Endogenous social capital in joint liability lending through mutual insurance

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Abstract

In this paper we argue that if borrowers are patient, then the possibility of mutual insurance inherent to group lending can, independent of existing social capital, serve as a disciplining device in order to solve information problems inherent to credit provision. This does not mean that existing social capital can not play a similar role, it simply means that existing social capital is not necessary to tackle the information problems associated with lending to the poor, if borrowers are patient, or equally if interactions are frequent, if they can benefit from the potential of mutual insurance through joint liability lending.

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1 Introduction

Numerous studies have documented the success of joint liability lending relative to individual liability lending in poor societies. At the same time this success has been attributed to the ability of joint liability lending to lower information costs faced by financial institutions through transferring them, partially, to the borrowers. The role of existing social capital among group members has been emphasized as an important driving force to tackle the major problems facing formal loan arrangements to the poor. As Gathak and Guinnane (1999) put is:

"... These economic models of JLLIs are efforts to formalize the idea that a well-structured JLLI can deal effectively with the four major (information) problems facing lenders by utilizing the local information and social capital that *exists* among borrowers." As such, the literature on joint liability lending has mainly emphasized how existing social capital favors the use of a joint liability loans over individual liability loans but fewer attention has been given to the intrinsic value of loans with joint liability. In this paper we argue that if borrowers are patient, then the possibility of mutual insurance inherent to group lending can, independent of existing social capital, serve as a disciplining device in order to solve information problems associated with group liability lending. This does not mean that existing social capital can not play a similar role, it simply means that existing social capital is not necessary to tackle the information problems associated with lending to the poor, if borrowers are patient, or equally if interactions are frequent, if they can benefit from the potential of mutual insurance through joint liability lending.

The idea that a joint liability loan contract can improve upon individual liability has been brought to the fore by Varian (1990), Rashid and Townsend (1992) who observed that joint liability lending creates the possibility of insurance between the group members: when borrowers form a group the possibility arises for consumption smoothing between them if the income realizations of the agents are observable. That is, when one borrower is not successful, the others can agree to relieve him from paying back his part of the joint loan expecting reciprocal behavior in the event fates are reversed in the future. An individual liability loan contract does not offer this possibility. Hence group liability can work as an insurance mechanism[1].

This reasoning would be straightforward, were it not that mutual insurance itself is plagued by information problems. In any insurance context an agent always has an incentive to report the state of the world that minimizes his/her repayment obligations. That is, private information about project results threatens the potential advantages embedded in a joint liability loan contract. This is particularly the case when audit costs are very high. Thus a difficulty arises when agents possess private information: participants of a lending group understand the benefit of helping eachother out in case of need but at the same time have an individual incentive to always claim need. The harder it is to monitor eachother's state of the world the more this tension, between wanting to cooperate by sharing information and individual incentives to cheat in one's own benefit, is present.

The goal of this paper is to argue that, by means of a very simple borrower(s)-lender model, this tension can be resolved, without incurring audit costs, in a dynamic setting if borrowers are patient enough by letting each group member's contribution depend on the history of contributions. We do so by developing a dynamic mechanism to solve the problem of private information in a setting of repeated group lending. In a way, social capital can arise endogenously even in an environment with private information.

[1] Conning (2005) recently argues that joint liability loans potentially offer an advantage over individual liability loans because of an "incentive diversification effect" that cannot be obtained by agents which are outside the group of borrowers. In a multi-agent, multi task game he shows that joint liability loans are chosen to implement a preferred Nash equilibrium.

Because of the potential of mutual insurance, a joint liability lending contract is more valuable than an individual liability contract. In this case the repetition of the loans by itself can decrease the information costs associated to micro-lending: the group can rely on future interaction to succesfully enter into a joint liability lending agreement, even when no (ex ante) existing social capital is present. Moreover, recent empirical studies reveal conflicting evidence on the relationship between social capital and the (repayment) success of group lending (for an overview see Cassar et al. (2007)). This is not inconsistent with our story that other factors are at play as well. Alhin and Townsend (2007) also stress that an important limitation of current models is the lack of dynamic analysis. In fact, dynamic incentives can provide an explanation why joint liability lending programs arise and are successful even in places which lack the typical characteristics of strong social capital, e.g. in urban environments.

In order to formally obtain our results we rely on techniques recently developed in the theory of repeated games with private information (Fudenberg et al (1994), Athey and Bagwell (2001) and Athey et al. (2004)). The main insight of which is that information costs can disappear as long as agents are patient enough. The idea is that the future surplus that is created through future joint liability can be used to deter both current observable deviations from the contract and unobservable deviations (moral hazard or adverse selection) by asymmetrically distributing future surplus in favor of those members who "appear" to have behaved more honestly in the current period. Our results thus hinge on dynamic incentives provided through the future surplus created by joint liability contracts.

Dynamic incentives combined with the contractual properties of group liability lending have so far received little attention in the literature on micro-lending. One exception is Wydick (2001), who shows, in an imperfect-information framework, that the combination of informational flows, dynamic repayment incentives, group pressure, intra-group insurance, and social relationships can work together to mitigate moral hazard problems in small-scale credit contracts. This is obtained by showing that when informational flows between group members are high, the potential for intra-group credit insurance, combined with the threat of being expelled from a borrowing group, deters some borrowers with a high rate of time preference from choosing risky investment strategies. He also shows that existing social capital and sanctions can thus compensate for poor informational flows in contexts where direct peer monitoring is difficult. The point we wish to make is that in the presence of private information and a lack of information flows, the potential of mutual insurance offered by group lending alone, can eliminate the need for monitoring or existing social capital to reduce the costs associated with information problems present in credit markets. In other words, patience or frequent interaction alone, can succefully make group lending work, even when no existing social capital is present. As such, our paper can be seen as one of the very few papers[2] that emphasizes that the benefits of group lending, solely through its contractual properties, can explain high repayment rates of group lending (the third category in Cassar et al. (2007). The results of the paper could at the same time shed light on the question why one observes succesful joint liability loan contracts in environments where usual social capital is not evident, such as in cities (Kugler and Oppes (2005)) or developed economies. In particular, this paper presents a very simple model to examplify how the future benefits from mutual insurance can help to overcome the current problem of costly state verification. To the best of our knowlegde, this paper is the first to illustrate the importance of these results in a micro-lending context, where problems of information asymmetry are particularly relevant. In section 2 we present

[2] A noticable exeption is Armendariz de Aghion and Gollier (2000).

a the static model and study its properties. In section 3 we introduce the repeated model. Section 4 studies the mutual insurance mechanism aimed at resolving the tension between private information and cooperation. Section 5 presents a general model and section 6 concludes.

2 The Static Model

We start by considering a very simple version of a standard model of a credit market with private information. In section 5 we present a generalization of the model and its conclusions. Borrowers are endowed with a risky investment project but have not enough initial resources available to invest and need to borrow in order to start their projects. In particular, it is assumed that there are 2 borrowers (investors), $i = 1, 2$, who each have an uncertain investment project, requiring one unit of capital which can be borrowed with repayment $r > 1$. The project's performance for both borrowers is stochastic and is independently drawn from the following distribution: with probability $\frac{1}{2}$ the project is successful and with probability $\frac{1}{2}$ it is not. All projects provide a sufficient return such that all borrowers can pay back the loan[3]. The performance of the project determines the marginal cost of paying back the loan, or equally the marginal utility of consumption. A failure leads to marginal utility of θ_H and a success leads to marginal utility θ_L, where $\theta_H > \theta_L$. This is illustrated in the Figure 1 below and simply implies that the marginal utility of consumption is constant in each state of the world but is higher in the failure state than in the success state, taking into account any possible repayment amount between 0 and $2r$. This assumption could be dispensed with, as we will become clear from our general setup in section 5, but it will allow us to present in a clear and analytical fashion the main message we wish to convey, a property the general model does not possess. We also assume the lending institution earns zero economic profits.

[3] Hence, no default risk is present.

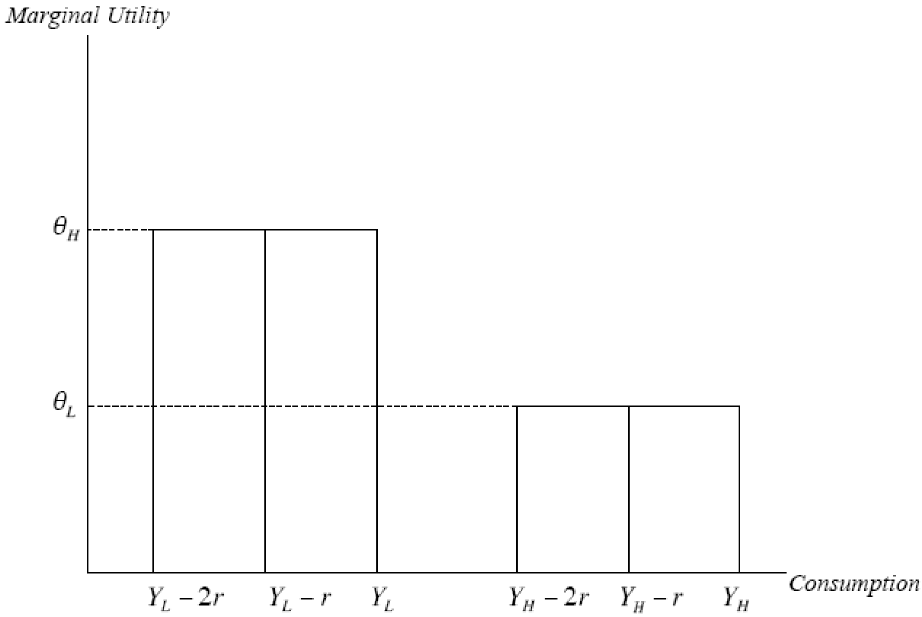

Figure 1. Marginal Utility

This can be either the objective of the lending institution or can come about through competition.

The performance of each project is privately known to each borrower. After learning the realization of their investment, the borrowers are able to announce their return[4]. The announcement for borrower i is denoted as:

$$\widehat{\theta}_i(.) : (\theta_H, \theta_L) \to (\theta_H, \theta_L)$$

The profile of the borrowers' announcements is denoted by $\widehat{\theta} = (\widehat{\theta}_1, \widehat{\theta}_2)$. We denote the signal space as $S : S = (\theta_H, \theta_L)$. After announcing their return, the borrowers choose how much to pay back of the full loan. Repayment, π_i, is thus a function of the private realization of the return and the claims of each borrower:

[4]We thus assume the borrowers can use cheap talk: they can communicate but the informational contents of the communication cannot be verified.

$$\pi_i(.) : S \times S \to [0, 2r]$$

The profile of the borrowers' repayments is denoted by $\pi = (\pi_1, \pi_2)$.

Borrowers can offer insurance to one another in a joint liability contract. Lemma 1 shows that there exists a possibility to decrease the expected cost of repayment for the borrowers through mutual insurance if the borrowers are honest: if they can agree to form a group which makes them jointly liable for the loan such the borrower(s) with the lowest marginal utility is (are) responsible for paying back the joint loan.

Lemma 1 *The expected utility cost of the loan repayment is higher under individual liability than under joint liability.*

Proof 1 *With individual liability the expected cost of repaying the amount r is equal to C_{IL} :*

$$C_{IL} = \frac{r}{2}(\theta_L + \theta_H)$$

With joint liability one can stipulate that a borrower with a succesful project repays the full loan amount ($2r$) if it is the case that the other borrower's prject was a failure. When they obtain the same performance they each pay r. This repayment plan under joint liability leads to an expected cost of repaying C_{JL} equal to:

$$C_{JL} = \frac{3}{4}\theta_L + \frac{1}{4}\theta_H$$

It is then easy to verify that:

$$C_{IL} - C_{JL} = \frac{r}{4}(\theta_H - \theta_L) > 0$$

Thus, group lending with joint liability offers the possibility for borrowers to insure one another when some borrowers saw their projects yielding a low return while others enjoyed a high return. The difficulty, however, is that the borrowers have an incentive to lie about the yield of their project, relying on being bailed out even when enjoying high returns. The consequence is that if there is no future relationship between the two borrowers and/or the lending insitution, then there is no incentive to claim the successful realization of a project. In the static game, the mutual insurance outcome cannot be obtained as a Nash equilibrium. Importantly, if the lender cannot impose a high enough cost on the parties for defaulting, the borrowers will have no incentive to repay at all, whether they have private information or not. In the absence of credible punishments the lender usually uses access to future loans as a stick to ensure repayment of the current loan. In order to answer the question whether the borrowers can use the future potential mutual insurance benefits to induce honest reporting of their investment outcome, we must turn to a repeated setting.

3 The Repeated Model

In the repeated game, the static credit game is played in each of the periods $t \in \{0, 1, ...\}$ [5]. The realization of the performance is drawn iid from the distribution described in the previous section. This implies that there is no serial correlation. The repeated game is then one with public monitoring. The public history $h_p(t)$ of the game in period t is a list of all observable actions before period $t : h_p(t) = \left\{\widehat{\theta}_0, \pi_0, \widehat{\theta}_1, \pi_1, ..., \widehat{\theta}_{t-1}, \pi_{t-1}\right\}$. It is thus a list of announcements (claims) and repayment profiles upto period t. The set of public histories is denoted as H_p, where $H_p = \bigcup_{t=0}^{\infty} S^t$. The private history $h_i(t)$ of the game in period t is a list of all private information upto period $t : h_i(t) = \{\theta_0, \theta_1, ..., \theta_t\}$. A (pure) public strategy s_i for a borrower i is a mapping from the set of all possible public histories to the set of pure actions. In each period the borrowers must decide whether to announce truthfully or not and, knowing the announcements, to repay a certain amount r_i.

[5] All variables defined before will receive a time indication whenever necessary.

The borrowers wish to minimize their expected cost of repayment and discount the future using a common discount factor $\delta, 0 < \delta < 1$.

$$C_i = \sum_{t=0}^{\infty} \delta^t \theta_{it} \pi_{it}(s_i, s_j)$$

These games have been studied extensively in the game theory literature. The main result is a Folk theorem (Fudenberg et al. 1994) which, translated to our setting, states that epsilon-efficient mutual insurance is possible as long as the borrowers are patient enough. We discuss the consequence of the Folk theorem for repeated games with private information in section 5.

Although the Folk Theorem guarantees, in a general way, existence of almost efficient equilibria, it does not answer how one can characterize a particular equilibrium, nor if there are fully efficient equilibria that do not require absolute patience. The main purpose of this paper is to show how, in our simple setup, borrowers overcome the costly state verification problem at no cost and thus can minimize there expected cost of repayment and fully benefit from mutual insurance present in joint liability lending. Interestingly in our example, the level of patience needed in order to obtain the full benefits from mutual insurance is bounded away from one. The main intuition will be that borrowers who contemplate falsely claiming a low return when instead they have a high return, will be deterred from doing so because of the expectation of receiving a future transfer in the form of a higher continuation payoff of the credit game.

We will follow the mechanism design approach to repeated games with private information pioneered by Athey and Bagwell (2001) and Athey et al. (2004), by explicitly designing a set of rules that patient enough borrowers wish to adhere to and allow them to solve the state verification problem. Observable deviations from equilibrium will provoke future punishment which will render them undesirable and unobservable deviations are deterred, as in a standard mechanism design problem, by intertemporal transfers which take the form of future continuation payoffs.

Coordination in our repeated game is modelled as follows: at the beginning of each period t, both borrowers report their private signals according to a reporting rule for each borrower $i : \rho_{it} : (\theta_L, \theta_H) \to (\theta_L, \theta_H)$. Having received the reports $\hat{\theta}_t = (\hat{\theta}_{1t}, \hat{\theta}_{2t})$, each borrower receives an instruction regarding the amount to repay in that period according to an instruction rule $i_t = (i_{1t}, i_{2t}) : (\theta_L, \theta_H)^2 \to [0, 2r]^2$. The levels of repayment ultimately chosen by any of the borrowers are publicly observed. Given this communication structure we model the behavior of borrowers as simply choosing a repayment rule $\tau_t = (\tau_{1t}, \tau_{2t}) : (\theta_L, \theta_H)^2 \times [0, 2r]^2 \to [0, 2r]^2$ which maps their type, their report and the instruction rule into actual individual repayments.

Communication history for a borrower in period t in the repeated game is the sequence of its reports and instructions in periods 1, 2, ..., $t-1$. Private history is the sequence of its private signals θ in periods 1, 2, ..., $t-1$. Finally, public history in period t is a sequence of instruction rules and the values of the payments actually chosen by both borrowers in periods 1, 2, ..., $t-1$. Borrower one's strategy σ^1 is an infinite list of pairs of reporting and repayments rules $(\rho^1, \tau^1) = (\rho^1_t, \tau^1_t)_{t=1}^{\infty}$ for each period defined as a function of its communication and private histories and of the public history at that time. A likewise definition holds for borrower two. Define $\hat{\sigma}$ to be the honest and obedient strategy which selects the pair $(\hat{\rho}, \hat{\tau})$ for all histories, where $\hat{\rho}$ is the honest reporting rule and $\hat{\tau}$ is the obedient repayment rule.

The coordination scheme C describes the choice of an instruction rule as a function of communication and public histories. The game is assumed to start in a group lending phase, from which it reverts to a punishment phase forever whenever there is an observable deviation by any of the borrowers. In the punishment phase, the lender is able to exclude the borrowers from any future loans.

The coordination scheme C is an equilibrium if the pair $\Sigma = (\hat{\sigma}^1, \hat{\sigma}^2)$ is a perfect public equilibrium (PPE) of the repeated game, i.e., if $\hat{\sigma}^1$ is optimal against $(\hat{\sigma}^2, C)$ after any public history of the game and vice versa. Note that we will characterize equilibrium strategies by using the one-shot deviation property.[6] These deviations, in turn, can be divided into two types which, following Athey and Bagwell (2001), we call on- and off-schedule deviations. Off-schedule deviations that are observable, i.e., setting repayment amounts at a level different from the ones instructed by the cooperative mechanism. On-schedule deviations, on the other hand, are those that arise when borrowers misrepresent their type: obviously, these deviations are not observable.

4 An efficient mutual insurance mechanism

We now introduce the mechanism and determine the conditions under which optimal mutual insurance can be obtained in our model. By doing so, besides shedding a new light on the benefits of group lending, we hope to have illustrated the merits of the mechanism design method, which has not been exploited in the theoretical analysis of micro credit issues. We will do so by developing the mechanism in two steps.

Step 1. Reward and Punishment phase in period t. The public and communication histories determine whether a borrower is in the Reward phase (R) or in the Punishment phase (P). If one borrower is the punishement phase, then the other is in the reward phase. The state (phase), together with the announcements will determine the instruction rule used by the borrowers during that period, i_t.

[6] The one-shot deviation property is valid in our setup due to the boundedness of per-period payoffs and discounting.

Borrower 1 in phase R

Borrower 1 \ Borrower 2	Success	Failure
S	(0,2r)	(2r,0)
F	(0,2r)	(0,2r)

Borrower 1 in phase P

Borrower 1 \ Borrower 2	S	F
S	(2r,0)	(2r,0)
F	(0,2r)	(2r,0)

Figure 2. The Repayment Rule

Step 2. Announcing the returns. After the realization of the investment return in period t, the borrowers communicate the return to one another and to the lender according to a reporting rule ρ_t.

The announcements have two consequences regarding the instruction rule. First, they determine the instruction rule used in period t. Second, the announcements determine the transition to tomorrow's state. Let us first examine the instruction rule used in period t :

- **Borrower i is in the punishment phase:** Always repay the full loan, $2r$, unless $\widehat{\theta}_{it}=\theta_H$ and $\widehat{\theta}_{jt}=\theta_L$ which induces zero payment.
- **Borrower i is in the reward phase:** Only repay the full loan $2r$ if $\widehat{\theta}_{it}=\theta_L$ and $\widehat{\theta}_{jt}=\theta_H$. No payment in any other case.

Figure 2 represents the possible phases. The top part represents the loan repayments when borrower one is in the reward state given possible announcements $(\widehat{\theta}^1_L, \widehat{\theta}^2_L)$, $(\widehat{\theta}^1_L, \widehat{\theta}^2_H)$, $(\widehat{\theta}^1_H, \widehat{\theta}^2_L)$ and $(\widehat{\theta}^1_H, \widehat{\theta}^2_H)$. Only when $(\widehat{\theta}^1_L, \widehat{\theta}^2_H)$ is observed is borrower one called upon to repay the entire group loan. It is

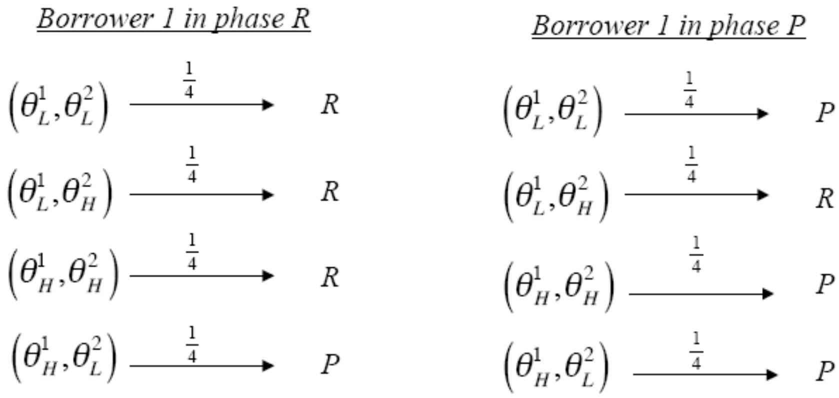

Figure 3. The Transition Rule

easy to see that this instruction rule is efficient since in any possible state of the world the repayment is made by the (weakly) lowest cost borrower. This is summarized in Lemma 2:

Lemma 2 *The mechanism yields same expected cost as group insurance, hence is efficient.*

The announcements play a double role in any period t, as they also determine the transition to the state in period $t+1$.This transition is characterized by the transition rule, illustrated in Figure 3.

Figure represents the transition rule for all possible announcements given the current state (phase R or phase P). Note that only when the punished borrower is called upon to pay the entire loan and the borrower in the reward state announces a failed project, does a transition occur between the states. This means that at the beginning of each period, the chances of a transition between states are equal to $\frac{1}{4}$.

We will now show under which conditions this mutual insurance mechanism can be supported as a perfect public equilibrium of the repeated group lending game. In order for this mechanism to induce an equilibrium of the repeated credit game, it must be, as indicated above, that both observable deviations (external delinquency) and unobservable devations (internal delinquency) are deterred. Theorem 1 states the conditions for an efficient equilibrium of repeated credit game.

Theorem 1 *For any $S = (\theta_L, \theta_H)$ such that $\theta_L < \theta_H$, there exists a $\delta^* = \frac{4\theta_L}{3\theta_L+\theta_H}$, such that for all $\delta \in (\delta^*, 1)$ the mechanism induces honest reporting and prevents off-equilibrium deviations. In other words it induces an effcient equilibrium of the repeated credit game.*

Proof 2 *First let us check the interim incentive compatibility conditions. Define $C^i_j(\widehat{\theta}, \theta)$ as the interim payoff for borrower i in state j when announcing $\widehat{\theta}$ while the true payoff of the project is θ. This is the current and future cost of loan reimbursment assuming truthfulness in the future. Incentive compatibility then implies that $C^i_j(\widehat{\theta} = \theta, \theta) \geqslant C^i_j(\widehat{\theta} \neq \theta, \theta)$ for all $i = 1, 2$ and $j = R, P$. Note that given the above mechanism we can define the ex ante continuation payoff (cost) in phase P to be C_P and in phase R to be C_R. We then have that :*

$$C_P - C_R = 2r\frac{(1-\delta)(\frac{1}{4}\theta_L + \frac{1}{4}\theta_H)}{1-\frac{\delta}{2}} = r\frac{(1-\delta)(\theta_L+\theta_H)}{2-\delta}$$

Because of symmetry we only check for borrower i, this boils down to checking four conditions:

1. *Being in the reward state, borrower i prefers to announce a high marginal utility of consumption when the project failed: $C^i_R(\theta_H, \theta_H) \leqslant C^i_R(\theta_L, \theta_H)$. This translates into:*

$$C^i_R(\theta_H, \theta_H) = \delta(\frac{1}{2}C_P + \frac{1}{2}C_R) \leqslant (1-\delta)\frac{1}{2}2r\theta_H + \delta C_R = C^i_R(\theta_L, \theta_H)$$

$$\begin{aligned} \frac{\theta_H(1-\delta)2r}{(C_P - C_R)} &= \frac{2\theta_H(2-\delta)}{(\theta_L+\theta_H)} \geqslant \delta \\ \frac{4\theta_H}{\theta_L + 3\theta_H} &> 1 \geqslant \delta \end{aligned}$$

This condition is always satisfied.

2. *Being in the reward state, borrower i prefers to announce a low marginal utility of consumption when the project succeeds:* $C_R^i(\theta_L,\theta_L) \leqslant C_R^i(\theta_H,\theta_L)$. *This translates into:*

$$C_R^i(\theta_L,\theta_L) = (1-\delta)r\theta_L + \delta C_R \leqslant \delta(\frac{1}{2}C_P + \frac{1}{2}C_R) = C_R^i(\theta_H,\theta_L)$$

$$\begin{aligned} \delta(\frac{1}{2}C_P + \frac{1}{2}C_R) &\geqslant (1-\delta)r\theta_L + \delta C_R \\ 1 &> \delta \geqslant \frac{4\theta_L}{3\theta_L + \theta_H} \end{aligned}$$

3. *Being in the punishment state, borrower i prefers to announce a high marginal utility of consumption when the project failed:* $C_P^i(\theta_H,\theta_H) \leqslant C_P^i(\theta_L,\theta_H)$. *This translates into:* $C_P^i(\theta_H,\theta_H) = (1-\delta)r\theta_H + \delta C_P \leqslant (1-\delta)2r\theta_H + \delta(\frac{1}{2}C_P + \frac{1}{2}C_R) = C_P^i(\theta_L,\theta_H):$

$$\begin{aligned} \theta_H &\geqslant \frac{\delta(C_P - C_R)}{(1-\delta)2r} \\ \frac{\theta_H(1-\delta)2r}{(C_P - C_R)} &\geqslant \delta \\ \frac{4\theta_H}{\theta_L + 3\theta_H} &> 1 \geqslant \delta \end{aligned}$$

This condition is always satisfied.

4. *Being in the punishment state, borrower i prefers to announce a low marginal utility of consumption when the project succeeds:* $C_P^i(\theta_L,\theta_L) \leqslant C_P^i(\theta_H,\theta_L)$. *This translates into:* $C_P^i(\theta_L,\theta_L) = (1-\delta)2r\theta_L + \delta(\frac{1}{2}C_P + \frac{1}{2}C_R) \leqslant (1-\delta)(1-\alpha)2r\theta_L + \delta C_P = C_P^i(\theta_H,\theta_L):$

$$\begin{aligned} \theta_L &\leqslant \frac{\delta(C_P - C_R)}{(1-\delta)2r} \\ 1 &> \delta \geqslant \frac{4\theta_L}{3\theta_L + \theta_H} \end{aligned}$$

In conclusion, since $\theta_L < \theta_H$ *on-schedule incentive compatibility is satisfied whenever* $\delta \in (\frac{4\theta_L}{3\theta_L+\theta_H}, 1)$.

Off-schedule deviations are deterred by Nash reversion (no future loans). Let the cost of financing in the event of no future loan be $\phi > r\theta_L$. The most one can gain by deviating observably is if one is in the punishment state, one is to repay the full loan having experienced a failure announced θ_L while the other borrower announced θ_H and one does not repay. Then payoffs will be defined as:

$$(1-\delta)2r\theta_H + \delta C_P \leqslant \delta r\theta_L < \delta r\phi \tag{1}$$

Were it is the case that

$$C_P = r\left[\frac{2\theta_L + \theta_H}{2} - \frac{\delta}{4}\frac{\theta_L + \theta_H}{2-\delta}\right]$$

Plugging this into 1 we observe that this inequality is satisfied for $\delta^* = \frac{4\theta_L}{3\theta_L + \theta_H}$, and hence also for all $\delta \in (\frac{4\theta_L}{3\theta_L+\theta_H}, 1)$.

It is straightforward to see that the critical level of patience needed to support the efficient equilibrium depends negatively on the 'insurance potential', defined as $\frac{\theta_H}{\theta_L}$. This is confirmed by the following corollary

Corollary 1 *The higher the ratio $\frac{\theta_H}{\theta_L}$, the lower δ needed to sustain cooperation.*

Proof 3 *The derivative of the inverse of the critical level of patience, $\frac{1}{\delta^*}$, with repect to the ratio $\frac{\theta_H}{\theta_L}$ is positive:*

$$\frac{d(\frac{3\theta_L+\theta_H}{4\theta_L})}{d\frac{\theta_H}{\theta_L}} = \frac{1}{4} > 0$$

5 A general Model of Mutual Insurance and Joint Liability Lending

We have just studied how, by means of a very simple model, borrowers can be induced to be honest if they are patient enough through intertemporal incentives. We now claim that the intuition of our results carry over to a more general framework, but unfortunately, it does so at the cost of not being able to characterize the exact equilibrium strategies. Nonetheless, we will rely on a very general existence result due to Fudenberg, Levine and Maskin (1994) to show that the argument holds in a general setup.

We can generalize our borrowing game by assuming there are N ex ante identical borrowers $i = 1, ..., N$, each borrowing r which they invest in a project. Each period, the project return of any borrower $i : y^i$, is identically and independently drawn from a set $(y_1, ..., y_K) = Y$, according to a distribution $P = (P(y_1), ..., P(y_K))$ with $\sum_{k=1}^{K} P(y_k) = 1$ and $P(y_k) \geqslant 0$ for all $k = 1, ..., K$. Hence every borrower i receives an investment return $y^i \in Y$. Each borrower has a common continuous concave instantaneous utility function $u(.) : \mathbb{R} \to \mathbb{R}$; with $u' > 0$ and $u'' < 0$. Concavity guarantees that borrowers can benefit from mutual insurance through a group lending contract. This is summarized in the following lemma of which the proof is delegated to the appendix:

Lemma 3 *Let u^e_{IL} be the expected utility under individual liability and u^e_{JL} be the expected utility under joint liability if borrowers are honest. Joint liability lending improves upon individual liability through mutual insurance: $u^e_{JL} > u^e_{IL}$.*

Proof 4 *See Appendix*

Clearly, if the borrowing game is only played once, no borrower has an incentive to tell the truth about her realized income. The question that arises is if, in a repeated credit game, the borrowers can fully benefit from the possibility of mutual insurance, that is, can honesty be induced without cost? The Folk theorem due to FLM (1994) tells us that, if patients become arbitrarily patient, they can induce honesty at an arbitrarily low cost. By extending our notation of the repeated game to from 2 to N

borrowers and using a more general utility function, we say that the coordination scheme C is an equilibrium if the vector $\Sigma = (\hat{\sigma}^1, ..., \hat{\sigma}^N)$ is a perfect public equilibrium (PPE) of the repeated game, i.e., if $\hat{\sigma}^i$ is optimal against $(\hat{\sigma}^{-i}, C)$ after any public history of the game and vice versa, where $\hat{\sigma}^{-i} = (\hat{\sigma}^1, ..., \hat{\sigma}^{i-1}, \hat{\sigma}^{i+1}, ..., \hat{\sigma}^N)$.

Let $W(\mu)$ be the average payoffs of the static credit game when players are truthful and obediently follow instruction rule μ. It is said that the coordination scheme C implements instruction rule μ if it is an equilibrium and yields expected average discounted payoffs equal to $W(\mu)$. Let μ^* be the instruction rule that upon announcement of realized project return implements the efficient mutual insurance outcome described above. The following adaptation of FLM's theorem to our model then holds:

Theorem 2 *Fix an instruction rule μ and let σ^{NE} denote a profile of strategies that constitute a Nash equilibrium of the corresponding static credit game. Suppose that the distribution of types is independent across borrowers. Let V^0 be the set formed by the convex hull of $W(\sigma^{NE})$ and the feasible points that Pareto dominate it. If V^0 has a non-empty interior, then all payoff vectors in V^0 can be approximated by equilibrium coordination schemes for discount factors close enough to 1. In particular, if $\mu = \mu^*$, then there exists an equilibrium coordination scheme C that (approximately) implements μ^* for all δ sufficiently close to* 1.

Proof 5 *FLM (1994) p 1030.*

Hence, when borrowers are sufficiently patient they can almost perfectly benefit from mutual insurance while still telling the truth. An alternative interpretation is that the opportunity to benefit from future mutual insurance acts as a sufficient disciplining device to keep borrowers from cheating, without needing to recur to existing social capital. We need to emphasize that even when borrowers are not arbitrarily patient then they can still use the promise of future mutual insurance to partially overcome the costly state verification.That is, at a positive but small cost.

6 Conclusion

This paper shows that the costly audit problem can solved through the value of mutual insurance inherent to group lending. The current and future benefits from mutal insurance can be used to induce truthtelling among group members. When this is the case, no existing social capital is required. When borrowers are patient enough, group lending can be successful, not by relying on existing social capital, but by endogenously creating social capital; in the form of trust in truthfully reporting the state of the world by group members.

This could explain why we observe succesful joint liability loan contracts in environments where existing social capital is not evident, such as in cities or developed economies. The more general message of this paper is that existing social capital is a not the only important force in tackling the information problems faced by lenders, but that the contractual terms of the loan themselves can attenuate these information problems in a repeated environment. That is, if the members of the group are patient enough, they can cooperate honestly at zero cost, and hence they can benefit from joint liability even without previous contact between the group members. This immediately implies that existing social capital can influence, negatively or positively, the patience level the members have. The idea that existing social capital may be helpful but is not necessary for the success of joint liability loan may explain the mixed empirical evidence found in the literature.

Of course, we have studied just one form of asymmetric information that can plague a credit relationship, but we conjecture that our insights can equally be translated to other settings such as adverse selection and moral hazard. We leave this for future work.

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Part I

Appendix

Proof of Lemma 3. **Lemma 3.** Let u^e_{IL} be the expected utility under individual liability and u^e_{JL} be the expected utility under joint liability if borrowers are honest. Joint liability lending improves upon individual liability through mutual insurance: $u^e_{JL} > u^e_{IL}$.

Proof 6 *When borrowers are individually liable for their repayment, then the expected utility from paying back r is equal to u^e_{IL} where:*

$$\sum_{k=1}^{K} P(y_k)u(y_k - r) = u^e_{IL}$$

Under joint liability in which every borrower reports their project income honestly, the borrowers jointly pay back $N \times r$ but distribute it among them in an optimal way. In order to optimally benefit from insurance, borrowers wish to maximize the joint payoff for any vector of realized incomes $y^1, ..., y^N$. They solve

$$\max_{r_1,\dots,r_N} \sum_{i=1}^{N} u_i(y^i - r_i) \text{ such that } \sum_{i=1}^{N} r_i = N \times r$$

The optimal allocation of repayment r_i for every borrower $i = 1, ..., N$ is such that $u'_i(.) = u'_j(.)$ for all i, j. Hence it is as if all receive the average income, $\frac{1}{N}\sum_{i=1}^{N} y^i$, and then pay back the individual loan amount r. The realization of these incomes happens with probability $P(y^1) \times P(y^2) \times ... \times P(y^N)$. Expected utility under joint liability, u^e_{JL}, then becomes:

$$\sum_{k_1=1}^{K} ... \sum_{k_N=1}^{K} P(y^1_{k_1})P(y^2_{k_2})...P(y^N_{k_N})u_i(\frac{1}{N}\sum_{i=1}^{N} y^i_{ki} - r) = u^e_{JL}$$

We now show that $u^e_{JL} > u^e_{IL}$. For any realizations of $y^1, ..., y^N$ we have that $\sum_{i=1}^{N} u_i(y^i - r) < N \times u_i(\frac{1}{N}\sum_{i=1}^{N} y^i - r)$ because of concavity of u. This happens with probability $P(y^1)P(y^2)...P(y^N)$. But then $u^e_{IL} = \sum_{k_1=1}^{K} P(y^1_{k_1})u(y^1_{k_1} - r) = \sum_{k_1=1}^{K} ... \sum_{k_N=1}^{K} P(y^1_{k_1})P(y^2_{k_2})...P(y^N_{k_N})u_i(y^1_{k_i} - r)$. Because of symmetry, we have that

$$\begin{aligned} N \times u^e_{IL} &= N \times \sum_{k_1=1}^{K} ... \sum_{k_N=1}^{K} P(y^1_{k_1})P(y^2_{k_2})...P(y^N_{k_N})u_i(y^1_{k_i} - r) \\ &< N \times \sum_{k_1=1}^{K} ... \sum_{k_N=1}^{K} P(y^1_{k_1})P(y^2_{k_2})...P(y^N_{k_N})u_i(\frac{1}{N}\sum_{i=1}^{N} y^i_{ki} - r) = N \times u^e_{JL} \end{aligned}$$