two sections. Secondly, in our model, borrowers are better off when they guarantee one another as their probability of contract renewal is higher. In Rai and Sjöström (2010) this is not the case as the lender is simply assumed to use a punishment that simply imposes a utility cost on the borrowers in case of default. In fact, the optimal contract delivers the same borrower welfare whether they guarantee one another or not.

Other than the above mentioned papers, our paper is also broadly related to the theoretical literature in microfinance that have emerged in the light of the Grameen Bank of Bangladesh abandoning explicit joint liability and switching to the Grameen II model, focusing on aspects other than joint liability, such as sequential lending (e.g., Chowdhury (2005)), frequent repayment (Jain and Mansuri (2003), Fischer and Ghatak (2010)), exploring more general mechanisms than joint liability (e.g., Laffont and Rey (2003)), and exploring market and general equilibrium (Ahlin and Jiang (2008); McIntosh and Wydick (2005) and de Quidt et al. (2012)).

The paper is structured as follows: in section 2 we present the basic model where in principle lending may take place with or without group meetings. We introduce our concept of implicit joint liability and show when it will occur and be welfare improving. Section 3 formalizes a key transaction cost in group and individual lending - the time spent attending repayment meetings. Section 4 then shows how meeting costs can give borrowers incentives to invest in social capital, and shows when this is welfare improving. Section 5 presents results of a simulation of the core model, while section 6 summarises the results and concludes.

## 2 Model

We model a lending environment characterized by costly state verification and limited liability. Borrowers are risk neutral, have zero outside option, no capital and limited liability. They have access to a stochastic production technology that requires 1 unit of capital per period with expected output  $\bar{R}$ , and therefore must borrow 1 per period to invest (we assume no savings for simplicity). There are three possible output realizations,  $R \in \{R_h, R_m, 0\}$ ,  $R_h \geq R_m > 0$  which occur with positive probabilities  $p_h, p_m$  and  $1 - p_h - p_m$  respectively. We define the following:

$$\begin{aligned} p &\equiv p_h + p_m \\ \Delta &\equiv p_h - p_m \\ \bar{R} &\equiv p_h R_h + p_m R_m. \end{aligned}$$

We will refer to  $p$  as the probability of “success”, and  $\bar{R}$  as expected output.

We assume that output is not observable to the lender and hence the only relevant state variable from his perspective is whether or not a loan is repaid. Since output is non-contractible, the lender uses dynamic repayment incentives, as in Bolton and Scharfstein (1990). We assume that if a borrower’s loan contract is terminated following a default, she can never borrow again. Under individual liability (IL), a borrower’s contract is renewed if she repays and terminated otherwise. Under explicit joint liability (EJ), both contracts are renewed if and only if both loans are repaid.

Now we introduce the notion of social capital used in the paper. We assume that pairs of individuals in the village share some pair-specific social capital worth  $S$  in discounted lifetime utility, that either can credibly threaten to destroy. In other words, a friendship yields lifetime utility  $S$  to each person. If the social capital is destroyed it is lost forever. We assume that each individual has a very large number of friends, each worth  $S$ . Thus each friendship that breaks up represents a loss of

size  $S$ .<sup>7</sup>

We assume a single lender with opportunity cost of funds equal to  $\rho > 1$ . In the first period, the lender enters the community, observes  $S$  and commits to a contract to all potential borrowers. The contract specifies a gross interest rate,  $r$  and EJ or IL. We assume the lender to be a non-profit who offers the borrower welfare maximizing contract, subject to a zero-profit constraint.<sup>8</sup>

In this section we ignore the role of groups altogether - being in a group or not has no effect on the information or cost structure faced by borrowers and lenders. Although borrower output is unobservable to the lender, we assume it is observable to other borrowers. As a result, they are able to write informal side contracts to guarantee one another's repayments, conditional on the output realizations. For simplicity, in the theoretical analysis we assume such arrangements are formed between pairs of borrowers.<sup>9</sup>

EJ borrowers will naturally side contract with their partner, with whom they are already bound by the EJ clause. Specifically, we assume that once the loan contract has been fixed, pairs of borrowers can agree a "repayment rule" which specifies each member's repayment in each possible state  $Y \in \{R_h, R_m, 0\} \times \{R_h, R_m, 0\}$ . Then in each period, they observe the state and make their repayments in a simultaneous-move "repayment game". Deviations from the agreed repayment rule are punished by a social sanction: destruction of  $S$ . The repayment rule, social sanction and liability structure of the borrowing contract thus determine the payoffs of the repayment game and beliefs about the other borrower's strategy. To summarize, once the lender has entered and committed to the contract, the timings each period are:

1. Borrowers form pairs, and agree on a repayment rule.

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<sup>7</sup>One way to conceptualize  $S$  is as the net present value of lifetime payoffs in a repeated "social game" played alongside the borrowing relationship, similar to the multi-market contact literature, such as Spagnolo (1999), who models agents interacting simultaneously in a social and business context, using one to support cooperation in the other. As an illustration, suppose the borrowers play the following "coordination" stage-game each period: if both play  $A$ , both receive  $s$ . If one plays  $A$  and the other,  $B$ , both receive  $-1$ . If both play  $B$ , both receive  $0$ . Clearly, both  $(A, A)$  and  $(B, B)$  are Nash equilibria in the stage-game. If players expect to play  $(A, A)$  forever, their expected payoff is  $S \equiv \frac{s}{1-\delta}$ . However, switching to  $(B, B)$  forever as a social sanction is always a credible threat, and can be used to support the repayment rule.

<sup>8</sup>We abstract from other organizational issues related to non-profits, see e.g. Glaeser and Shleifer (2001).

<sup>9</sup>This could be for example because there are two types of investment project available and returns within a project type are perfectly correlated, such that side-contracting with another borrower who has the same project type yields no benefit. In the simulations we extend the analysis to larger groups.



2. Loans are disbursed, borrowers observe the state and simultaneously make repayments (the repayment game).
3. Conditional on repayments, contracts are renewed or terminated and social sanctions carried out.
4. If an IL borrower's partner was terminated but she repaid, she rematches with a new partner.

We restrict attention to repayment rules that are stationary (depending only on the state) and symmetric (do not depend on the identity of the borrower). This enables us to focus on the stationary value function of a representative borrower. Stationarity also rules out repayment rules that depend on repayment histories, such as reciprocal arrangements. In addition, we assume that the borrowers choose the repayment rule to maximize joint welfare. Welfare maximization implies that social sanctions are never used on the equilibrium path, since joint surplus would be increased by an alternative repayment rule that did not punish this specific deviation.

Given repayment probability  $\pi$ , the lender's profits are:

$$\Pi = \pi r - \rho$$

and therefore the zero-profit interest rate is:

$$\hat{r} \equiv \frac{\rho}{\pi}. \tag{1}$$

By symmetry, each borrower  $i$  pays  $\pi r = \rho$  per period in expectation.

There are two interesting cases that arise endogenously and determine the feasibility of borrowers guaranteeing one another's loans. In Case A  $R_m \geq 2r$  and hence a successful borrower can always afford to repay both loans. In Case B we have  $R_h \geq 2r > R_m \geq r$ , thus it is not feasible for a borrower with output  $R_m$  to repay both loans. Case B will turn out to be the more interesting case for our analysis, since in this case there is a cost to using joint liability lending. Specifically there are states of the world (when one borrower has zero output and the other has  $R_m$ ) in which under joint liability both borrowers will default, since it is not feasible to repay both loans and they will therefore be punished whether or not the successful partner repays her loan. Meanwhile under individual liability, the successful partner is able to repay her loan and will not be punished if she does so.

Consider Case A. If borrowers agree to guarantee one another's loans, they will repay in every state except  $(0, 0)$ , so the repayment probability is  $\pi = 1 - (1 - p)^2 = p(2 - p)$ , in which case  $\hat{r} = \frac{\rho}{p(2-p)}$ . Therefore Case A applies if  $R_m \geq \frac{2\rho}{p(2-p)}$ , i.e. when the successful partner can afford to repay both loans even if her income is only  $R_m$ . If this condition does not hold, then it will not be feasible for the successful borrower to help her partner in this state of the world, and therefore Case B applies.

**Definition 1** *Case A applies when  $R_m \geq \frac{2\rho}{p(2-p)}$ . Case B applies when  $R_m < \frac{2\rho}{p(2-p)}$ .*

Suppose that borrowers only repay when both are successful, i.e. when both have at least  $R_m$ , which occurs with probability  $p^2$ . If this is the equilibrium repayment rate, then  $\hat{r} = \frac{\rho}{p^2}$ . We make a simple parameter assumption that ensures that this will be the highest possible equilibrium interest rate (lowest possible repayment rate), by ensuring that even with income  $R_m$ , borrowers can afford to repay  $\frac{\rho}{p^2}$ .

**Assumption 1**  $R_m \geq \frac{\rho}{p^2}$ .

We also assume that  $R_h$  is sufficiently large that a borrower with  $R_h$  could afford to repay both loans even at interest rate  $\hat{r} = \frac{\rho}{p^2}$ . Since this is the highest possible equilibrium interest rate, this implies that  $R_h$  is always sufficiently large for a borrower to repay both loans.

**Assumption 2**  $R_h \geq 2\frac{\rho}{p^2}$ .

To summarize, together these assumptions guarantee that  $R_m \geq r$  and  $R_h \geq 2r$  on the equilibrium path.

We can now write down the value function  $V$  for the representative borrower, which represents the utility from access to credit. Suppose that borrower i's loan is repaid with some probability  $\pi$ . Since the repayment rule is assumed to maximize joint welfare, it follows that borrowers's loans are only repaid when repayment leads to the loan contracts being renewed, and therefore the representative borrower's contract is also renewed with probability  $\pi$ . Since the lender charges zero profit interest rate  $\hat{r} = \frac{\rho}{\pi}$ , the borrower repays  $\pi\hat{r} = \rho$  in expectation. Hence, her welfare is:

$$\begin{aligned} V &= \bar{R} - \rho + \delta\pi V \\ &= \frac{\bar{R} - \rho}{1 - \delta\pi}. \end{aligned} \tag{2}$$

For any borrower to be willing to repay her loan, it must be that the value of access to future loans exceeds the interest rate, or  $\delta V \geq r$ . If this condition does not hold, all borrowers will default immediately. We refer to this condition as Incentive Condition 1 (IC1), and it must hold under any equilibrium contract.

Provided IC1 is satisfied, borrower welfare is maximized by achieving the highest repayment rate possible. To see this, suppose the lender charges some interest rate  $r$ . Then  $V = \frac{\bar{R} - \pi r}{1 - \delta \pi}$ . It can be verified that this is increasing in  $\pi$  if and only if IC1 holds. Therefore, in the subsequent discussion the ranking of welfare will be equivalent to the ranking in terms of the repayment probability.

Using (2) and  $\hat{r} = \frac{\rho}{\pi}$  we can derive the equilibrium IC1 explicitly:

$$\rho \leq \delta \pi \bar{R}. \tag{IC1}$$

By Assumption 1, the lowest possible equilibrium repayment probability  $\pi$  is equal to  $p^2$ . For the theoretical analysis we make the following parameter assumption that ensures IC1 is satisfied in equilibrium:

**Assumption 3**  $\delta p^2 \bar{R} > \rho$ .

Now that the model is set up we analyze the choice of contract type.

## 2.1 Individual Liability

Suppose first of all that the borrower does not reach a repayment guarantee arrangement with a partner. Since IC1 is satisfied, the borrower will repay her own loan whenever she is successful, so her repayment probability is  $p$ . Her utility  $V$  is then equal to  $\frac{\bar{R} - \rho}{1 - \delta p}$ .

Now we consider when pairs of IL borrowers will agree a repayment guarantee arrangement. If this occurs, we term it implicit joint liability (IJ).

Since IC1 holds, the borrowers want to agree a repayment rule that maximizes their repayment probability. There are many possible such rules that can achieve the same repayment rate, so for simplicity we focus on the most intuitive one, whereby borrowers agree to repay their own loan whenever they are successful, and also repay their unsuccessful partner's loan if possible.<sup>10</sup>

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<sup>10</sup>An example of an alternative, less intuitive rule that can sometimes achieve the same repayment rate but cannot do better is where borrowers agree to repay their partner's loan, and then repay their own as well if they can afford to do so.

We already know that repayment of the borrower's own loan is incentive compatible by IC1. For it to be incentive compatible for her to repay on behalf of her partner as well, it must be that social sanction outweighs the cost of the extra repayment, i.e.  $r \leq \delta S$ . This gives us a constraint which we term IJ Incentive Constraint 2, or IJ IC2. For equilibrium interest rate  $\hat{r} = \frac{\rho}{\pi^{IJ}}$  IJ IC2 reduces to:

$$\rho \leq \delta \pi^{IJ} S. \quad (\text{IJ IC2})$$

There is a threshold value of  $S$ ,  $\hat{S}^{IJ}$ , such that IJ IC2 holds for  $S \geq \hat{S}^{IJ}$ :

$$\hat{S}_k^{IJ} \equiv \frac{\rho}{\delta \pi_k^{IJ}}, k \in \{A, B\},$$

where  $k$  denotes the relevant case. When  $S \geq \hat{S}^{IJ}$ , it is feasible and incentive compatible for borrowers to guarantee one another's loans, and therefore they will do so as this increases the repayment probability and thus joint welfare. Therefore IJ applies for  $S \geq \hat{S}^{IJ}$ .

Next we work out the equilibrium repayment probabilities and interest rates in cases A and B respectively. Assume  $S \geq \hat{S}^{IJ}$ . In Case A, a successful borrower can always afford to repay both loans, so both loans are repaid with probability  $\pi_A^{IJ} \equiv 1 - (1 - p)^2 = p(2 - p)$ . In Case B, both loans are repaid whenever both are successful, and in states  $(R_h, 0), (0, R_h)$ . In state  $(R_m, 0)$ , borrower 1 cannot afford to repay borrower 2's loan, so she repays her own loan, while borrower 2 defaults and is replaced in the next period with a new partner. Therefore  $\pi_B^{IJ} \equiv p^2 + 2p_h(1 - p) + p_m(1 - p) = p + p_h(1 - p)$ . Notice that both  $\pi_A^{IJ}$  and  $\pi_B^{IJ}$  are greater than  $p$ .

The lender observes whether Case A or Case B applies, and the value of  $S$  in the community, and offers an individual liability contract at the appropriate zero profit interest rate. Equilibrium borrower welfare under individual liability is equal to:

$$V_k^{IL}(S) = \begin{cases} \frac{\bar{R} - \rho}{1 - \delta p} & S < \hat{S}_k^{IJ} \\ \frac{\bar{R} - \rho}{1 - \delta \pi_k^{IJ}} & S \geq \hat{S}_k^{IJ} \end{cases}, k \in \{A, B\}.$$

It is straightforward to see that as  $S$  switches from less than  $\hat{S}_k^{IJ}$  to greater than or equal to it,  $V_k^{IL}(S)$  goes up as  $\pi_k^{IJ} > p$ .

## 2.2 Explicit Joint Liability

Now we analyze EJ contracts. Recall that under EJ, a pair of borrowers are offered a contract such that unless both loans are repaid, both partners lose access to credit in the future. The advantage of this contractual form is that it gives additional incentives to the borrowers to guarantee one another's loans. However, the disadvantage is that when borrower  $i$  is successful and  $j$  is unsuccessful, there may be states in which borrower  $i$  would repay were she under individual liability, but she will default under joint liability because she is either unwilling or unable to repay both loans.

The borrowers will agree a repayment rule, just as under IJ. Since this will be chosen to maximize joint welfare, it will only ever involve either both loans being repaid or both defaulting, due to the joint liability clause that gives no incentive to repay only one loan. Subject to this, because IC1 holds, joint welfare is maximized by ensuring both loans are repaid as frequently as possible.

IC1 implies that when both borrowers are successful, they will both be willing to repay their own loans. We therefore need to consider  $i$ 's incentive to repay both loans when  $j$  is unsuccessful. Borrower  $i$  will be willing to make this loan guarantee payment provided the threat of termination of her contract, plus the social sanction for failing to do so, exceeds the cost of repaying two loans. Formally, this requires  $2r \leq \delta(V^{EJ} + S)$ . We refer to this condition as EJ IC2. Rearranging, and substituting for  $\hat{r} = \frac{\rho}{\pi^{EJ}}$ , we obtain:

$$\rho \leq \frac{\delta\pi^{EJ}[\bar{R} + (1 - \delta\pi^{EJ})S]}{2 - \delta\pi^{EJ}}. \quad (\text{EJ IC2})$$

We can derive a threshold,  $\hat{S}^{EJ}$ , such that EJ IC2 is satisfied for  $S \geq \hat{S}^{EJ}$ :

$$\hat{S}_k^{EJ} \equiv \max \left\{ 0, \frac{\rho}{\delta\pi_k^{EJ}} - \frac{\delta\pi_k^{EJ}\bar{R} - \rho}{\delta\pi_k^{EJ}(1 - \delta\pi_k^{EJ})} \right\}, k \in \{A, B\}$$

where as before,  $k$  denotes the relevant Case.

Note that  $\hat{S}^{EJ}$  can be equal to zero. This corresponds to the basic case in Besley and Coate (1995) where borrowers can be induced to guarantee one another even without any social capital. This relies on the lender's use of joint liability to give borrowers incentives to help one another, and is not possible under individual liability.

Provided  $S \geq \hat{S}^{EJ}$ , borrowers are willing to guarantee one another's repayments. The repayment rule will then specify that  $i$  repays on  $j$ 's behalf whenever  $i$  can afford

to and  $j$  is unsuccessful. If  $S < \hat{S}^{EJ}$ , borrowers will not guarantee one another. They will therefore only repay when both are successful.

We now derive the equilibrium repayment probability under each Case. Firstly, if  $S < \hat{S}^{EJ}$ , borrowers repay only when both are successful, so  $\pi^{EJ} = p^2$  in either Case.

Now suppose  $S \geq \hat{S}^{EJ}$ . In Case A, both loans can be repaid whenever at least one borrower earns at least  $R_m$ . Thus the repayment probability is  $\pi_A^{EJ} = p(2 - p)$ . In Case B,  $R_m$  is not sufficient to repay both loans. Therefore both loans are repaid in all states except  $(0, 0)$ ,  $(R_m, 0)$ ,  $(0, R_m)$ . In these three states both borrowers default. The repayment probability is therefore  $\pi_B^{EJ} = p^2 + 2p_h(1 - p) = p + \Delta(1 - p)$ .

Borrower welfare is:

$$V_k^{EJ}(S) = \begin{cases} \frac{\bar{R} - \rho}{1 - \delta p^2} & S < \hat{S}_k^{EJ} \\ \frac{\bar{R} - \rho}{1 - \delta \pi_k^{EJ}} & S \geq \hat{S}_k^{EJ} \end{cases}, k \in \{A, B\}.$$

Note that  $\hat{S}_A^{EJ} \leq \hat{S}_B^{EJ}$ . This is because the interest rate is lower in Case A, and  $V$  is higher (due to the higher renewal probability), so the threat of termination is more potent.

Now that we have derived the equilibrium contracts assuming either IL or EJ, we turn to analyzing the lender's choice of contractual form in equilibrium, which will depend crucially on the borrowers' ability to guarantee one another's loans.

Let us define  $V(S) \equiv \max\{V^{EJ}(S), V^{IL}(S)\}$  as the maximum borrower welfare from access to credit. Observe that the repayment probability and borrower welfare from access to credit,  $V(S)$ , are stepwise increasing in  $S$ .

## 2.3 Comparing contracts

In this section we compare borrower welfare under each contractual form. We have seen that EJ has the advantage that it may be able to induce borrowers to guarantee one another even when they have no social capital. However, in Case B it has a perverse effect: in some states of the world borrowers will default when they would have repaid under IL.

This is most acute when  $p_m > p_h$ . Then  $\pi_B^{EJ} = p + \Delta(p_h - p_m) < p$ . Therefore in Case B, EJ actually performs worse than IL for all levels of social capital - the perverse effect dominates. Thus for Case B, EJ would never be offered.

We have already derived thresholds for  $S$ ,  $\hat{S}^{IJ}$  and  $\hat{S}^{EJ}$ , above which borrowers will guarantee one another's loans under individual and joint liability respectively. The lender's choice of contract will depend on the borrowers ability to do so, so first we derive a lemma that orders these thresholds in Case A and Case B.

**Lemma 1**

1.  $\hat{S}_A^{IJ} > \hat{S}_A^{EJ}$ .
2. Suppose  $p_h \geq p_m$ . Then  $\hat{S}_B^{IJ} > \hat{S}_B^{EJ}$ .

**Proof.** See appendix. ■

Lemma 1 shows that supporting a loan guarantee arrangement requires more social capital under IL than under EJ. The reason for this is that the lender's sanction under EJ is a substitute for social capital in providing incentives to borrowers to guarantee one another.<sup>11</sup>

The lender is a non-profit who offers the borrower welfare-maximizing contract. Therefore he offers IL if  $V^{EJ}(S) \leq V^{IL}(S)$  and EJ otherwise. This will depend on the Case (A or B), the sign of  $\Delta$ , and  $S$ . We summarize the key result of this section as:

**Proposition 1** *The contracts offered in equilibrium are as follows:*

**Case A:** *IL is offered at  $\hat{r} = \frac{\rho}{p}$  for  $S < \hat{S}_A^{EJ}$ , otherwise EJ is offered at  $r = \frac{\rho}{\pi_A^{EJ}}$ .*

**Case B,  $\Delta > 0$ :** *IL is offered at  $\hat{r} = \frac{\rho}{p}$  for  $S < \hat{S}_A^{EJ}$ , EJ is offered at  $\hat{r} = \frac{\rho}{\pi_B^{EJ}}$  for  $S \in [\hat{S}_B^{EJ}, \hat{S}_B^{IJ})$ , IL is offered at  $\hat{r} = \frac{\rho}{\pi_B^{IJ}}$  for  $S \geq \hat{S}_B^{IJ}$ .*

**Case B,  $\Delta \leq 0$ :** *IL is offered at  $\hat{r} = \frac{\rho}{p}$  for  $S < \hat{S}_B^{IJ}$ , IL is offered at  $\hat{r} = \frac{\rho}{\pi_B^{IJ}}$  otherwise.*

*Whenever EJ is offered borrowers guarantee one another's repayments. Whenever IL is offered and  $S \geq \hat{S}^{IJ}$  borrowers guarantee one another's repayments.*

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<sup>11</sup>A slight complication arises in the proof because in Case B the repayment probability is higher and therefore the interest payment is lower under IJ. As a result, the size of the guarantee payment that must be incentive compatible is actually smaller under IJ, but the net effect is still that borrowers are more willing to guarantee one another under EJ.

**Proof.** See appendix. ■

The result is summarized in Table 1, which gives the equilibrium contract and repayment probability  $\pi$  in alternate rows. Borrower welfare is not shown, but is easily computed as  $V = \frac{pR-\rho}{1-\delta\pi}$ , is strictly increasing in  $\pi$ .

	Case A	Case B, $\Delta > 0$	Case B, $\Delta \leq 0$
$S < \hat{S}^{EJ}$	IL (no IJ) $p$	IL (no IJ) $p$	IL (no IJ) $p$
$S \in [\hat{S}^{EJ}, \hat{S}^{IJ})$	EJ $p(2-p)$	EJ $p + \Delta(1-p)$	
$S \geq \hat{S}^{IJ}$	EJ $p(2-p)$	IL (with IJ) $p + p_h(1-p)$	IL (with IJ) $p + p_h(1-p)$

Table 1: Equilibrium contracts and repayment probabilities

This table shows that there are clear trade-offs in the contractual choice. In Case A, IJ has no advantage over EJ because in both cases borrowers repay both loans whenever successful. Therefore IL is offered for low  $S$ , and EJ for high  $S$ . In Case B when  $\Delta \leq 0$ , we have already remarked that EJ is always dominated by IL. Therefore basic IL is offered for low  $S$ , and when  $S$  is high enough, borrowers will begin to guarantee one another, leading to an increase in the repayment rate and a fall in the equilibrium interest rate.

The most interesting case is Case B for  $\Delta > 0$ . Here there is a clear progression as  $S$  increases. For low  $S$ , borrowers cannot guarantee one another under either contract, so basic IL is offered. For intermediate  $S$ , EJ can sustain a loan guarantee arrangement but IL cannot, so EJ is offered. Finally for high  $S$ , borrowers are able to guarantee one another under IL as well. Since this avoids the perverse effect of EJ, the lender switches back to IL lending.

## 2.4 A remark on loan size

For simplicity, our core model assumes loans of a fixed size. However we can allow for variable loan size as a simple extension. To keep things simple, we assume that borrowers require a loan of size  $L$ . The relation between loan size and output is linear, that is, with a loan of size  $L$ , output is  $LR_h$  with probability  $p_h$ ,  $LR_m$  with probability  $p_m$ , and 0 otherwise. Therefore we can simply scale  $\bar{R}$  and  $r$  by  $L$ , so borrower welfare is now equal to  $LV$ . However, borrowers' social capital is derived



from relationships external to the production function and therefore is assumed not to depend on  $L$ . Thus for a given amount of social capital  $S$ , borrowers are less willing to guarantee one another's loans as the loan size increases.<sup>12</sup> Thus we have the following observation:

**Observation 1**  $\hat{S}^{EJ}(L)$  and  $\hat{S}^{IJ}(L)$  are increasing in loan size,  $L$ . For a given  $S$  borrowers are less likely to guarantee one another's repayments as loan sizes increase. The repayment probability is thus decreasing in  $L$ .

Note that the region  $L(\hat{S}^{IJ} - \hat{S}^{EJ})$  is increasing in  $L$ . In particular, as  $L$  increases, the region  $[0, \hat{S}^{EJ})$  expands. Over this region, borrowers are receiving "basic" IL, and not guaranteeing one another. Thus this result suggests a simple intuition for the stylized fact that IL loans tend to be larger. When loan sizes are small, the borrowers' social capital can be tapped to smooth out occasional small imbalances in income. As loan sizes and incomes increase, this becomes less feasible. As borrowers become unwilling to guarantee one another's loans, EJ becomes unattractive as it induces the borrowers to default unless both are successful.<sup>13</sup>

## 2.5 Discussion

Borrowers form partnerships that optimally leverage their social capital to maximize their joint repayment probability. Thus when social capital is sufficiently high to generate implicit joint liability, IL lending can dominate EJ: borrower  $i$  no longer defaults in state  $(R_m, 0)$ . This does not however mean there is no role for EJ. In particular, for intermediate levels of social capital, EJ can dominate IL - social capital is high enough for repayment guarantees under EJ but not under IL. We analyze borrower welfare under EJ and IL/IJ quantitatively in the simulations.

The results of Giné and Karlan (2011) are consistent with our Case A. Here, IL and EJ lending can achieve the same repayment probability, provided  $S$  is sufficiently high. This does not imply that those same borrowers would repay as frequently if they were not able to side-contract. Giné and Karlan (2011) additionally find that

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<sup>12</sup>Formally, the IJ IC2 is  $Lr \leq \delta S$  and the EJ IC2 is  $Lr \leq \delta(LV + S)$ . Both are tighter as  $L$  increases. Replacing  $\bar{R}$  with  $L\bar{R}$ , we observe that  $\hat{S}^{EJ}(L) = L\hat{S}^{EJ}$  and  $\hat{S}^{IJ}(L) = L\hat{S}^{IJ}$ .

<sup>13</sup>Baland et al. (2010) obtain a result that gives the same negative correlation between the use of IL and loan size. Our above result is different in a nuanced way. In their model the poorest borrowers need the largest loan. Hence, their model generates a positive correlation between loan size and poverty.

borrowers with weak social ties are more likely to default after switching to IL lending - this is consistent with these borrowers having  $\hat{S}^{EJ} \leq S < \hat{S}^{IJ}$ , so they are unable to support implicit joint liability.

So far, we have ignored the use of groups for disbursal and repayment of loans. However, it is frequently argued (see e.g. Armendáriz de Aghion and Morduch (2010)) that group meetings generate costs that differ from those under individual repayment. In the next section we show that this may induce the lender to prefer one or the other. We then proceed to show that by interacting with the benefits from social capital, group meetings may induce the creation of social capital. This is consistent with the results of a field experiment by Feigenberg et al. (2011).

### 3 Meeting Costs

In this section we lay out a simple model of loan repayment meeting costs. This immediately suggests a motivation for the use of groups. Holding group repayment meetings shifts the burden of meeting costs from the lender to the borrowers. This enables the lender to reduce the interest rate, which in turn makes it easier for borrowers to guarantee one another. Then in the next section we explore how the use of groups might create social capital, and thus generate implicit joint liability.

Since we want to focus on the interplay between meeting costs and social capital under individual liability, we assume that Case B applies and  $\Delta \leq 0$ . Therefore we can ignore EJ and drop the  $A, B$  notation.

A common justification for the use of group meetings by lenders is that it minimizes transaction costs. Meeting with several borrowers simultaneously is less time-consuming than meeting with each individually. However, group meetings might be costly for the borrowers, as they take longer and are less convenient than individual meetings. We term IL lending to groups ILG and IL lending to individuals ILI.

We assume that loan repayment meetings have two components, each of which takes a fixed amount of time. For simplicity, we assume that the value of time is the same for borrowers and loan officers<sup>14</sup> Also, for simplicity, we assume that the cost of borrower time is non-monetary so that borrowers are able to attend the meeting even if they have no income. However, more time spent in meetings by the loan officer increases monetary lending costs, for example because more staff must be hired.

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<sup>14</sup>This may not be too unrealistic. For example, the large Indian MFI, Bandhan, deliberately hires loan officers from the communities that they lend to.

Each meeting incurs a fixed and variable cost. The fixed cost includes travel to the meeting location (which we assume to be the same for borrower and loan officer for simplicity), setting up the meeting, any discussions or advice sessions that take place at the meeting, reminding borrowers of the MFI's policies, and so on. This costs each borrower and the loan officer an amount of time worth  $\gamma_f$  irrespective of the number of borrowers in the group. Secondly there is a variable cost that depends on the number of borrowers at the meeting. This time cost is worth  $\gamma_v$  per borrower in the meeting. This covers tasks that must be carried out once for each borrower: collecting and recording repayments and attendance, reporting back on productive activities, rounding up missing borrowers, and so on. As with the fixed cost, each borrower and the loan officer incurs the variable cost. We assume that for group loans, each borrower also has to incur the cost having to sit through the one-to-one discussion between the loan officer and the other borrower, i.e., in a two group setting, the total variable cost per borrower is  $2\gamma_v$  whereas under individual lending, it is  $\gamma_v$ .

Therefore, in a meeting with one borrower, the total cost incurred by the loan officer is  $\gamma_f + \gamma_v$ , and the total cost incurred by the borrower is the same, bringing the aggregate total time cost of the meeting to  $2\gamma_f + 2\gamma_v$ . In a meeting with two borrowers the loan officer incurs a cost of  $\gamma_f + 2\gamma_v$ , and similarly for the borrowers. Thus the aggregate cost in this case is  $3\gamma_f + 6\gamma_v$ . The lender's cost of lending per loan under ILI is  $\rho + \gamma_f + \gamma_v$ . Under ILG it is  $\rho + \frac{\gamma_f}{2} + \gamma_v$ . Therefore the corresponding zero-profit interest rates are  $\hat{r}^{ILI} \equiv \frac{\rho + \gamma_f + \gamma_v}{\pi}$  and  $\hat{r}^{ILG} \equiv \frac{\rho + \frac{\gamma_f}{2} + \gamma_v}{\pi}$ .

Accounting for these costs, per-period expected utility for borrowers under ILI is  $\bar{R} - \rho - 2(\gamma_f + \gamma_v)$ . Under ILG, the per-period utility is  $\bar{R} - \rho - \frac{3}{2}(\gamma_f + 2\gamma_v)$ .<sup>15</sup>

Of course, the first thing to check is whether one lending method is less costly than the other in the absence of any loan guarantee arrangement between borrowers. This is covered by the following observation:

**Observation 2** *Suppose  $S = 0$ . The lender uses ILG if and only if  $\gamma_v < \frac{\gamma_f}{2}$ .*<sup>16</sup>

The intuition is straightforward. When  $\frac{\gamma_f}{\gamma_v}$  is large, i.e., fixed costs are important relative variable costs (e.g., when a large part of repayment meetings is repetitious) it

<sup>15</sup>We need to adapt Assumptions 1, 2 and 3 to reflect the additional costs. We assume  $R_m \geq \frac{\rho + \frac{1}{2}(\gamma_f + 2\gamma_v)}{p^2}$ ,  $R_h \geq 2\frac{\rho + \frac{1}{2}(\gamma_f + 2\gamma_v)}{p^2}$ ,  $\delta p^2 \bar{R} - \max\{(1 + \delta p^2)(\gamma_f + \gamma_v), (\frac{1}{2} + \delta p^2)(\gamma_f + 2\gamma_v)\} \geq \rho$ .

<sup>16</sup>Proof:  $S = 0$  implies IJ is not possible so  $\pi = p$  under ILI and ILG. The result then follows from comparison of per-period borrower welfare.

is economical to hold group meetings. However, the more time is spent on individual concerns, the more costly it is to the borrowers to have to attend repayment meetings in groups because they have to sit through all the bilateral exchanges between another borrower and the loan officer. Microfinance loans are typically highly standardized and so  $\frac{\gamma_f}{\gamma_v}$  will be relatively large, which is consistent with the common usage of group lending methods in microfinance.

Now consider borrowers' incentives to guarantee one another's loans. First we observe that for a given  $\gamma_v, \gamma_f$ , half of the aggregate meeting cost per borrower is borne by the lender under ILI, while only a third is borne by the lender under ILG. The lender passes on all costs through the interest rate, so inspecting the value functions suggests that it is innocuous upon whom the cost of meetings falls. In fact this is not the case. Consider once again IJ IC2:  $r \leq \delta S$ . The only benefit a borrower receives from bailing out her partner is the avoidance of a social sanction, while the cost depends on the interest payment she must make. Therefore a lending arrangement in which the lender bears a greater share of the costs, and thus must charge a higher interest rate, tightens IJ IC2. This gives us the next proposition, which is straightforward:

**Proposition 2** *Borrowers are more likely to engage in IJ under group lending than individual lending:  $\hat{S}^{IJG} < \hat{S}^{IJI}$ .<sup>17</sup>*

The implication of this result is that there is a trade-off between minimizing total meeting costs, and minimizing those costs borne by the lender. It may actually not be optimal to minimize total costs as shown by the following corollary, the proof of which is straightforward and given in the appendix. This arises from the fact that in an environment where the borrowers' participation constraints are not binding, the lender does not put weight on the disutility costs of meetings (individual or group) to the borrowers.

**Corollary 1** *Suppose  $S \in [\hat{S}^{IJG}, \hat{S}^{IJI})$ . Borrower welfare under ILG may be higher than under ILI, even if  $\gamma_v > \frac{\gamma_f}{2}$ .*

We have now set the stage to analyze the interaction between meeting costs and social capital.

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<sup>17</sup>Proof: Borrowers are willing to guarantee their partner's repayments provided  $r \leq \delta S$ . Plugging in for the interest rates under ILG and ILI, we obtain  $\hat{S}^{IJG} = \frac{\rho + \frac{1}{2}(\gamma_f + 2\gamma_v)}{\delta\pi^{IJ}} < \frac{\rho + \gamma_f + \gamma_v}{\delta\pi^{IJ}} = \hat{S}^{IJI}$ .

## 4 Social capital creation

In this section we show how group lending can actually generate social capital that is then used to sustain IJ. This analysis is motivated by the findings of Feigenberg et al. (2011). In their experiment, borrowers who were randomly assigned to higher frequency repayment meetings went on to achieve higher repayment rates. The authors attribute this to social capital being created by frequent meetings, social capital which can then support mutual insurance.

We show two main results. Firstly, group lending may create social capital where individual lending does not. The reason is simply that forcing the borrowers to spend time together in group meetings gives them an added incentive to invest in getting to know one another, as this makes the time spent in group meetings less costly. The knock-on effect is then that individual liability in groups may outperform individual liability with individual meetings because the groups are creating social capital that is then being used to support IJ.

Secondly, we turn to a comparative static more closely related to the Feigenberg et al. (2011) finding. Our simple framework does not easily allow us to model varying meeting frequency, so instead we study the effect on social capital creation of increasing the meeting costs ( $\gamma_f$  or  $\gamma_v$ ). We find that an increase in the amount of time spent in group meetings can induce borrowers to switch to creating social capital, and can in fact be welfare-increasing.

Suppose that initially borrowers do not have any social capital, because creating social capital is too costly. For example, borrowers must invest time and effort in getting to know and understand one another, extend trust that might not be reciprocated, and so forth. Assume that social capital can take two values only, 0 and  $S > 0$  and for a pair to generate social capital worth  $S$  in utility terms, each must make a discrete non-monetary investment that costs them  $\eta$ . To make the analysis interesting, we assume that in the absence of microfinance, they prefer not to do so, namely,  $\eta > S$ .

Once we introduce group lending, social capital generates an indirect benefit, by enabling the formation of a guarantee arrangement. This may or may not be sufficient to induce them to make the investment - that would depend on how  $\eta - S$  compares with the insurance gains from

<sup>18</sup>.

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<sup>18</sup>Note that each time a borrower's partner defaults and is replaced, she must invest in social

Suppose the lender offers ILI and  $S$  is sufficiently large to sustain IJ. If the borrowers prefer to invest in social capital, each time their partner defaults they must invest in social capital with their new partner. We obtain the following result:

**Lemma 2** *Borrowers will not invest in social capital under ILI if:*

$$\eta - S > G_1. \quad (3)$$

where

$$G_1 \equiv \frac{p_h(1-p) \left[ \delta \left( \bar{R} - \frac{\rho}{\pi^{IJ}} \right) - \frac{1+\delta\pi^{IJ}}{\pi^{IJ}} (\gamma_f + \gamma_v) \right]}{(1-\delta p)(1-\delta(p + \Delta(1-p)))}.$$

The proof is given in the appendix. The greater the welfare gain from insurance, the higher is  $G_1$  so the more likely the borrowers will invest in social capital. If (3) holds, the only equilibrium under ILI is one in which the borrowers do not invest in social capital, and therefore are not able to guarantee one another's loans.

Now assume that under ILG, the per-meeting cost to borrowers is decreasing in  $S$ . Attending group meetings is a chore unless the other group members are friends, in which case it can be a social occasion. By forcing the borrowers to meet together, the lender might give them an incentive to create social capital, benefiting them.

For simplicity, we assume that the cost to the borrowers of the time spent in group meetings is  $(1 - \lambda(S))(\gamma_f + 2\gamma_v)$ . In particular,  $\lambda(0) = 0$  and  $\lambda(S) = \lambda > 0$ . The larger is  $\lambda$ , the smaller the disutility of group meetings, and when  $\lambda > 1$ , borrowers actually derive positive utility from group meetings that is increasing in the length of the meeting. We can now check when social capital will be created in groups.

**Lemma 3** *Borrowers invest in social capital under ILG if:*

$$\eta - S \leq G_2. \quad (4)$$

where

$$G_2 \equiv \frac{p_h(1-p) \left[ \delta \left( \bar{R} - \frac{\rho}{\pi^{IJ}} \right) - \frac{1+2\delta\pi^{IJ}}{2\pi^{IJ}} (\gamma_f + 2\gamma_v) \right] + \lambda(1-\delta p)(\gamma_f + 2\gamma_v)}{(1-\delta p)(1-\delta(p + \Delta(1-p)))}.$$

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capital with the new partner in order to continue with IJ.

The proof is given in the appendix. The greater the welfare gain from insurance, the higher is  $G_2$ , but in addition,  $G_2$  is increasing in  $\lambda$ , which represents the reduction in the cost of attending group meetings when the borrowers have social capital. The larger is  $G_2$ , the more likely borrowers are to invest in social capital.

Lemmas 2 and 3 suggest that there may exist an interval,  $(G_1, G_2]$  for  $\eta - S$  over which groups create social capital but individual borrowers do not. The condition for this to be the case is derived in the next proposition, which follows from straightforward comparison of (3) and (4):

**Proposition 3** *If the following condition holds:*

$$\lambda > \frac{p_h(1-p)(\delta\pi^{IJ}\gamma_v - \frac{\gamma_f}{2})}{4\pi^{IJ}(1-\delta p)(\gamma_f + 2\gamma_v)} \quad (5)$$

*then there exists a non-empty interval for  $\eta - S$  over which both (3) and (4) are satisfied. If  $\eta - S$  lies in this interval, groups create social capital, and individual lending does not.*

This is a key result, as it shows that when creating social capital sufficiently offsets the cost to borrowers of attending group meetings, borrowing groups may create social capital and guarantee one another's loans, while individual borrowers may not do so. We can see that the threshold for  $\lambda$  in (5) is negative if  $\frac{\gamma_f}{2} > \gamma_v > \delta\pi^{IJ}\gamma_v$  and so the condition (5) is always satisfied if group lending has a cost advantage to the lender. What can be checked is, even if this is not the case, and  $\delta\pi^{IJ}\gamma_v - \frac{\gamma_f}{2} > 0$  the critical threshold for  $\lambda$  is always strictly less than 1 and therefore, there always exists a  $\lambda$  high enough (but strictly less than 1) such that the condition (5) would hold. However it does not yet establish that the use of groups is necessarily welfare-improving. In other words, observing that groups are bonding and creating social capital does not tell the observer that group lending is the welfare-maximizing lending methodology. All it tells us is that investment is preferred to no investment under ILG, and no investment is preferred to investment under ILI. The welfare ranking of these two will depend on the meeting costs,  $\eta$  and  $S$ . The following proposition addresses the welfare question.

**Proposition 4** *Suppose condition (5) is satisfied and  $\eta - S \in (G_1, G_2]$ . Borrower welfare under ILG is higher than that under ILI if:*

$$\eta - S \leq G_3 \quad (6)$$

where

$$G_3 \equiv \frac{\delta p_h(1-p)(\bar{R}-\rho) + 2(1-\delta\pi^{IJ})(\gamma_f + \gamma_v) - \frac{1}{2}(1-\delta p)(\gamma_f + 2\gamma_v)(3-2\lambda)}{(1-\delta p)(1-\delta(p + \Delta(1-p)))}$$

The proof is given in the appendix.  $G_3$  is higher the larger is the meeting cost under ILI relative to under ILG. It is also increasing in  $\lambda$ , representing the reduction in the cost of attending group meetings when the borrowers have social capital. Note that (6) is always satisfied for sufficiently large  $\lambda$ .

The expressions  $G_1, G_2$  and  $G_3$  are somewhat unwieldy. The following proposition establishes a sufficient condition under which  $G_1 < G_2 < G_3$ , i.e. there is guaranteed to exist an interval for  $\eta - S$  over which groups invest in social capital and individuals do not, and over which borrower welfare is higher under group than individual lending:

**Proposition 5** *Suppose total meeting costs per borrower are weakly lower under ILG than ILI, i.e.  $\gamma_v \leq \frac{\gamma_f}{2}$ . Then  $G_1 < G_2 < G_3$ , i.e.:*

1. *There always exists an interval for  $\eta - S$  over which groups create social capital and individuals do not.*
2. *Borrower welfare is weakly higher under ILG than ILI for all values of  $\eta - S$ .*

The proof is given in the appendix. The condition  $\gamma_v \leq \frac{\gamma_f}{2}$  implies that ILG has a (weak) cost advantage over ILI, as was discussed in Observation 2. In addition, when  $G_1 < \eta - S \leq G_2$ , groups invest in social capital while individuals do not, and this gives ILG a further advantage.

## 4.1 Meeting frequency and social capital creation

Now we take this basic framework and carry out one particular comparative-static exercise, motivated by the findings of Feigenberg et al. (2011). They find that groups that were randomly assigned to meet more frequently have better long-run repayment performance, which they attribute to higher social capital and informal insurance within the group. It is not possible to model repayment frequency in our simple setup, but nevertheless our model is able to capture some of this intuition.

We model an increase in meeting frequency as an increase in meeting costs, represented by an increase in either  $\gamma_f$  or  $\gamma_v$ . The more time spent in group meetings,



the greater the benefit from social interaction within those meetings, captured by  $\lambda$ . Intuitively, it may not be too costly to attend meetings once a month with a stranger, but the more frequent those meetings are, the greater the incentive the borrowers have to build social capital.

However, more frequent meetings require more of the loan officer's time as well, leading to higher lending costs and a higher interest rate. This reduces the borrowers' incentive to invest in  $S$ , since the higher meeting costs reduce the value of maintaining access to credit.

The net effect on borrowers willingness to invest in  $S$  is positive if  $\lambda$  is sufficiently large, as shown by the following proposition.

**Proposition 6** *Increases in  $\gamma_f$  or  $\gamma_v$  make borrowers under group lending more willing to invest in social capital if and only if the following condition holds:*

$$\lambda > \frac{p_h(1-p)(1+2\delta\pi^{IJ})}{2\pi^{IJ}(1-\delta p)}. \quad (7)$$

The proof is immediate from inspection of (4). This proposition implies an interesting corollary: an increase in meeting costs can actually be welfare-improving, by inducing borrowers to invest in social capital and thus engage in implicit joint liability.

**Corollary 2** *Suppose (7) holds. Then there exists a threshold at which increases in the costs  $\gamma_f$  or  $\gamma_v$  cause group borrowers to switch to creating social capital, and this is welfare-improving.*

The proof is given in the appendix. The reason for this result is that in the neighborhood of (4) binding, the no-investment equilibrium is inefficient. A marginal increase in the meeting cost can be enough to give the borrowers sufficient incentive to switch to the investment equilibrium, generating a strict welfare increase.

It is worth explaining here why it is that there may not be an investment equilibrium even when utility is strictly higher under the investment than the no-investment equilibrium. In fact the reasoning is straightforward: the welfare cost of switching from investment to no-investment may be high. This is because of two things: the repayment rate is lower in the no-investment equilibrium, and the interest rate is higher. However, a borrower considering whether to deviate under the investment equilibrium does not consider the effect on the interest rate, since this only changes in

equilibrium. Hence the cost of deviating from a hypothetical investment equilibrium is lower than the cost of switching from investment to no-investment.

Proposition 3 derives a condition on  $\lambda$  under which groups are better able to create social capital than individual borrowers. Proposition 6 simply focuses on group lending and asks when higher meeting costs actually lead to more social capital creation. As meeting costs increase, two things occur. Firstly, the lender must charge a higher interest rate, which reduces borrower welfare and tightens IJ IC2. Secondly, the cost to borrowers of being in a group with a stranger increase: by creating social capital the cost to borrowers of time spent in meetings decreases by  $\lambda(\gamma_f + 2\gamma_v)$ . If  $\lambda$  is sufficiently large, the second effect dominates and higher meeting costs increase the borrowers' incentive to invest in  $S$ .

Feigenberg et al. (2011) show that the improvement in repayment performance associated with higher meeting frequency approximately offset the increase in the lender's cost. This implies that among contracts with group meetings the total surplus was increasing in meeting frequency in their experiment. In our model, all surplus accrues to the borrower, so condition (7) is necessary for there to exist a region over which total surplus is increasing in the meeting frequency.

If the lender holds the interest rate fixed, as in Feigenberg et al. (2011), borrowers will be more willing to create social capital for a given increase in the meeting frequency (the extra cost is not passed on through a higher interest rate). However, a parallel condition must then hold for the increase in repayment frequency to offset the lender's costs.

## 5 Simulation

In this section, we simulate a simple extension of the model calibrated to empirically estimated parameters. This enables us to illustrate the costs and benefits of explicit joint liability and explore under which environments it will be dominated by individual liability lending that induces implicit joint liability.

We find that in low social capital environments, EJ does quite well compared to IJ. For example, when the standard deviation of project returns of 0.5, for social capital worth 10% of the loan size, the welfare attainable under IJ is 32.4% lower compared to the welfare under EJ. However, with social capital worth 50% of the loan size, the welfare attainable under EJ is 5% lower to the one attainable under

IJ. We find that for social capital worth around 25% of the loan size, EJ and IJ perform approximately equally well in terms of borrower welfare. For lower values of  $S$ , EJ dominates, and for higher values of  $S$ , IJ dominates. This analysis thus gives us insights into the extent of the perverse effect of JL. With high  $S$  under IJ, the borrowers now have enough social capital to help one another when they can afford to do so, but are not penalized in states of the world where only some of the group can repay. We also find that the interest rate, repayment rate and borrower welfare are highly insensitive to social capital under EJ, whereas IJ is highly sensitive to social capital, since the only sanction available is coming through the social capital. For example, when the standard deviation of project returns is 0.5, the EJ net interest rate is 11.3%, while the IJ net interest rate ranges between 10.4% and 21.4% for levels of  $S$  valued at 10% to 50% of the loan size respectively. The difference in the interest rate translates correspondingly into borrower welfare. If borrowers share social capital worth 10% of the loan size, the attainable IJ welfare is  $V^{IJ} = 2.29$ , which is 35.9% lower compared to the IJ welfare of  $V^{IJ} = 3.57$  attained by borrowers who share social capital worth 50% of the loan size. We also find that these welfare and interest rate differentials between low and high levels of social capital  $S$  are increasing in the variance of project returns.

From theory we know the basic trade off between EJ, II and IJ and how that changes with social capital. What this analysis adds is to give a quantitative magnitude to the relevant thresholds and also suggests some policy implications. In low social capital environments, despite its well known costs (Besley and Coate (1995)) EJ is an effective device to induce repayment incentives and moreover, if the extent of social capital is not known *ex ante* it is a robust instrument. It also suggests a high payoff from encouraging investing in social capital given the welfare implications of higher  $S$  on borrower welfare in IJ.

## 5.1 Approach

We approach the simulations in a very similar way to de Quidt et al. (2012). Firstly, while it is theoretically convenient to model groups of size two, these require empirically implausibly high returns to investment for the borrowers to be able to repay on one another's behalf, so instead we extend the model to groups of size 5, the group size originally used by Grameen Bank and others. For simplicity, we carry over our concept of social capital unaltered to the larger groups. Previously a borrower who

did not help her partner when the repayment rule stipulated she should was sanctioned by her partner. Now we simply assume she is sanctioned by the whole group, losing social capital worth  $S$ .

We express all units in multiples of the loan size and a loan term of 12 months. For example, if  $S = 0.15$  this means the borrowers have social capital worth 15% of the loan size. We obtain our parameter values from the estimates in de Quidt et al. (2012).  $\bar{R}$ , the expected return to borrowers' investments, is set to 1.6, i.e. a 60% annual return, based on De Mel et al. (2008)'s preferred estimates of the rate of return to capital among microenterprises in Sri Lanka. The lender's cost of capital,  $\rho$ , is set to 1.098, which was estimated using lender cost data from the MixMarket database of financial information from MFIs around the world. Lastly, we set  $\delta$  equal to 0.864. This is the midpoint between the value implied by the return on US treasury bills and a lower bound implied by the model in de Quidt et al. (2012).

The two key ingredients that drive the trade-off between explicit and implicit joint liability are the level of social capital and the shape of the borrowers' return distribution function. We do not have data on social capital, so instead we estimate the equilibrium interest rate, repayment rate and welfare for a range of values for  $S$ . This enables us to say, for example, how much social capital is required for implicit and joint liability to perform as well or better than explicit joint liability.

It is more difficult to explore how the shape of the returns distribution affects the trade-off between EJ and IJ. In the theoretical analysis it was convenient to illustrate the key intuition using a simple categorical distribution with three output values and associated discrete probabilities. With larger groups, this distribution function is less useful. It no longer gives a simple and intuitive set of states of the world in which EJ does and does not perform well (with a group of size  $n$ , there are  $3^n$  possible states of the world). More problematic is that the distribution has four parameters  $(p_m, R_m, p_h, R_h)$ , only one of which can be tied down by our calibrated value of  $\bar{R}$ . As a result, it is very difficult to perform meaningful comparative statics - there are too many degrees of freedom.<sup>19</sup>

Therefore, for the main simulations we use the most obvious two-parameter distribution function, the Normal distribution.<sup>20</sup> Fixing the mean at  $\bar{R}$ , we can vary the

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<sup>19</sup>We perform one exercise in the appendix, where we vary  $p_h - p_m$  while holding  $p, R_h, R_m$  constant. The confound here is that the mean return also varies as we vary  $p_h$  and  $p_m$ .

<sup>20</sup>One complication arises, namely the possibility of negative income realizations. For simplicity, we allow these to occur, but we assume that only borrowers with positive incomes can assist others with repayment.

shape of the distribution by changing the standard deviation. The range for  $\sigma$  was chosen to obtain the highest and lowest possible repayment rates at which the lender is able to break even. For the benchmark simulations, we assume the borrowers' returns are uncorrelated, but we also allow for positive and negative correlations in an extension.

To simulate the model, for each contract we work out a welfare-maximizing repayment rule for the borrowing group, i.e. one that maximizes the repayment rate, subject to the borrowers' incentive constraints. Solving analytically for the equilibrium repayment probability (which then gives us the interest rate and borrower welfare) is complex, so instead we simulate a large number of hypothetical borrowing groups and use these to compute the equilibrium repayment probability. We describe the simulation approach in detail in appendix B.

## 5.2 Results

The main results for uncorrelated borrower incomes are presented in Figure 1. The standard deviation  $\sigma$  of individual borrower returns is varied on the horizontal axis of each figure.

For the distribution and parameter values used, it turns out that individual liability is in fact marginally loss-making for all  $\sigma$ , so we just present results for implicit joint liability and explicit joint liability for values  $S \in \{0.1, 0.3, 0.5\}$ .

The figures show that increasing the variance of returns is bad for repayment and thus welfare under both contracts. This is unsurprising: higher variance income processes are more difficult to insure (the required transfers between members tend to be larger), so states in which members cannot or will not help one another out become more common. Increasing  $S$  partially mitigates this effect since it increases the size of incentive-compatible transfers between borrowers.

Our simulated repayment rates vary between around 85% to close to 100% as the variance of borrower income decreases. These high repayment rates follow from the fact that the calibrated mean return  $\bar{R}$  is higher than the lender's cost of funds,  $\rho$ , so perfect repayment is attainable for sufficiently low variance. However, these values are fairly typical for microfinance repayment rates. For example, in de Quidt et al. (2012) we conservatively estimate a repayment rate in the MIX Market dataset of around 0.92. Using the simulated repayment rate, we can obtain the zero-profit interest rate and borrower welfare. The net interest rate varies between 10% and

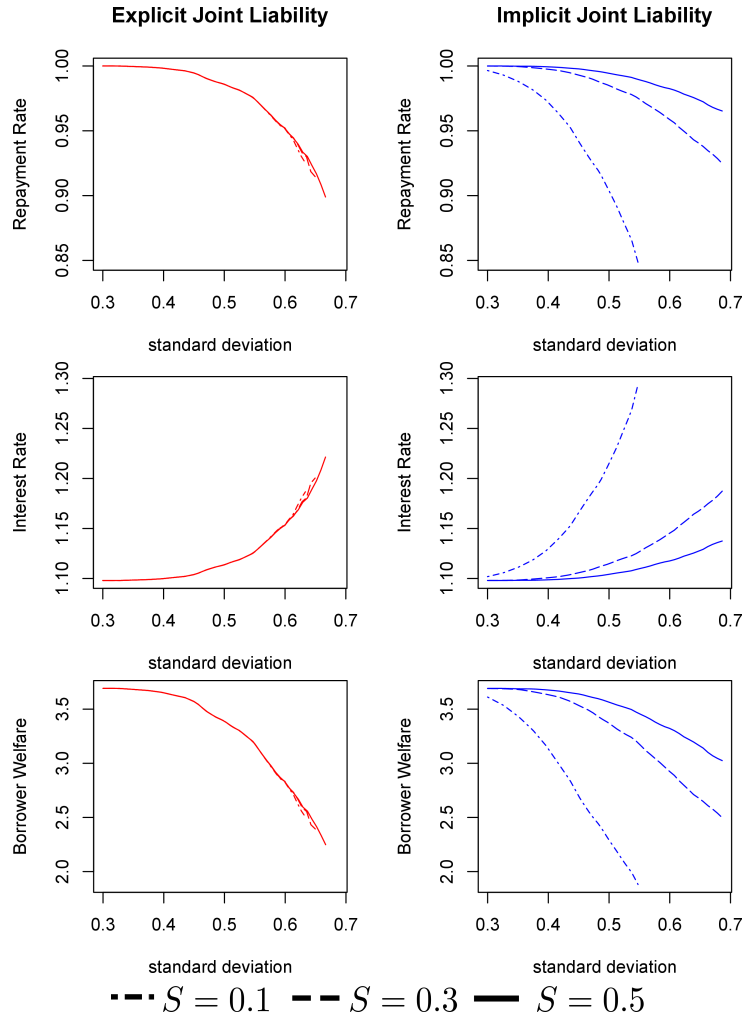


Figure 1: Simulation results for uncorrelated borrower returns. Explicit joint liability results are in the left column and implicit joint liability in the right column. Each figure plots the relevant object (repayment rate, interest rate and borrower welfare) for three levels of social capital,  $S = 0.1, 0.3, 0.5$ . The standard deviation of the individual borrower's income is varied on the horizontal axis of each figure.

30% per year (again, these are not unreasonable values for the microfinance context), while borrower welfare varies between around 1.8 and 3.7 multiples of the loan size.

One of the most striking lessons we learn from the graphs is that the interest rate, repayment rate and borrower welfare are highly insensitive to social capital under explicit joint liability. The reason is that social capital is only shifting the borrowers from default to repayment in states of the world where they can afford to help one another and where the joint liability penalty is not already sufficient. The probability that such a state occurs is lower, the bigger the sample of borrowers. Meanwhile, implicit joint liability is highly sensitive to social capital, since the only sanction available is coming through the social capital. For example, at  $\sigma = 0.5$ , the IJ repayment rate is 91% for  $S = 0.1$ , 98% for  $S = 0.25$ , and close to 100% for  $S = 0.5$ , while the EJ repayment rate is fixed at 98% throughout.<sup>21</sup>

In order to more easily compare EJ and IJ, in Figure 2 we overlay the welfare curves for EJ and IJ. The simulation exercise emphasizes much of the core intuition from the model. When  $S$  is low, explicit joint liability tends to dominate since the joint liability clause gives the borrowers an additional incentive to help one another. When  $S$  is high, implicit joint liability dominates, due to the perverse effect of JL - the borrowers now have enough social capital to help one another when they can afford to do so, but are not penalized in states of the world where only some of the group can repay.

To give a numerical example of the magnitudes of the welfare gains from EJ and IJ as a function of  $S$ , consider the case of a standard deviation of project returns of 0.5. Here for social capital worth 10% of the loan size for example, the welfare attainable under IJ,  $V^{IJ} = 2.29$  is 32.4% lower compared to the welfare under EJ  $V^{EJ} = 3.39$ . This highlights the clear welfare gains that are possible under EJ in environments with low  $S$ . These gains disappear however for higher levels of  $S$ . With social capital worth 50% of the loan size, the welfare attainable under EJ  $V^{EJ} = 3.39$  is in fact 5 % lower to the one attainable under EJ  $V^{IJ} = 3.56$ . The higher levels of social capital make it incentive compatible to help each other out, when they are able to, while not being punished when not the whole group is able to repay.

The graph also highlights that the EJ and IJ contracts are almost completely

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<sup>21</sup>Note that in de Quidt et al. (2012) we find that the interest rate and borrower welfare are sensitive to social capital when the lender is a monopolist, since higher social capital relaxes IC2, and therefore enables the lender to increase the interest rate. The non-profit lender, as modeled in this paper, does not do this.

overlapping for intermediate values of  $S = 0.3$  of the loan size, suggesting that in environments with intermediate levels of social capital both contracts can perform equally well.

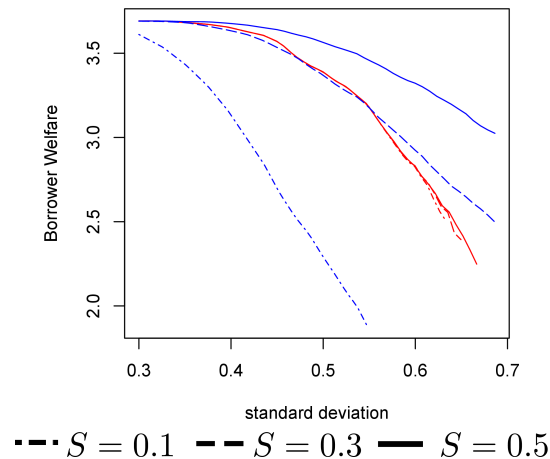


Figure 2: Simulation results for uncorrelated borrower returns. Explicit joint liability results are in red and implicit joint liability in blue. The figure plots borrower welfare for three levels of social capital,  $S = 0.1, 0.3, 0.5$ . The standard deviation of the individual borrower’s income is varied on the horizontal axis.

While these results illustrate the problems with strict EJ,<sup>22</sup> we also interpret them as showing why EJ should not be prematurely dismissed as an important contractual tool (as also recently argued by Banerjee (2012)). Many of the candidates for alternative mechanisms discussed in the literature are complex and potentially difficult to implement, so we have focused on two extremely simple mechanisms that we feel are empirically relevant. What we find is that implicit joint liability can perform very well, provided borrowers have enough social capital: borrowers have to be willing to impose sanctions on one another worth at least 25% of their loan size. Meanwhile EJ functions well in our simulations even for low levels of social capital. This illustrates how important the lending environment, and in particular borrowers’ social ties are for determining the preferred contract in our framework.

### 5.3 Correlated returns

As an extension, we now present simulation results when borrowers’ returns are correlated. A number of recent papers have analyzed how correlated returns affect

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<sup>22</sup>Problems that have also received attention in Besley and Coate (1995), Rai and Sjöström (2004), Bhole and Ogden (2010), Rai and Sjöström (2010) and Allen (2012).



repayment behavior under joint liability lending.<sup>23</sup> As a simple extension, we consider how our EJ and IJ borrowers are affected by introducing positively or negatively correlated returns into the model. We simulate the borrowing group’s per-period income vector  $[Y_1, \dots, Y_n]$  as a multivariate Normal distribution. We fix the standard deviation at 0.5, the midpoint of the range considered in the previous section, and vary the pairwise correlation between group members from  $-0.25$  to  $0.45$ .<sup>24</sup> We graph the results in Figure 4.<sup>25</sup>

The main conclusion from this analysis is that for a given level of social capital, EJ is sufficiently more sensitive to the strength of correlation between borrower incomes. EJ requires all loans to be repaid. When borrower incomes are only weakly correlated, there will typically only be a small number of failures in a group, which are relatively easy for the other members to assist with. With a strongly positive correlation this is no longer the case, it becomes more common to have large numbers of failures. In this environment IJ is an advantage because the borrowers are not penalized when their partners default. This becomes evident when comparing the gradient of the IJ curves relative to the EJ curves as the correlation increases.

## 6 Conclusion

Anecdotal evidence suggests that there has been a move away from explicit joint liability towards individual liability by some prominent institutions. Most of these institutions have retained the use of groups to facilitate credit disbursal. The key question now is whether groups do more than just facilitate the lender’s operations. The interest in this question has been strengthened by two recent field experiments by Giné and Karlan (2011) and Feigenberg et al. (2011).

The first of these, Giné and Karlan (2011), found that removing the joint liability clause, but retaining the group meetings, of a random subset of borrowing groups of Green Bank in the Philippines had no meaningful effect on repayment rates, although borrowers with weak social ties to other borrowers were more likely to drop out.

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<sup>23</sup>For example, Laffont (2003), Ahlin and Townsend (2007) and Allen (2012)

<sup>24</sup>For correlation smaller than  $-0.25$  we essentially have 100% repayment everywhere, and for greater than  $0.45$  there is typically no lending equilibrium.

<sup>25</sup>Note that the graphs are less smooth than those in Figure 1. This is because for the benchmark simulations we are able to reuse the same underlying random draws for each set of output realizations, simply by rescaling as the standard deviation changes. This is not possible when considering variously correlated returns, so we need to generate a new sample of borrower output realizations for each value of the correlation coefficient, and this naturally introduces some extra noise.

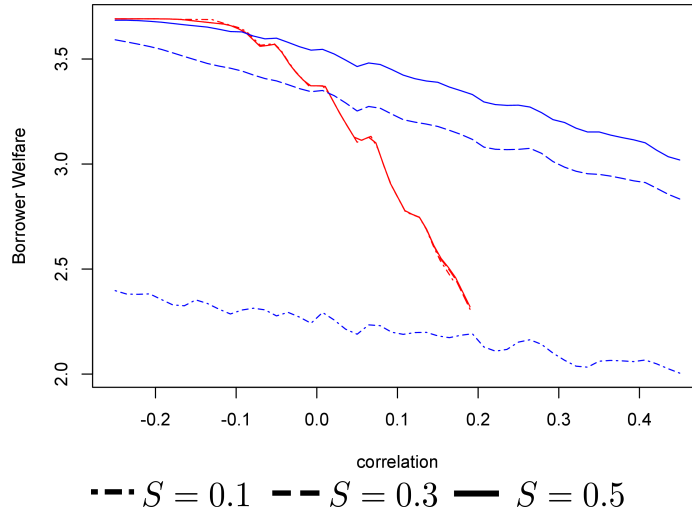


Figure 3: Simulation results for correlated borrower returns. Explicit joint liability results are in red and implicit joint liability in blue. The figure plots borrower welfare for three levels of social capital,  $S = 0.1, 0.3, 0.5$ . The correlation between pairs of borrower’s returns is varied on the horizontal axis.

In this paper we have shown that this outcome may result when the newly individually liable groups have sufficient social capital to continue to guarantee one another’s repayments, as under EJ, which we call implicit joint liability (IJ). We show that this may even lead to higher repayment rates and borrower welfare. However this first result does not depend upon the use of groups, provided borrowers are able to side contract on loan repayments outside of repayment meetings.

We next show that when individual and group repayment meetings are costly, mutual insurance or IJ are easier to sustain under group lending, because IJ depends crucially on the interest rate, which in turn depends on the share of total meeting costs borne by the lender. Group meeting reduces the lender’s share of meeting costs, enhancing the advantages of IJ.

The second experimental paper highlighting the role of groups is Feigenberg et al. (2011). They find that varying meeting frequency for a subset of individually liable borrowing groups seemed to have persistent positive effects on repayment rates. They suggest that this is due to improved informal insurance among these groups due to higher social capital.

We analyze situations under which microcredit might induce borrowers to create social capital, which in turn enables them to sustain IJ. We derive conditions under which group lending is more likely than individual lending to create social capital,

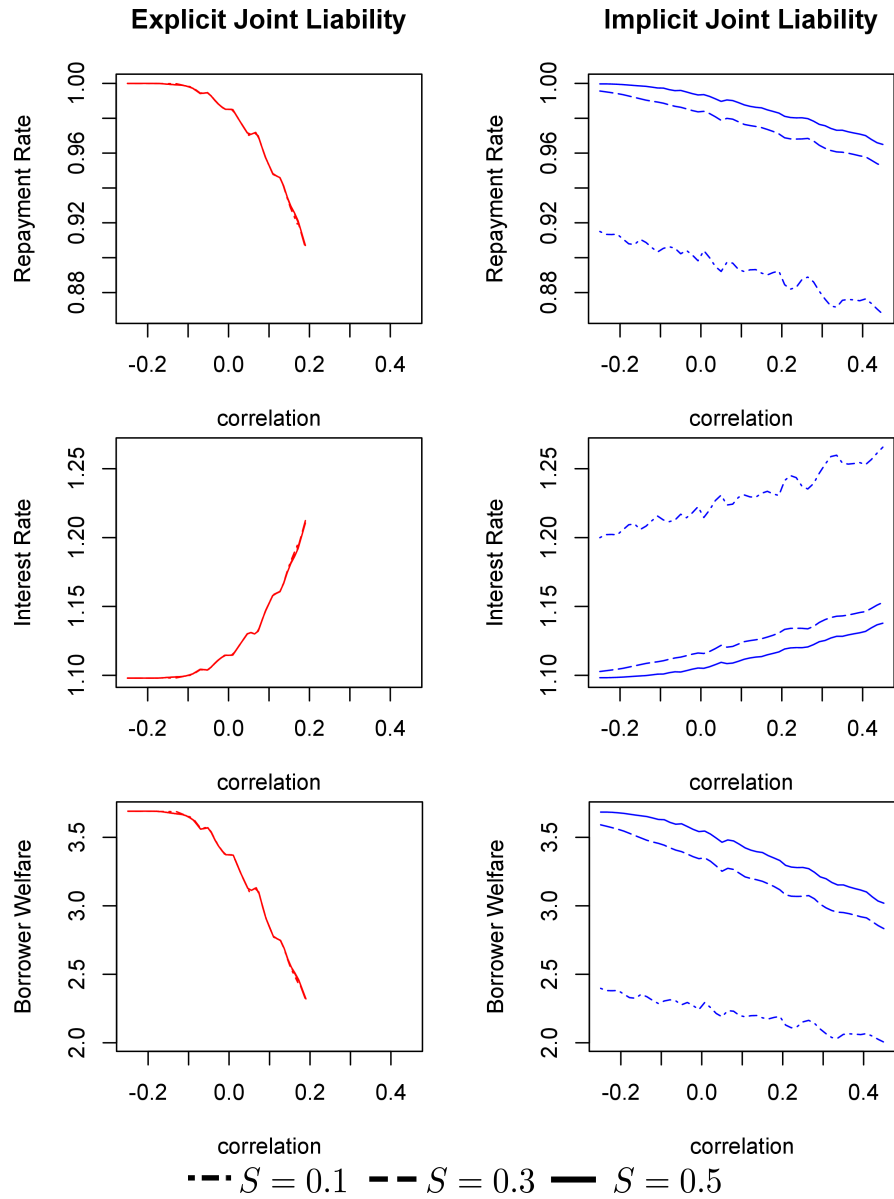


Figure 4: Simulation results for uncorrelated borrower returns. Explicit joint liability results are in the left column and implicit joint liability in the right column. Each figure plots the relevant object (repayment rate, interest rate and borrower welfare) for three levels of social capital,  $S = 0.1, 0.3, 0.5$ . The correlation between pairs of borrower's returns is varied on the horizontal axis of each figure.

and show when this is indeed welfare increasing. Finally, relating to one of the key findings of Feigenberg et al. (2011), we derive conditions under which more frequent meetings, modeled here as an increase in the amount of time borrowers and loan officers must spend in loan repayment meetings, increases borrowers' incentive to invest in social capital. This provides a theoretical foundation for Feigenberg et al. (2011)'s observation. We also carry out a simulation exercises to assess the quantitative magnitudes of the effects of alternative forms of lending, as well as some of the relevant thresholds of social capital.

## References

- Ahlin, C. and N. Jiang (2008, January). Can micro-credit bring development? *Journal of Development Economics* 86(1), 1–21.
- Ahlin, C. and R. M. Townsend (2007, January). Using Repayment Data to Test Across Models of Joint Liability Lending. *The Economic Journal* 117(517), F11–F51.
- Allen, T. (2012). Optimal (Partial) Group Liability in Microfinance Lending. *mimeo*.
- Anderson, C., L. Locker, and R. Nugent (2002, January). Microcredit, Social Capital, and Common Pool Resources. *World Development* 30(1), 95–105.
- Armendáriz de Aghion, B. and J. Morduch (2010, May). *The Economics of Microfinance, Second Edition*. MIT Press Books. Cambridge, MA: The MIT Press.
- Attanasio, O., B. Augsburg, R. De Haas, E. Fitzsimons, and H. Harmgart (2011). Group Lending or Individual Lending? Evidence from a Randomized Field Experiment in Mongolia. *EBRD Working Paper No. 136*.
- Baland, J.-M., R. Somanathan, and Z. Wahhaj (2010, January). Repayment incentives and the distribution of gains from group lending. *CDEDSE Working Paper* (192).
- Banerjee, A. V. (2012, September). Microcredit Under the Microscope: What Have We Learned in the Past Two Decades, and What Do We Need to Know? *Annual Review of Economics* 5(1).
- Besley, T. and S. Coate (1995). Group lending, repayment incentives and social collateral. *Journal of Development Economics* 46(1), 1–18.
- Bhole, B. and S. Ogden (2010). Group lending and individual lending with strategic default. *Journal of Development Economics* 91(2), 348–363.

- Bolton, P. and D. Scharfstein (1990). A Theory of Predation Based on Agency Problems in Financial Contracting. *The American Economic Review* 80(1), 93–106.
- Carpena, F., S. Cole, J. Shapiro, and B. Zia (2010). Liability Structure in Small-Scale Finance: Evidence from a Natural Experiment. *World Bank Policy Research Working Paper 5427*.
- Chowdhury, P. R. (2005). Group-lending: Sequential financing, lender monitoring and joint liability. *Journal of Development Economics* 77(2), 415–439.
- Cull, R., A. Demirgüç-kunt, and J. Morduch (2009). Microfinance meets the market. *Journal of Economic Perspectives* 23(1), 167–192.
- De Mel, S., D. McKenzie, and C. Woodruff (2008). Returns to Capital in Microenterprises: Evidence from a Field Experiment.
- de Quidt, J., T. Fetzter, and M. Ghatak (2012). Market Structure and Borrower Welfare in Microfinance. *BREAD Working Paper No. 360*.
- Feigenberg, B., E. Field, and R. Pande (2011). The Economic Returns to Social Interaction: Experimental Evidence from Microfinance. *mimeo*.
- Fischer, G. and M. Ghatak (2010). Repayment Frequency in Microfinance Contracts with Present-Biased Borrowers. *mimeo*.
- Ghatak, M. and T. W. Guinnane (1999). The economics of lending with joint liability: theory and practice. *Journal of Development Economics* 60(1), 195–228.
- Giné, X. and D. S. Karlan (2011). Group versus Individual Liability : Short and Long Term Evidence from Philippine Microcredit Lending Groups. *mimeo*.
- Glaeser, E. L. and A. Shleifer (2001). Not-for-profit entrepreneurs. *Journal of Public Economics* 81(1), 99–115.
- Jain, S. and G. Mansuri (2003, January). A little at a time: the use of regularly scheduled repayments in microfinance programs\*. *Journal of Development Economics*.
- Kabeer, N. (2005). Is Microfinance a 'Magic Bullet' for Women's Empowerment? Analysis of Findings from South Asia. *Economic and Political Weekly* 40(44/45), 4709–4718.
- Laffont, J. J. (2003, January). Collusion and group lending with adverse selection. *Journal of Development Economics*.
- Laffont, J.-J. and P. Rey (2003). Moral Hazard, Collusion and Group Lending. *mimeo*.

- McIntosh, C. and B. Wydick (2005). Competition and microfinance. *Journal of Development Economics* 78(2), 271–298.
- Rai, A. and T. Sjöström (2010). Redesigning Microfinance. *Working paper*.
- Rai, A. S. and T. Sjöström (2004). Is Grameen Lending Efficient? Repayment Incentives and Insurance in Village Economies. *Review of Economic Studies* 71(1), 217–234.
- Sanyal, P. (2009, January). From Credit to Collective Action: The Role of Microfinance in Promoting Women’s Social Capital and Normative Influence. *American Sociological Review* 74(4), 529–550.
- Spagnolo, G. (1999, January). Social relations and cooperation in organizations. *Journal of Economic Behavior & Organization* 38(1), 1–25.

# A Mathematical appendix

## Proof of Lemma 1

**Proof.** Comparing the expressions for  $\hat{S}_A^{EJ}$  and  $\hat{S}_A^{IJ}$ , it is immediate that  $\hat{S}_A^{EJ} < \hat{S}_A^{IJ}$  since  $\pi_A^{EJ} = \pi_A^{IJ}$  and  $\delta\pi_A^{EJ}\bar{R} - \rho > 0$  by Assumption 3.

Now consider Case B. It is obvious that if  $\hat{S}^{EJ} = 0$ ,  $\hat{S}^{IJ} > \hat{S}^{EJ}$ , since  $\hat{S}^{IJ} > 0$ . Suppose therefore that  $\hat{S}^{EJ} > 0$ . It is straightforward to check that Assumptions 1, 2 and 3 imply that  $\delta p \geq \frac{1}{2}$ . Given this, and  $p_h \geq p_m$ , it follows that  $\pi^{IJ} \geq p \geq \frac{1}{2}$  and  $\pi^{EJ} \geq p \geq \frac{1}{2}$ . Also using the fact that  $\pi_B^{EJ}$  can be written as  $p^2 + 2p_h(1-p)$ . We have:

$$\begin{aligned} \hat{S}^{IJ} - \hat{S}^{EJ} &= \frac{\delta\pi_B^{EJ}\bar{R} - \rho}{\delta\pi_B^{EJ}(1 - \delta\pi_B^{EJ})} + \frac{\rho}{\delta\pi_B^{IJ}} - \frac{\rho}{\delta\pi_B^{EJ}} \\ &= \frac{\pi_B^{IJ}(\delta\pi_B^{EJ}\bar{R} - \rho) - p_m(1-p)(1 - \delta\pi_B^{EJ})\rho}{\delta\pi_B^{IJ}\pi_B^{EJ}(1 - \delta\pi_B^{EJ})} \\ &\geq \frac{(\delta\pi_B^{EJ}\bar{R} - \rho) - p_m(1-p)\rho}{2\delta\pi_B^{IJ}\pi_B^{EJ}(1 - \delta\pi_B^{EJ})} \\ &= \frac{\delta p^2\bar{R} - \rho + p_h(1-p)(2\delta\bar{R} - \rho) + (p_h - p_m)(1-p)\rho}{2\delta\pi_B^{IJ}\pi_B^{EJ}(1 - \delta\pi_B^{EJ})} \\ &> 0 \end{aligned}$$

which follows from  $2\delta\bar{R} - \rho > 0$  by Assumption 3. ■

## Proof of Proposition 1

To compare IL and EJ, we consider first Case A, then Case B with  $p_h > p_m$ , and lastly Case B with  $p_h \leq p_m$ .

In Case A, borrower repayment guarantees under IL offer no advantage over EJ, so provided  $S \geq \hat{S}_A^{EJ}$ , EJ is the borrower welfare-maximizing contract (with indifference for  $S \geq \hat{S}_A^{IJ}$ ). For  $S < \hat{S}_A^{EJ}$ , borrower will not mutually guarantee under EJ and also default unless their partner is successful, so IL is preferred to EJ:

$$V_A^{EJ}(S) - V_A^{IL}(S) = \begin{cases} -\frac{\delta p(1-p)(\bar{R}-\rho)}{(1-\delta p)(1-\delta p^2)} & S < \hat{S}_A^{EJ} \\ \frac{\delta p(1-p)(\bar{R}-\rho)}{(1-\delta p)(1-\delta p(2-p))} & S \in [\hat{S}_A^{EJ}, \hat{S}_A^{IJ}) \\ 0 & S \geq \hat{S}_A^{IJ} \end{cases}$$

In Case B, with  $p_h > p_m$ , EJ dominates IL when borrowers guarantee one another under EJ but not under IL, for  $S \in [\hat{S}_B^{EJ}, \hat{S}_B^{IJ})$ , so EJ is preferred in this region. However, once IJ is possible, for  $S \geq \hat{S}_B^{IJ}$ , it dominates EJ. This is because borrower 1 repays her own loan in state  $(R_m, 0)$ , while she would default under EJ. We have:

$$V_B^{EJ}(S) - V_B^{IL}(S) = \begin{cases} -\frac{\delta p(1-p)(\bar{R}-\rho)}{(1-\delta p)(1-\delta p^2)} & S < \hat{S}_B^{EJ} \\ \frac{\delta \Delta(1-p)(\bar{R}-\rho)}{(1-\delta p)(1-\delta(p+\Delta(1-p)))} & S \in [\hat{S}_B^{EJ}, \hat{S}_B^{IJ}) \\ -\frac{\delta p_m(1-p)(\bar{R}-\rho)}{(1-\delta(p+p_h(1-p)))(1-\delta(p+\Delta(1-p)))} & S \geq \hat{S}_B^{IJ} \end{cases}$$

Lastly, in Case B with  $p_h \leq p_m$ , EJ is always dominated by IL. This is because under EJ the highest possible repayment probability is  $p + \Delta(1-p)$ , which is weakly smaller than  $p$ , the lowest possible repayment probability under IL. Therefore we do not need to know the ordering of  $\hat{S}_B^{EJ}$  and  $\hat{S}_B^{IJ}$  for this case - EJ will never be used.

## Proof of Corollary 1

Suppose total meeting costs are higher under ILG:  $\frac{3}{2}(\gamma_f + 2\gamma_v) > 2(\gamma_f + \gamma_v)$  or  $2\gamma_v > \gamma_f$ . Suppose also that  $S \in [\hat{S}^{IJG}, \hat{S}^{IJI})$ . Then group lending sustains IJ but individual lending does not. Welfare is higher under group lending if:

$$\frac{\bar{R} - \rho - \frac{3}{2}(\gamma_f + 2\gamma_v)}{1 - \delta(p + p_h(1-p))} > \frac{\bar{R} - \rho - 2(\gamma_f + \gamma_v)}{1 - \delta p}$$

Taking the limit as  $\gamma_f \rightarrow 2\gamma_v$ , it is clear that this condition holds strictly, while  $\hat{S}^{IJG} > \hat{S}^{IJI}$  continues to hold, thus the corollary follows for a non-trivial interval of costs by a standard open set argument.

## Proof of Lemma 2

First, note that  $\frac{\partial^2 V}{\partial r \partial \pi} < 0$ . Therefore, the benefit of increasing  $\pi$  is higher when interest rates are low.

We want to find conditions under which ILI borrowers will not invest in social capital in equilibrium. To show this, we hypothesize a (low interest rate) equilibrium in which ILI borrowers do invest, and show that there exists a profitable deviation. Then, we know that in a (high interest rate) equilibrium in which borrowers do not



invest, they will not wish to deviate to investing; this follows from  $\frac{\partial^2 V}{\partial r \partial \pi} < 0$  as noted above.

Consider then a hypothetical equilibrium in which the borrowers do invest in social capital and repay with probability  $\pi^{IJ} \equiv p + p_h(1 - p)$ . They are charged  $\hat{r} = \frac{\rho + \gamma_f + \gamma_v}{\pi^{IJ}}$ .

At the beginning of the first period, the borrower and her partner pay cost  $\eta$  and create social capital. Then, each period with probability  $p + \Delta(1 - p)$ , both loans are repaid and both contracts renewed. With probability  $p_m(1 - p)$ , only borrower  $i$ 's loan is repaid. As a result, at the beginning of the next period, she must again pay cost  $\eta$  to create social capital with her new partner.<sup>26</sup>

Consider an ILI borrower in the first period, or one whose partner has just defaulted. We know that IC1 is satisfied, since by repaying her loan she can guarantee herself at least  $\delta(\bar{R} - (\gamma_f + \gamma_v)) - \frac{\rho + \gamma_f + \gamma_v}{\pi^{IJ}}$  if she agrees with the new partner to simply take a loan and default immediately. This expression is positive by the modified Assumption 3 in footnote 15. Then we note that if it is an equilibrium for the borrower to invest in social capital, it must be that she does even better than this, and therefore IC1 must hold.

As we are considering an equilibrium in which she invests in social capital, we use an ‘‘IJI’’ superscript to denote the fact that IJ is taking place. If she invests in social capital with the new partner, she earns utility  $U$ , defined as follows:

$$U_1^{IJI} = S - \eta + W_1^{IJI}$$

where

$$W_1^{IJI} = (\bar{R} - \rho - 2(\gamma_f + \gamma_v)) + \delta(p + \Delta(1 - p))W_1^{IJI} + \delta p_m(1 - p)U_1^{IJI}.$$

The first term in  $W$  is the per-period utility under ILI. The second term represents the continuation payoff when both borrowers repay and have their contracts renewed. This occurs with probability  $p + \Delta(1 - p)$ . In this case she earns  $W_1^{IJI}$  next period. The third term represents the continuation payoff if she repays but her partner defaults, which occurs with probability  $p_m(1 - p)$ . In this case she matches with a new partner and therefore earns  $U_1^{IJI}$  next period.

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<sup>26</sup>Since no social capital is destroyed on the equilibrium path, the  $S$  created with the original partner is not lost but cannot be leveraged in the credit contract.

Substituting for  $W$ , we can write  $U$  as:

$$\begin{aligned} U_1^{IJI} &= S - \eta + \frac{(\bar{R} - \rho - 2(\gamma_f + \gamma_v)) + \delta p_m(1-p)(S - \eta)}{1 - \delta\pi^{IJ}} \\ &= \frac{(\bar{R} - \rho - 2(\gamma_f + \gamma_v)) + (1 - \delta(p + \Delta(1-p)))(S - \eta)}{1 - \delta\pi^{IJ}}. \end{aligned}$$

Now we check for a one-shot deviation. In this context, a deviation is to defer investing in social capital by one period, i.e. to undergo one period without social capital (and therefore with repayment probability  $p$ ), then invest in social capital next period. She prefers to deviate if:

$$U_1^{IJI} < \left( \bar{R} - p \frac{\rho + \gamma_f + \gamma_v}{\pi^{IJ}} - (\gamma_f + \gamma_v) \right) + \delta p U_1^{IJI}. \quad (8)$$

The first term on the right hand side represents the per-period utility of a borrower under ILI without social capital, paying an interest rate of  $\hat{r} = \frac{\rho + \gamma_f + \gamma_v}{\pi^{IJ}}$  (intuitively, since the lender does not know she has deviated, the interest rate is not adjusted). With probability  $p$  her loan is repaid, and in the next period she invests in  $S$ , thus receiving continuation value  $U_1^{IJI}$ . Substituting for  $U_1^{IJI}$  and rearranging yields condition (3).

### Proof of Lemma 3

Hypothesize an equilibrium in which borrowers invest in social capital. We know that IC1 is satisfied, since by repaying her loan she can guarantee herself at least  $\delta(\bar{R} - (\gamma_f + 2\gamma_v)) - \frac{\rho + \frac{1}{2}(\gamma_f + 2\gamma_v)}{\pi^{IJ}}$  if she agrees with the new partner to simply take a loan and default immediately. This expression is positive by the modified Assumption 3 in footnote 15.

We need to check that no borrower prefers to deviate by deferring their investment by one period, exactly as in Lemma 2. We define the value functions analogously to those in the proof of Lemma 2:

$$\begin{aligned} U_1^{IJG} &= S - \eta + W_1^{IJG} \\ W_1^{IJG} &= \left( \bar{R} - \rho - \frac{1}{2}(\gamma_f + 2\gamma_v)(3 - 2\lambda) \right) + \delta(p + \Delta(1-p))W_1^{IJG} + \delta p_m(1-p)U_1^{IJG}. \end{aligned}$$

Where the possession of social capital reduces the borrowers' cost of group meetings

by  $\lambda(\gamma_f + 2\gamma_v)$ . The appropriate substitutions yield:

$$U_1^{IJG} = \frac{\bar{R} - \rho - \frac{1}{2}(\gamma_f + 2\gamma_v)(3 - 2\lambda) + (1 - \delta(p + \Delta(1 - p)))(S - \eta)}{1 - \delta\pi^{IJ}}.$$

There will be no deviation if  $U_1^{IJG} \geq \left(\bar{R} - p\frac{\rho + \frac{1}{2}(\gamma_f + 2\gamma_v)}{\pi^{IJ}} - (\gamma_f + 2\gamma_v)\right) + \delta p U_1^{IJG}$ . Simplifying yields condition (4).

## Proof of Proposition 4

Total borrower welfare under ILI (where borrowers do not invest in social capital) is:

$$\begin{aligned} V^{ILI} &= \bar{R} - \rho - 2(\gamma_f + \gamma_v) + \delta p V^{ILI} \\ &= \frac{\bar{R} - \rho - 2(\gamma_f + \gamma_v)}{1 - \delta p} \end{aligned}$$

and when groups are used (and the borrowers do invest in social capital) it is:

$$U_1^{IJG} = \frac{\bar{R} - \rho - \frac{1}{2}(\gamma_f + 2\gamma_v)(3 - 2\lambda) + (1 - \delta(p + \Delta(1 - p)))(S - \eta)}{1 - \delta\pi^{IJ}}.$$

as was derived in the proof of Lemma 3. The result then follows from comparison of these value functions.

## Proof of Proposition 5

First, observe that if  $\gamma_v \leq \frac{\gamma_f}{2}$ , condition (5) is satisfied for all  $\lambda \geq 0$ , hence  $G_1 < G_2$ .

From the proof of Lemma 3,  $\eta - S \leq G_2$  if and only if  $U_1^{IJG} \geq \frac{\bar{R} - p\frac{\rho + \frac{1}{2}(\gamma_f + 2\gamma_v)}{\pi^{IJ}} - (\gamma_f + 2\gamma_v)}{1 - \delta p}$ .

Call the RHS of this condition  $B$ . From the proof of Proposition 4,  $\eta - S < G_3$  if and only if  $U_1^{IJG} > V^{ILI}$ . Finally, note that  $B - V^{ILI} = \frac{p_h(1-p)(\rho + \gamma_f) + p(\frac{\gamma_f}{2} - \gamma_v)}{\pi(1 - \delta p)}$ , which is strictly positive if  $\gamma_v < \frac{\gamma_f}{2}$ . Thus,  $\eta - S \leq G_2$  implies  $\eta - S < G_3$ , or  $G_2 < G_3$ .

Claim 1 follows immediately from  $G_1 < G_2 < G_3$ . Claim 2, that borrower welfare is *always* higher under ILG, can be broken into three parts. Firstly, if  $\eta - S \leq G_1$ , both groups and individuals invest in social capital. Then, the cost advantage of ILG ( $\gamma_v \leq \frac{\gamma_f}{2}$ ) implies that welfare is higher under ILG. Secondly, if  $\eta - S > G_2$ , neither groups nor individuals invest in  $S$ , and again the cost advantage leads to ILG dominating. Lastly, if  $G_1 < \eta - S \leq G_2$ , groups invest and individuals do not, and thus ILG dominates by Proposition 4.

## Proof of Corollary 2

Suppose condition (4) binds, such that a small decrease in  $\gamma_f$  causes borrowers to stop investing in social capital. We want to show that this leads to a discontinuous decrease in welfare.

Before the change, welfare is:

$$U_1^{IJG} = \frac{\bar{R} - \rho - \frac{1}{2}(\gamma_f + 2\gamma_v)(3 - 2\lambda) + (1 - \delta(p + \Delta(1 - p)))(S - \eta)}{1 - \delta\pi^{IJ}}.$$

after the change (in the limit as the increase in  $\gamma_f$  approaches zero), it is:

$$V^{ILG} = \frac{\bar{R} - \rho - \frac{3}{2}(\gamma_f + 2\gamma_v)}{1 - \delta p}$$

since the borrowers can no longer sustain IJ, so the new equilibrium is one in which they repay with probability  $p$  and the interest rate is  $\frac{\rho + \frac{1}{2}(\gamma_f + 2\gamma_v)}{p}$ . From condition (4) binding we know that:

$$\eta - S = \frac{p_h(1 - p) \left[ \delta \left( \bar{R} - \frac{\rho}{\pi^{IJ}} \right) - \frac{1 + 2\delta\pi^{IJ}}{2\pi^{IJ}}(\gamma_f + 2\gamma_v) \right] + \lambda(1 - \delta p)(\gamma_f + 2\gamma_v)}{(1 - \delta p)(1 - \delta(p + \Delta(1 - p)))}. \quad (9)$$

For  $U_1^{IJG}$  to be strictly larger than  $V^{ILG}$  we require:

$$\frac{\bar{R} - \rho - \frac{1}{2}(\gamma_f + 2\gamma_v)(3 - 2\lambda) + (1 - \delta(p + \Delta(1 - p)))(S - \eta)}{1 - \delta\pi^{IJ}} > \frac{\bar{R} - \rho - \frac{3}{2}(\gamma_f + 2\gamma_v)}{1 - \delta p}$$

which reduces to

$$\frac{\delta p_h(1 - p) \left( \bar{R} - \rho - \frac{3}{2}(\gamma_f + 2\gamma_v) \right) + \lambda(1 - \delta p)(\gamma_f + 2\gamma_v)}{(1 - \delta p)(1 - \delta(p + \Delta(1 - p)))} > \eta - S.$$

Substituting for  $\eta - S$  from (9) and simplifying, we obtain:

$$2\delta\rho(1 - \pi^{IJ}) + (1 - \delta\pi^{IJ})(\gamma_f + 2\gamma_v) > 0$$

which is satisfied.

More generally, this demonstrates that the no-investment equilibrium is inefficient in the neighborhood of  $\eta - S = G_2$ . A marginal increase in the meeting cost that gives the borrowers greater incentive to invest in social capital can lead to a strict

increase in borrower welfare.

## B Simulation approach

This Appendix outlines the algorithm used to simulate the core model. The simulation was implemented in  $R$ . The intuition of the simulation procedure is very straightforward. We use a random sample of  $N$  groups with  $n$  members each. A group merely constitutes a vector of income realizations. These incomes are drawn from some distribution function  $F$ . We assume that  $F$  is a Normal distribution with  $\mu = \bar{R} = 1.6$ , however we allow the standard deviation  $\sigma$  to vary.

Given these income realizations, we compute the repayment rate that would arise under each contract for a given interest rate  $r$ . This process gives us a repayment probability function  $\pi(r)$  under either contract.

Given this repayment probability function, we can then compute the break-even repayment rate and thus the break-even interest rate under each contract, along with borrower welfare. This then allows us to make comparisons between the two contractual forms.

We now describe in detail how the group-level repayment rate is computed, as this is different under each contract type due to the different incentive constraints.

We denote an income realization of a group  $i$  with  $n$  borrowers is represented by an  $n$ -vector,  $Y_i = (y_1, \dots, y_n)$ , where  $y_j$  is group member  $j$ 's income draw.

We want to find a repayment rule analogous to the one outlined in the theory that allows for larger groups and the continuous output distribution. The most obvious way to do this is to construct for each  $Y_i$  a “group bailout fund” that can be used for transfers between group members to assist with repayments. Since the incentive constraints differ between EJ and IJ, the construction of the group fund also differs and is described below.

### Group Lending without Joint Liability

The relevant incentive constraint under group lending without joint liability implies that the maximum amount a group member  $j$  is willing to contribute to the group fund is  $c_{ij} = \max(y_{ij}, \delta S)$ . All the transfers are put into a common pool  $C_j$ . This pool is then used to ensure the maximum possible number of repayments. The borrowers are sorted in ascending order of the amount of transfer they require to

repay their own loan. and transfers made from the fund until it is exhausted.<sup>27</sup> If  $m$  group members repay, then we obtain a group level repayment rate  $\pi_i = \frac{m}{n}$ . As this procedure is repeated for a sample of  $N$  groups, we can then estimate the overall repayment probability as the simple average.

The procedure in pseudo-code:

### Group Lending without JL

1. Generate a  $N \times n$  matrix of income realizations from  $F$ .
2. For each possible value of the interest rate  $r$ :
  - (a) For each  $Y_i$ : compute the maximum level of contributions that each group member is willing to make to the common pool as  $c_{ij} = \max(y_{ij}, \delta S)$ . This pot amounts to  $C_{ij} = \sum_n c_{ij}$
  - (b) Compute the redistributions required by members to ensure repayment as  $t_{ij} = \max(0, r - y_{ij} - c_{ij})$ .
  - (c) Order the required transfer in ascending order and redistribute the pot  $C_{ij}$  until it is exhausted.
  - (d) Compute the group level repayment rate  $\pi_i(r)$ .
3. Given all the  $\pi_i$ , compute  $\pi(r) = \frac{\sum_i \pi_i}{N}$ .

### Group Lending with Joint Liability

The simulation of this contract is more involved, since the relevant incentive constraint is  $c_{ij} \leq \delta(V + S)$ . This implies that in order to construct the repayment rate  $\pi$ , a number for the continuation value  $V$  is needed.  $V$  however, is itself a function of  $\pi$ .

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<sup>27</sup>This in fact implies that in some cases the worse off borrowers will be bailing out the better off borrowers. In particular, it may be that an unlucky borrower gives her whole income to a partner to repay their loan, but defaults on her own loan. This is because the worse off borrowers require a larger transfer, which is thus less likely to be incentive compatible. This mechanism achieves the maximum possible repayment rate and therefore maximizes ex-ante expected utility.

This does not imply that a borrower with  $y_j > r$  would ever default (i.e. be forced to choose between losing  $\delta V$  and  $\delta S$ . The reason is that all borrowers "above" her in the bail out chain also have  $y > r$ , so are making net positive contributions to the fund, which therefore has a positive "balance" when her turn comes

The method proceeds as follows, for each possible value of  $r$ . First, we construct a set of possible candidates for  $\pi(r)$ , denoted  $\tilde{\pi}$ <sup>28</sup>, we calculate the associated  $V(\tilde{\pi})$ . Given these candidate  $\tilde{V}$ 's, the group fund  $C_{ij}$  is computed as follows. Each member is willing to contribute at most  $c_{ij} = \max(y_{ij}, \delta(\tilde{V} + S))$  toward repayment of the group's loan obligations. Explicit joint liability implies that the group will only repay when  $C_j = \sum_n c_{ij} \geq nr$ . Thus a group's repayment rate is  $\pi_i = \mathcal{I}[C_j \geq nr] \in \{0, 1\}$ . Taking the average we obtain the simulated repayment rate given  $\hat{\pi}(V(\tilde{\pi}))$ . In other words, taking as given a value for  $V(\tilde{\pi})$ , the implied repayment rate  $\hat{p}_i$  is computed. Then, the true  $\pi$  (and thus the true  $V$ ) is found by solving for the fixed point  $\pi = \hat{\pi}(V(\hat{\pi}))$ . By iterating over  $r$ , we obtain the schedule  $\pi(r)$  and the associated  $V(\pi(r))$ .

The procedure in pseudo code:

### Group Lending with JL

1. Generate a  $N \times n$  matrix of income realizations from  $F$ .
2. For each interest rate  $r$ :
  - (a) Construct a set of candidates for  $\tilde{\pi}(r)$ .
  - (b) For each  $\tilde{\pi}(r)$ :
    - For each  $Y_i$ : compute the maximum level of contributions that each group member is willing to make to the common pool as  $c_{ij} = \max(y_{ij}, \delta(S + V(\tilde{\pi})))$ . This pot amounts to  $C_{ij} = \sum_n c_{ij}$
    - The group defaults if  $C_j = \sum_n c_{ij} < nr$
    - Compute the group level repayment rate  $\hat{\pi}_i(\tilde{\pi})$ .
3. Given all the  $\hat{\pi}_i(V(\tilde{p}))$ , compute  $\hat{\pi}(V(\tilde{\pi}))$  as the average and find the fixed point  $\pi$  such that  $\pi = \hat{\pi}(V(\pi))$ .

## C Simulation Results for Piecewise Returns

As discussed in the main text, there is no straightforward approach to simulate the model with the piecewise returns distribution. The problem is one of too many

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<sup>28</sup>These candidate  $\pi$ 's exploit the monotonicity of the  $\pi(r)$  schedule. The upper bound is given by the previous iteration for a higher  $r$ , while the lower bound is globally defined as  $\frac{\rho}{(\delta R)}$

degrees of freedom. A sensible approach would be to vary the difference between the parameters  $p_h$  and  $p_m$ , as we saw in the main draft that for  $p_h < p_m$ , group lending with joint liability performs particularly bad. We can vary this difference, but still hold the sum  $p_h + p_m = \bar{p}$  fixed, where  $\bar{p} = 0.921$ , as in de Quidt et al. (2012).<sup>29</sup>

We still have three parameters to tie down. Namely  $R_m$ ,  $R_h$  and the mean return. There is no straightforward approach to tie down either of these parameters when varying the difference between  $p_h$  and  $p_m$ . This appendix will show the results from one pragmatic way. First, we tie down  $R_m = \rho/p^2$ . This condition is motivated by assumption 1 for the two player model. It implies that the medium return is high enough to repay a individual liability loan. Given this and the value of  $\bar{R} = 1.6$ , we compute  $R_h$  imposing the constraint that  $p_h = p_m$ . This thus gives us the value for  $R_h$ , when the difference between  $p_h$  and  $p_m$  is zero. Given these fixed values, we then simply vary the difference between  $p_h$  and  $p_m$ , holding everything else constant. This exercise thus maps somewhat into the table of the two-player model, where the model suggest that there is only an IL equilibrium for low  $S$  and only IJ equilibria for sufficiently high  $S$ . There is no EJ equilibrium in this case however. For  $\Delta > 0$ , the simple model would predict EJ lending for some range of parameter values. In the two-player model thus, the  $\Delta$  is key. For groups with larger size, we would not expect this simple result to go through as now there are a lot more states of the world. However, when plotting the simulation results as a function of the difference between  $p_h$  and  $p_m$  in figure 5, we do see that EJ performs better the larger  $p_h - p_m$ . However, this may simply be due to the fact that for higher  $p_h$  relative to  $p_m$ , the mean return in this case is changing as well.

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<sup>29</sup>Please refer to this paper for details on how this value was estimated using cross-sectional data from the MIX Market database



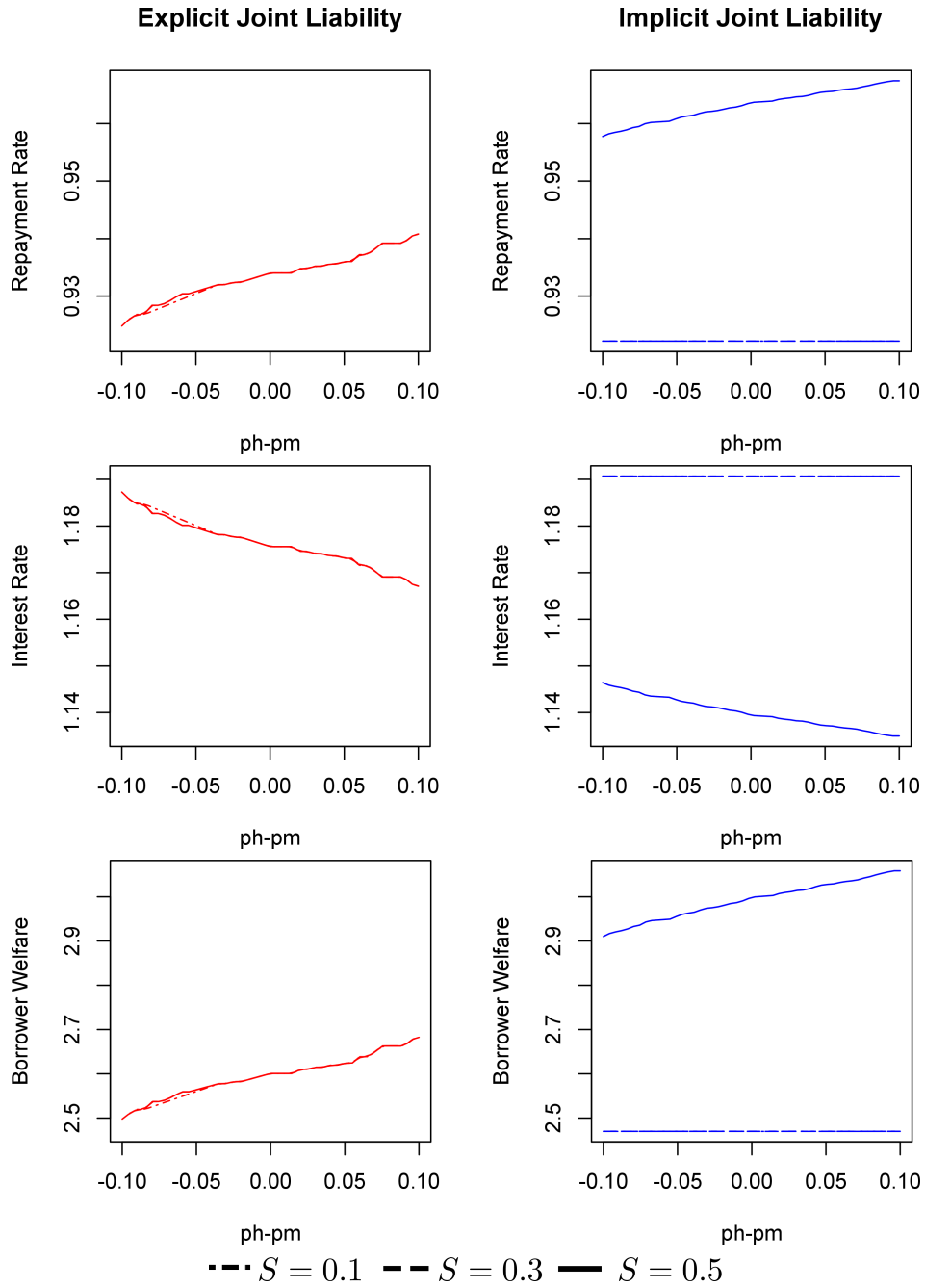


Figure 5: Simulation results for piecewise borrower returns distribution. Curves for explicit joint liability are drawn in red, and implicit joint liability in blue. Each figure plots the relevant object (repayment rate, interest rate and borrower welfare) for three levels of social capital,  $S = 0.1, 0.3, 0.5$ . The difference between  $p_h$  and  $p_m$  of individual borrower returns is varied on the horizontal axis of each figure.