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## Group lending with endogenous social collateral

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BEATRIX PAAL  
STANFORD UNIVERSITY and  
UNIVERSITY OF TEXAS AT AUSTIN  
paal@stanford.edu

Department of Economics, Landau Building  
Stanford University, Stanford, CA 94305-6072  
phone: (650) 724 4903  
fax: (650) 725 5702

THOMAS WISEMAN  
UNIVERSITY OF TEXAS AT AUSTIN  
wiseman@eco.utexas.edu

Department of Economics  
University of Texas at Austin, Austin, TX 78712  
phone: (512) 475 8516  
fax: (512) 471 3510

### Abstract

Inspired by microcredit institutions that interact with groups of borrowers and rely on “social capital” instead of seizable physical assets to collateralize their loans, we construct a model of lending to a community of borrowers who are connected by risk-sharing arrangements that are themselves subject to enforcement problems. We show that an outside lender, if he conditions his repeated interactions with each borrower on the history of his interactions with *all* the group members (a joint liability contract), can earn a higher profit than he could through offering individual liability contracts. The observation driving this result is that with individual liability loans, a joint-welfare maximizing group may prefer to have one or more group members default on their contracts, so that the group can consume a mix of outside loans and the defaulters’ stochastic income.

One contribution of our work is to give economic content to the concept of “social capital” as the surplus that an agent receives by adhering to the group risk sharing arrangement instead of retreating to autarky. The group can deter the agent from defaulting on his contract with the outside lender by threatening to reduce this surplus. We also derive predictions for how loan repayment performance changes as a function of changes in the level of endogenous social capital. We find a non-monotonic relationship, so that there is no presumption that increased social capital reduces loan delinquency.

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## I. Introduction

The concept of social capital or social collateral plays an important role in analyses of how group lending contracts overcome enforcement problems in rural credit markets. In this paper we propose a model that can be used to interpret social capital as an endogenous economic variable, a surplus that arises from repeated interactions between members of a community. We show how group lending contracts can successfully use this surplus as collateral against individual default. We also derive predictions for how loan repayment performance changes as a function of changes in the level of endogenous social capital. We find a non-monotonic relationship, which can help interpret why empirical investigations of this correlation returned mixed results.

Conventional lending to poor borrowers in developing countries is often unprofitable because of weak repayment performance. Nevertheless, specialized microcredit institutions have succeeded at maintaining reasonable ex post returns on their loans to such borrowers. These institutions manage to overcome enforcement problems by interacting with groups of borrowers instead of individuals. The joint liability contracts they offer imply negative consequences for each group member (typically in the form of non-refinancing threats) should one group member default. This arrangement creates an incentive for the group to apply their own sanctions against a delinquent borrower. To the extent that such low cost “social sanctions” are available to the community when direct sanctions by the lender are impossible or very costly, group contracts can dominate individual contracts. The phenomenon of lenders inducing groups to enforce contracts for them by applying “social penalties or pressures” is also referred to as collateralizing loans with the “social capital” of the borrower.

In this paper we explore how the value created by repeated economic interactions between members of a group can be used as collateral towards the outside. We construct an infinite horizon model of a monopolistic lender offering credit to a community of agents who are connected by informal social insurance arrangements. The members of the community face random income fluctuations and engage in risk sharing with each other in order to smooth their consumption. These risk sharing contracts are themselves subject to limited enforcement and are self-sustaining due to the repeated nature of community interactions. There is aggregate risk, so that there is demand for outside borrowing and lending. However, the outside lender also faces

the problem of lack of enforcement and must structure contracts with borrowers in the village in such a way as to overcome these enforcement problems. In this environment investigate the advantages of lending to a group rather than lending to individuals separately.

We show that a contract that conditions the lender's repeated interaction with any single member of the group on the history of his interactions with *all* group members may be self-sustaining even if a contract based on individual liability is not self-sustaining. The intuition behind this result is that the outside lender, by threatening to withhold future funds from the group at large, can compel the group to pressure a defaulting member to repay. This "social pressure" in our model takes the form of threatening the defaulting borrower with a reduced share of the surplus that community risk sharing generates over autarky. By contrast, given our assumption that group members may cooperate to maximize joint surplus, a lender interacting with individuals separately can only punish default by denying further credit, without being able to manipulate the terms of a defaulter's participation in village risk sharing. In fact, in some circumstances the group is actually better off when one or more members default on their contracts, so that the group can share a mixture of outside lending and the defaulters' random income. This difference between outside options drives the result.

The analysis of our model suggests an *operational definition of social capital* as the surplus that an agent receives by participating in the village risk-sharing arrangement instead of living in autarky. It is exactly this surplus, the credit of the individual with the village, that an outside lender can threaten to reduce in case of default. In this sense, the surplus that we call social capital of an individual represents a form of collateral. (Of course, the outside lender has no direct way of manipulating this surplus, but he can structure his interactions with the group at large in such a way that the group has incentives to apply the right sanctions for him.)

Our model environment is deliberately parsimonious. We make assumptions on the preferences and the joint income process of our villagers. We assume a single, risk-neutral outside lender. Both the villagers and the outside lender have access to perfect information but no access to any enforcement technology. Our final assumption is that the lender can commit to future actions but the villagers cannot. Our aim is to isolate the role of economic interactions within a community in creating social capital, and we formulate a model that demonstrates this possibility in a transparent manner. The stylized nature of our model environment also allows us to conjecture that the phenomenon we identify might be relevant outside of the microfinance context. For example, married couples are typically jointly liable for non-business loans. Still, it is useful to provide some motivations for our modeling choices from the perspective of the literature on rural credit markets. This is what we turn to next.

Theoretical work on why group lending outperforms individual lending has focused on how group lending overcomes various frictions that hinder the operation of rural credit markets. These postulated frictions include asymmetric information problems as well as enforcement difficulties. Our purpose in this paper is to further the understanding of how *enforcement* problems can be ameliorated by group lending practices. We are well aware that there are a number of other dimensions along which the practices of microcredit institutions differ from those of traditional lenders. For example, the group structure can be usefully exploited to better screen borrowers, to improve the monitoring of both the appropriate use of funds and the outcomes of projects, to reduce the cost of transacting with many small borrowers, or to provide education and technical assistance.<sup>1</sup> Ultimately, however, any lender must collect repayment. We single out enforcement issues because in environments with extremely weak legal systems and hardly any physical collateral, every lender must confront the possibility of strategic default.

To our knowledge the only systematic empirical investigation of the relative importance of enforcement problems versus various informational asymmetries is the work of Ahlin and Townsend (2000), comparing four static models of group lending. Their preliminary results indicate that data from Thai villages (particularly, the most rural areas) are best fit by the limited enforcement model of Besley and Coate (1995). Zeller (1998) uses data from lending programs in Madagascar and finds that increasing the per capita land holdings of members in a borrower group has an insignificant (negative) effect on the repayment rate of the group. He interprets this finding to mean that “the capacity to repay seems not to matter in actual repayment performance” (p. 615). Regarding the nature of interactions within a village community, Ligon, Thomas, and Worrall (2002) show that the kind of dynamic limited commitment environment that we assume in our model is a good description of the informal social insurance arrangements operating in three Indian villages. Albarran and Attanasio (2001), using data from a Mexican welfare program, also find that a number of implications of the limited commitment environment are generally supported.<sup>2</sup>

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<sup>1</sup> Examples of theoretical work on group liability and various asymmetric information problems include Varian (1990), Stiglitz (1990), Banerjee, Besley, and Guinnane (1994), Conning (1996), Ghatak (1999), and Madajewicz (1999). A comparison of various models is carried out by Ghatak and Guinnane (1999) and Ahlin and Townsend (2000). Morduch (1999) provides an extensive and interesting review of microfinance institutions.

<sup>2</sup> Kocherlakota (1996) proposes a test that could discriminate between dynamic limited commitment and dynamic asymmetric information models, but to our knowledge these alternatives have not been contrasted using micro data from rural communities.

The most important modeling choice we make is to give no informational or enforcement advantage to the villagers relative to the outside lender. This approach is quite distinct from the standard approach in the literature. For example, Ghatak and Guinnane (1999) emphasize that joint liability lenders outperform conventional lenders by giving incentives to members of a community to either use information about one another or to apply non-financial sanctions against one another. Indeed, all theoretical models of joint liability lending that we are aware of feature such an exogenous information or enforcement advantage. By contrast, in our model, information is freely available to everyone and all contracts must be self-enforcing. As a result, we can highlight how social capital is created through repeated community interactions, instead of arising from superior monitoring or punishment technology that the community possesses.

In the literature on group lending and strategic default, it is commonly assumed that society can impose a “social penalty” on an individual who reneges on a group lending contract. This penalty may be an exogenous constant, as in the paper of Armendariz de Aghion (1999), or it may be postulated as an exogenous function of the contemporaneous loss suffered by the complying partner and the repayment capacity of the defaulter, as in the work of Besley and Coate (1995). In contrast, we derive these penalties endogenously, which allows us to (1) study the incentives of the community to impose such penalties and (2) examine how the economic environment facing the community affects their magnitude and effectiveness.

The feature of our model that allows us to endogenize social penalties is its explicit dynamic nature. In this regard, our work is closest to that of Sadoulet (2000) and of Che (2002). Sadoulet (2000) examines how dynamic incentives to repay differ under individual versus joint liability contracts in an adverse selection environment. However, by assumption, there is no interaction between insurance provision within a group and credit transactions with the outside. In our model, this interaction is an important element in making joint liability loans more profitable. Che (2002) studies a moral hazard environment where agents repeatedly make effort choices. Joint liability contracts turn effort choice into an endogenous punishment device much in the same spirit as the terms of participation in village risk sharing is an endogenous punishment device in our model.

We model village interactions as risk sharing by risk averse agents who face exogenous stochastic income streams. The outcomes in this environment, in absence of an outside lender, have been investigated by Kocherlakota (1996) and Ligon, Thomas, and Worrall (2002). A natural alternative would have been to assume productive opportunities and capital accumulation. Ligon, Thomas, and Worrall (2002) show that extending the model to include

stochastic storage leaves the implications with respect to insurance provision qualitatively unaffected.

Empirical evidence also suggests that providing consumption insurance is an important component of rural credit transactions. The work of Townsend (1994, 1995) emphasizes the importance of income risk and the sharing of this risk within poor rural communities. In his classic study of credit arrangements in Northern Nigerian villages, Udry (1994) also demonstrates that repayments on loans are state contingent, and depend on the realizations of shocks to both the borrower's and the lender's incomes. In another context, Calomiris and Rajaraman (1998) show that implicit interest rates on funds placed in ROSCA (rotating savings and credit association) accounts fluctuate significantly from month to month. They argue that this observation is more consistent with insurance provision against random shocks to tastes or incomes than with the presumption that these accounts represent savings in preparation for anticipated large purchases (such as durables). Nevertheless, our main reason for assuming an endowment economy is to gain tractability and maintain the transparency of our results.

Finally, the assumption of a monopolistic outside lender deserves comment. First, we note that it is consistent with the observed operation of microfinance institutions in developing countries. For example, van Bastelaer (1999) describes a typical segmentation between the roles of NGOs and local moneylenders in providing credit to different subsets of borrowers. He reports that the interest rates on the loans from different sources do not display a strong tendency to converge. Second, the microfinance institutions in question, although close to self sustaining, do not generate positive profits, so that incentives for new entry are limited.<sup>3</sup>

We believe that our definition of the term social capital captures the meaning that has been attributed to this concept in the less formal literature. We also believe that it is useful to have a formal economic definition, for example to motivate empirical work. We illustrate this by asking whether in our model higher levels of social capital are associated with higher group loan repayment rates. This is an interesting question because the corresponding empirical hypothesis has been investigated with quite mixed results. We show that our model simply does

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<sup>3</sup> From a theoretical perspective, the presence of multiple outside institutions would raise some interesting issues. The existence of self-enforcing contracts would depend on how the interaction between these outside lenders is modeled. (See, for example, Bulow and Rogoff (1989), Krueger and Uhlig (2000), Kletzer and Wright (2000), and Wright (2002).) Whether group lending would retain some advantage over individual lending is not immediately clear. It would be worthwhile to pursue these issues, particularly to make predictions about the future of microcredit. However, in our current context, it would take us too far from the main point.

not generate the hypothesis: A plausible measure of loan repayment rates displays a non-monotonic relationship to our measure of social capital.

We formally describe the model in Section II. Different lending contracts are compared in Section III, where we show that an outside lender can obtain higher profits using group contracts instead of using individual contracts. In Section IV, we relate previous uses of the term social capital to our more formal definition, and show that the empirical hypothesis that more social capital should improve the repayment performance of group loans does not follow from our model. In Section V, we conclude by discussing the robustness of our main message to various plausible alterations of the environment.

## II. Model

### A. Environment

The environment (which is similar to the one that Kocherlakota (1996) studies) is as follows: A village comprises  $N$  infinitely-lived individual agents. The income of individual  $i$  in period  $t$  is denoted  $y_t^i$ ;  $Y_t$  is the vector of individual incomes in period  $t$ . Joint income  $Y_t$  is stochastically determined according to the distribution  $P$ , which has finite support and which is i.i.d. across time. The distribution  $P$  is symmetric: If income vector  $Y$  is in the support of  $P$ , and vector  $Y'$  is a permutation of  $Y$ , then  $Y'$  is also in the support of  $P$ , and  $P(Y') = P(Y)$ . For each individual, then, the possible realizations of  $y_t^i$  are given by a set  $\{y(1), \dots, y(S)\}$ , where  $y(1) < y(2) < \dots < y(S)$ . We assume that income is non-negative, so that  $y(1) \geq 0$ , and that individuals face some uncertainty over income, so that  $S \geq 2$ .

Agents have identical preferences. An individual who consumes  $x_t$  in period  $t$  receives utility  $u(x_t)$ , where the function  $u$  is increasing, concave (individuals are risk averse), and twice-continuously differentiable. The total utility is the discounted sum of per period utility, multiplied by  $(1 - \delta)$  to put it on the same scale as utility per period:

$$(1 - \delta) \sum_{t=1}^{\infty} \delta^{t-1} u(x_t), \quad \delta \in (0, 1).$$

An individual who consumes his own income in each period, for example, receives expected utility

$$E(1 - \delta) \sum_{t=1}^{\infty} \delta^{t-1} u(y_t^i) = Eu(y^i) = \sum_{s=1}^S P(y(s)) u(y(s)),$$

where  $P(y)$ , in an abuse of notation, is the probability that an individual receives income  $y$ . (That is,  $P(Y)$  is the joint distribution, and  $P(y)$  is the marginal distribution.)

### B. Internal Risk Sharing (No Outside Lender)

In the absence of an outside lender, the risk averse members of the village group can increase their welfare by participating in a risk sharing (social insurance) arrangement, as long as

individual income realizations are not perfectly correlated. In each period, agents with high incomes can make a transfer to agents with low incomes, in the expectation of receiving similar transfers in the future when their own incomes are low.

Formally, in each period the income vector  $Y_t$  is realized and is observed by all agents. Agents then have the opportunity to transfer income to some or all of the other agents; denote by  $R_t$  the matrix of transfers made by the agents in period  $t$ . The history  $h_t$  at period  $t$  is the sequence of past and present income realizations and past transfers:

$$h_t = (Y_1, R_1, \dots, Y_{t-1}, R_{t-1}, Y_t).$$

A strategy for each individual is a function from the set of possible histories to a vector of non-negative transfers. Individual  $i$ 's strategy specifies how much of his income  $y_t^i$  goes to each agent after every history, subject to the constraints that none of the transfers be negative and that their sum is no greater than  $y_t^i$ . Individual  $i$ 's consumption, after the transfers are made, is denoted  $x_t^i$ .

Let  $\bar{y}_t \equiv \sum_{i=1}^N y_t^i / N$  be the mean of the realized individual incomes in period  $t$  and let  $\bar{p}$  be the distribution of  $\bar{y}_t$ . In a full risk sharing arrangement, each individual's consumption  $x_t^i$  depends only on  $\bar{y}_t$ , and not on his own income  $y_t^i$ . In a symmetric full risk sharing arrangement, each agent consumes the average income  $\bar{y}_t$  of all individuals in every period. Because individuals are risk averse, and the variance of  $\bar{y}$  is less than the variance of  $y^i$ ,  $Eu(\bar{y}) > Eu(y^i)$ , so the group members are better off when they share risk. Full risk sharing is sustainable as a subgame perfect equilibrium if the following condition is satisfied:

$$\max_{\hat{Y} \in \text{supp}(P)} \left\{ (1-\delta)u\left(\sum_{j=1}^N (\hat{y}^j / N)\right) + \delta Eu(\bar{y}) - (1-\delta)u(\hat{y}^i) - \delta Eu(y^i) \right\} \geq 0 \quad (\text{FRS})$$

Given an income realization, an agent is willing to make his specified transfer if the expected utility that he gets from doing so and remaining in the group exceeds the expected utility that he would receive from consuming his own income today, being cast out of the risk sharing group, and then consuming his own income in every period in the future. (An individual's expected utility in autarky,  $Eu(y^i)$ , is his minmax payoff, so casting an agent into autarky is the harshest punishment that can be enforced in a subgame perfect equilibrium.) If an agent prefers to remain in the risk sharing arrangement after any realization of  $Y$  (if Condition FRS holds), then the arrangement is sustainable.

We will assume throughout that Condition FRS holds, so that full risk sharing is subgame perfect. Increasing the discount factor  $\delta$  increases the sustainability of full risk

sharing, as does increasing the degree of risk aversion. Decreasing the correlation between individual income realizations also increases sustainability, by lowering the variance of  $\bar{y}$  and thus increasing the expected utility that it provides. Similarly, a larger group size decreases aggregate risk (holding the degree of individual income correlation fixed) and increases the gain from risk sharing. On the other hand, a larger group size may increase the size of the maximum transfer an individual is called upon to make — when one individual receives the highest income  $y(S)$  and the other  $N - 1$  receive the lowest income  $y(1)$  — and thus make sustaining the risk sharing agreement more difficult. (Ligon, Thomas, and Worrall (2002) examine efficient partial risk sharing when full risk sharing is not sustainable, and Kocherlakota (1996) looks at risk sharing between a pair of agents.)

We assume that the agents choose a symmetric equilibrium, and that from the set of symmetric subgame perfect equilibria they play one that is Pareto optimal. Because full risk sharing is efficient, and Condition FRS holds, those assumptions imply that in the absence of an outside lender the group will engage in a symmetric full risk sharing arrangement. We define social capital, then, as the surplus that a group member receives each period from participating in internal risk sharing relative to autarky:

$$\text{social capital} \equiv \frac{Eu(\bar{y})}{Eu(y^i)} - 1.$$

### C. Monopolistic Outside Lender

Now consider the problem faced by a single outside lender who approaches a group that engages in internal risk sharing. The lender maximizes

$$E_0(1 - \delta) \sum_{t=0}^{\infty} \delta^t \pi_t$$

where  $\pi_t$  is his profit in period  $t$ . We assume that the lender offers individuals contracts of the following type: The lender guarantees a constant level of consumption,  $c$ . At the beginning of each period, an agent's income  $y_t^i$  is realized and observed by all parties. If  $y_t^i$  is less than  $c$ , then the lender transfers the difference,  $c - y_t^i$ , to the agent. In periods when  $y_t^i$  exceeds  $c$ , the agent turns over the surplus to the lender. In effect, the individual trades his entire stochastic

stream of future income to the lender in exchange for a guaranteed level of consumption.<sup>4</sup> Because income is i.i.d. across time, then, the lender's problem is to maximize a sequence of one-period expected profits. The expected per period profit,  $E\pi(c)$ , can be written as

$$E\pi(c) = \sum_{s=1}^S [P(y(s))y(s) - c] = Ey^i - c.$$

The lender is able to commit himself *ex ante* to such a contract. That is, the lender may specify in the contract offered to agent  $i$  conditions (on the history of the lender's interactions with all villagers) under which the lender will permanently abandon the agreement. In any period where those conditions are not met, the lender is constrained to provide  $c$  to agent  $i$ . Contracts where the lender's continued participation depends only on the sequence of agent  $i$ 's transfers to the lender are *individual liability* contracts. Under *joint liability* contracts, the lender conditions on the histories of all villagers. (Note that individual liability contracts are a special case of joint liability contracts.)

The borrowers, on the other hand, cannot commit. They can walk away from the deal at any point at which they find it profitable to do so, because the lender lacks the ability to enforce the terms of the contract. Thus, a strategy for the lender specifies only what contract (if any) will be offered to each agent in period 0. A villager's strategy specifies which contracts to accept in period 0, and in all subsequent periods specifies a vector of non-negative transfers to each agent and to the lender. As before, the sum of agent  $i$ 's transfers cannot exceed  $y_t^i$ .

Because of the one-sided commitment, the lender must offer *self-enforcing* contracts. A contract is self-enforcing if after every possible history no villager finds it in his interest to walk away from it. In the absence of a group risk sharing arrangement, an agent who breaks the terms of the loan contract is denied future credit and must return to consuming only his own income, so the condition for a contract to be self-enforcing is that

$$u(c) \geq (1 - \delta)u(y(S)) + \delta Eu(y^i). \quad (\text{SE})$$

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<sup>4</sup> The assumption of a constant income stream offered by the lender is made for the sake of tractability. However, because the lender is risk-neutral and discounts at the same rate as the villagers, the assumed contract form is likely to be only slightly restrictive relative to the unconstrained optimal contract. For example, if the lender interacts with only a single isolated agent, the unconstrained optimal contract converges, with probability one, to a constant in a finite number of periods. A similar outcome will occur when multiple, sufficiently patient, villagers interact with each other in a closed village. (See Sargent and Ljungqvist (2000), pp. 402-416.)

That is, even when an agent receives the highest income level,  $y(S)$ , he prefers consuming  $c$  in every period to breaking the contract, consuming  $y(S)$  today, and returning to autarky in all future periods. Note that if  $c \geq CE(\bar{y})$ , where  $CE(\bar{y})$  is the certainty equivalent of the stochastic average income  $\bar{y}$ , then Condition FRS (guaranteeing that full risk sharing is sustainable) implies that Condition SE is satisfied.

If, on the other hand, the borrowers are also participating in risk sharing, then the outside option of an agent who walks away from a contract may be higher. For example, if an agent is allowed to continue sharing income with the rest of the group even after being denied access to credit from the lender, then his expected payoff after breaking the contract is greater than the autarky payoff  $Eu(y^i)$ . In that case, self-enforcement requires a stricter condition than Condition SE: The lender must provide a higher guaranteed consumption level  $c$  to induce borrowers not to abandon the contract. Furthermore, if the villagers can collude to jointly deviate from a contract, then an even higher level of  $c$  is necessary. In the next section, we explore that situation in detail and examine the conditions under which the lender can do better by offering joint liability contracts rather than by dealing with individual borrowers separately.

### III. Individual versus Joint Liability

The goal of the lender is to maximize expected profits  $M \cdot E\pi(c)$  (where  $M \leq N$  is the number of individuals offered contracts) subject to the constraint that the contract must be self-enforcing. The lender chooses the number  $M$  of villagers to lend to, the level  $c$  of guaranteed income offered, and the structure (joint or individual liability) of the contract's renewal policy. For simplicity, we restrict the lender to offering the same  $c$  and the same renewal policy to each borrower, although he may offer contracts to only a subset of the villagers. We assume, as before, that the group of villagers, given the set of contracts offered, will maximize their joint utility subject to subgame perfection. The solution to the lender's problem, then, will be a subgame perfect equilibrium that is coalition-proof (in the sense of Bernheim, Peleg, and Whinston (1987) and Moreno and Wooders (1996)) with respect to the coalition of all villagers. We provide general conditions under which a lender may be able to increase profits by offering joint rather than individual liability contracts to the members of a village, even when borrowers are arbitrarily patient. First, we derive an upper bound on the lender's profits from any contract. Second, we show in Proposition 1 that there is a joint liability contract that can achieve that upper bound. Third, we demonstrate through an example that in some cases the optimal individual liability contract provides a strictly lower profit, and in Proposition 2 we describe formally the circumstances in which this will occur.

In interacting with a potential borrower who is part of a village risk sharing arrangement, the lender must take that arrangement into account, even if he offers only individual liability contracts. Consider agent  $i$  in the village, who has stochastic income stream  $y^i$ . Suppose that the outside lender approaches this agent and offers to provide constant income  $c$  forever in exchange for that random income stream. If agent  $i$  lived in isolation from the village and simply planned to consume  $c$ , then the proposed contract is self-enforcing if Condition SE is satisfied. In the limit as  $\delta \rightarrow 1$ , the lender's profit-maximizing choice of  $c$  converges to  $CE(y^i)$ , the certainty equivalent of agent  $i$ 's random income. In fact, however, individual  $i$  is already involved in the village risk sharing arrangement, so that his effective income is not  $y^i$  but  $\bar{y}$ , the village's average income. Thus, maximizing profits subject to Condition SE is not the right problem for the lender to solve, because the borrower has a better outside option. Instead, the lender must provide a guaranteed consumption level  $c$  at least as large as  $CE(\bar{y})$ ,

the certainty equivalent of the villagers' pooled income, or else the villagers could do better through internal risk sharing.

Furthermore,  $c$  must in fact be strictly greater than  $CE(\bar{y})$ , so that the villagers cannot gain by jointly abandoning the contract when they all receive high income realizations. If  $c$  were equal to  $CE(\bar{y})$ , then in any period when  $\bar{y}_t > c$ , the villagers would break the contract, consume  $\bar{y}_t$  today and receive  $Eu(\bar{y}) = u(CE(\bar{y}))$  in each future period by reverting to internal risk-sharing. By honoring the contract, on the other hand, they would consume  $c < \bar{y}_t$  today and  $c = CE(\bar{y})$  in the future, which gives them strictly lower utility. To be sustainable,  $c$  must be at least  $CE(\bar{y}) + \varepsilon(\delta)$ , where  $\varepsilon(\delta)$  is defined as the smallest value satisfying

$$u(CE(\bar{y})) + \varepsilon(\delta) \geq \max_{\bar{y} \in \text{supp}(\bar{p})} \{(1 - \delta)u(\bar{y}) + \delta u(CE(\bar{y}))\}.$$

As the discount factor  $\delta$  approaches one,  $\varepsilon(\delta)$  converges to zero. That limit on  $c$  puts an upper bound, equal to the greater of  $N \cdot (Ey^i - CE(\bar{y}) - \varepsilon(\delta))$  and zero, on the lender's expected profit per period in a self-enforcing contract. The lender can achieve that maximum profit with the following strategy, which uses joint liability contracts: If  $N \cdot (Ey^i - CE(\bar{y}) - \varepsilon(\delta)) > 0$ , the lender offers each villager a contract guaranteeing income  $c_J^* \equiv CE(\bar{y}) + \varepsilon(\delta)$  in each period, as long as no villager has failed in any previous period to turn over his realized income  $y_t^i$  to the lender (and as long as the lender himself has not deviated). Otherwise, the lender offers no contract. The villagers' strategy is to reject any contract with  $c \leq y(1)$  and revert to symmetric internal risk-sharing; to accept any contract with  $y(1) < c < c_J^*$  and eventually deviate from it;<sup>5</sup> and to accept any contract  $c \geq c_J^*$  and not deviate in any period before a deviation. In the third case, if villager  $i$  fails to turn over his income, then all villagers move to an internal risk sharing equilibrium where villager  $i$ 's utility is reduced to  $Eu(y^i)$ , his autarkic utility. If the lender deviates, or if more than one borrower deviates simultaneously, the village group reverts to symmetric internal risk sharing. Those strategies constitute a subgame perfect equilibrium that is proof to self-enforcing joint deviations by the villagers when  $\delta$  is high enough, as shown in Proposition 1.

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<sup>5</sup> The optimal time to deviate is the first period in which realized mean income  $\bar{y}'$  satisfies the following condition:

$$(1 - \delta)u(\bar{y}') + \delta Eu(\bar{y}) > (1 - \delta)u(c) + \delta EV(c, \bar{y}),$$

where  $V(c, x)$  is given recursively by

$$V(c, x) \equiv \max \{(1 - \delta)u(x) + \delta Eu(\bar{y}), (1 - \delta)u(c) + \delta EV(c, \bar{y})\}.$$

**Proposition 1:** Let  $N$ ,  $u$ , and  $P(Y)$  be given. Then there exists  $\underline{\delta} < 1$  such that for all  $\delta \in (\underline{\delta}, 1)$ , there is a subgame perfect equilibrium that is proof to self-enforcing joint deviations by the villagers that gives the lender expected profits of  $\max\{N(Ey^i - c_J^*), 0\}$  per period.

*Proof:* The strategies are as given above. First, let  $\delta$  be at least high enough that Condition FRS is satisfied. Then if the lender is patient enough, its strategy is clearly optimal: Given that the borrowers will eventually reject any  $c$  less than  $c_J^*$ ,  $\max\{N(Ey^i - c_J^*), 0\}$  is the maximum possible profit.

The villagers get higher expected utility from accepting the contracts when  $c \geq c_J^*$  than from reverting to internal risk sharing, so it is a best response for them all to accept. Given the punishment strategies, Condition SE guarantees that no borrower can ever gain from consuming his income rather than turning it over to the lender, even when he receives the highest possible income  $y(S)$ ; Condition SE is satisfied because Condition FRS holds. After a deviation, the lender's strategy is not to interact with the villagers, so not interacting with the lender is a best response for the villagers. Therefore, the best the villagers can do is an efficient (subject to the enforcement constraints) risk sharing arrangement. As in Kocherlakota (1996), there is such an efficient self-enforcing arrangement that gives agent  $i$  expected utility equal to his autarkic utility  $Eu(y^i)$  and gives the other agents utility strictly higher than  $Eu(\bar{y})$ , the expected utility from symmetric risk sharing. Therefore, the punishment path is subgame perfect and proof to self-enforcing joint deviations.

Thus, the specified strategies constitute a subgame perfect equilibrium that is coalition-proof with respect to the coalition of the whole village and that gives the lender expected profits of  $\max\{N(Ey^i - c_J^*), 0\}$  per period. *Q.E.D.*

The maximum profit that the lender can achieve by offering individual liability contracts, on the other hand, is strictly lower than  $N \cdot (Ey^i - CE(\bar{y}) - \varepsilon(\delta))$ , as long as there is sufficient aggregate risk in the villagers' pooled income  $\bar{y}$ . That result is driven by the observation that for  $c < Ey^i$ , a group of risk averse agents that shares income fully may prefer to have one member receive random income  $y^i$  and the rest get  $c$  for sure in each period rather than all of them getting  $c$ . That is, it may be that

$$Eu\left(\frac{(N-1)c + y^i}{N}\right) > u(c),$$

even though  $u(c) > Eu(y^i)$ . The intuition follows from the definition of a strictly concave function: If distinct alternatives  $A$  and  $B$  give the same level of expected utility, then a strict convex combination of the two alternatives is strictly preferred to either. For example, if  $c = CE(y^i)$  (the certainty equivalent of  $y^i$ ), and the alternative is getting  $y^i$ , then the group strictly prefers to have one or more members receiving their random incomes and sharing them with the rest of the group, which is getting  $c$ :

$$\begin{aligned} Eu\left(\frac{(N-1)CE(y^i) + y^i}{N}\right) &> E\left(\frac{N-1}{N}u(CE(y^i)) + \frac{1}{N}u(y^i)\right) \\ &= \frac{N-1}{N}u(CE(y^i)) + \frac{1}{N}Eu(y^i) \\ &= u(CE(y^i)) \\ &= u(c) \end{aligned}$$

However, the lender must offer at least  $c_J^*$ , which is greater than  $CE(y^i)$ . In that case, risk aversion does not imply that the group necessarily prefers to have one member (or more) receiving  $y^i$ . Nevertheless, given a group size  $N$  and preferences  $u$ , they still do prefer it as long as  $\alpha(\delta)$  is small enough and the certainty equivalent of pooled income  $\bar{y}$  is not too much greater than the certainty equivalent of individual income  $y^i$  — that is, as long as there is sufficient aggregate risk in the village. If the income distribution  $P$  satisfies that condition, then, and if the lender has an individual liability contract with every agent, it is certain that at least one agent will break it. To avoid that, the lender must offer a higher  $c$ , lend to fewer agents (both of which options reduce expected profits), *or* offer only joint liability contracts. If the lender offers credit only as long as all  $N$  agents accept and honor their contracts, then the group no longer has the option of “mixing”  $c$  with  $y^i$ . As long as  $c$  gives greater utility than internal risk sharing (that is,  $c$  is greater than the certainty equivalent of  $\bar{y}$ ) and agents are patient enough, then the group does better to honor the lending contracts than to break them and revert to risk sharing. Thus, joint liability contracts can provide higher expected profits than individual lending. The following numerical example demonstrates that possibility, and Proposition 2 formalizes the result.

**Example 1:** Let the discount factor  $\delta$  be 0.95, and suppose that  $N = 5$  and that utility is given by  $u(y) = -1/y$ , so agents have a constant coefficient of relative risk aversion equal to 2. The income vector is determined as follows: In each period, there are two possible states,  $G$  and  $B$ , each of which has probability 0.5. Given the state, each agent’s income is chosen

independently. In state  $G$ , an agent's income is  $y_H = 300$  with probability  $a \geq 0.5$  and  $y_L = 100$  with probability  $1 - a$ . In state  $B$ , the probabilities are reversed. The correlation between agents' incomes is increasing in the parameter  $a$ . Figure 1 graphs the utility from  $c_J^* \equiv CE(\bar{y}) + \varepsilon(\delta)$ , the constant level of consumption provided by the optimal joint liability contract, against the expected utility from  $0.8c_J^* + 0.2y^i$  as the correlation varies. For high enough levels of correlation (corresponding to high aggregate risk), the expected payoff from having one villager deviate is greater than the payoff from all consuming  $c_J^*$ .

Now consider specifically the case that  $a = 0$ , and let  $\delta$  be close to 1. Since  $a = 0$ , income realizations are independent across individuals, and  $y_H$  and  $y_L$  occur with equal probability. The expected value of income is 200, and the certainty equivalent of the income  $\bar{y}$  from group risk sharing is approximately 189.0264.

First consider the optimal joint liability contract, under which the outside lender guarantees a constant level of consumption  $c_J^* \equiv CE(\bar{y}) + \varepsilon(\delta)$  to all agents in exchange for any excess income over that level. If any individual breaks the terms of the contract, then there is no further interaction between the lender and any of the agents. As the discount factor  $\delta$  approaches one, the group members will accept any  $c$  greater than 189.0264. If they break the contract, they revert to internal risk sharing, which gives them a lower expected payoff than  $u(c)$ . In the limit, then, the expected profits per period for the lender approach roughly  $5(200 - 189.0264) = 54.868$ .

If the lender offers the same  $c_J^*$  in individual liability contracts, so that only group members who have themselves broken their contracts are denied credit, at least one agent will certainly walk away from his contract. The reason is that the group gets higher expected utility from sharing  $4(189.0264) + y^i$  (which is sustainable for high enough  $\delta$ ) than from consuming 189.0264 each:

$$.5\left(\frac{-1}{2(1056.1056)}\right) + .5\left(\frac{-1}{2(856.1056)}\right) > \frac{-1}{189.0264}.$$

To avoid that problem, the lender must either offer contracts to fewer agents or provide a larger  $c$ . In this case, the lender maximizes expected profits by offering  $c_J^* \approx 189.564$  to all five agents, which yields expected profits per period of 52.18. Thus, the profits from individual lending are approximately 4.9 percent lower than group lending profits.

**Proposition 2:** Let  $N$ ,  $u$ , and the marginal income distribution  $P(y)$  be given. Then there exists an open and non-empty set  $\Psi$  of symmetric joint income distributions such that if  $P(Y) \in \Psi$ , then there is a  $\underline{\delta} < 1$  such that for all  $\delta \in (\underline{\delta}, 1)$ , any subgame perfect equilibrium that is proof to self-enforcing joint deviations by the villagers gives the lender expected profits per period strictly less than  $N \cdot (Ey^i - CE(\bar{y}) - \varepsilon(\delta))$  if  $Ey^i - CE(\bar{y}) - \varepsilon(\delta) > 0$ .

*Proof:* Let  $M$  be the number of elements in the support of the marginal distribution  $P(y)$ . Then a joint income distribution  $P(Y)$  is a vector in the  $(M^N - 1)$ -dimensional simplex. Let  $P^*(Y)$  denote the joint distribution where individual incomes are perfectly correlated, so that  $y_t^i = y_t^j$  for all  $t$  and for all  $i, j \in \{1, \dots, N\}$ . Given  $P^*(Y)$ , the distribution of pooled income  $\bar{y}$  is the same as the marginal distribution  $P(y)$ , so  $CE(\bar{y}) = CE(y^i)$ . Because  $u$  is concave, therefore,

$$Eu\left(\frac{(N-1)CE(\bar{y}) + y^i}{N}\right) > Eu(CE(\bar{y})).$$

Thus, when  $\delta$  is high enough, the following inequality holds:

$$Eu\left(\frac{(N-1)CE(\bar{y}) + y^i}{N}\right) > u(c_J^*). \quad (\text{CC})$$

When Conditions CC and FRS are satisfied, the lender cannot offer individual liability contracts promising income  $c_J^* \equiv CE(\bar{y}) + \varepsilon(\delta)$  because, as in Example 1, at least one borrower is sure to break the contract and share his future stream of random income with the other borrowers, who are still receiving  $c_J^*$ . Instead, the lender must either provide a higher level of guaranteed income or lend to fewer borrowers. Because  $c_J^*$  is continuous as a function of the joint distribution  $P(Y)$ , Condition CC holds in an open neighborhood (with respect to Euclidean distance) of  $P^*(Y)$ . Around any point in the interior of that neighborhood, there is an open sub-neighborhood where for some  $\underline{\delta} < 1$  Condition FRS also holds. That sub-neighborhood is the desired set  $\Psi$ . *Q.E.D.*

## IV. Discussion

Above, we present a model that endogenizes social capital and its role as collateral in joint liability contracts between an outside lender and village members, who possess no informational or enforcement advantage over the lender. Here we elaborate on the relationship between our operational measure of social capital and the concept of social capital discussed in the microfinance literature. We examine whether higher levels of social capital are associated with better repayment performance on joint liability loans.

### A. The Concept of Social Capital

Grootaert and van Bastelaer (2001), in their summary report on the results of the Social Capital Initiative of the World Bank, provide an in-depth discussion of the term social capital. On a micro level (which is the relevant scope of the concept from our perspective) they describe social capital as “those features of social organization such as networks of individuals and households, and the associated norms and values that create an externality for the community as a whole.” They also emphasize that social capital is an asset, in the sense that it generates a stream of benefits. Finally, they note that one of the channels through which social capital produces payoffs is “by increasing the benefits of compliance with expected behavior or by increasing the costs of non-compliance.” In the context of our model, participating in informal social insurance arrangements creates a surplus that arises from the repeated interactions of a group of agents. This surplus can be used to repeatedly collateralize outside loans even if loans to individuals are not sustainable. The group interactions are not formally sanctioned; instead they are maintained in equilibrium by shared beliefs about expected behavior and how deviations from it would be punished.

It is often asserted in the literature that social capital can be used to support credit contracts that would not be supportable in a more market based, anonymous context. Plunkett (1904) (quoted in Guinnane (1994)), writing about credit cooperatives in Ireland, cleverly expresses this idea when he suggests these institutions perform “the apparent miracle of giving solvency to a community of almost entirely insolvent individuals”. In our model, agents who may not be creditworthy individually are creditworthy as a group.

## B. Social Capital and Repayment Performance

The observation that social capital can perform the function of collateral in joint liability loans led to the hypothesis in the empirical literature that increased social capital lowers the default probability on loans. Researchers have not found robust support for this hypothesis, however. Sharma and Zeller (1997) and Ahlin and Townsend (2000) find that groups with higher levels of family relations are more likely to default. On the other hand, Karlan (2002), using Peruvian data, finds a positive relationship between proxies for social capital (such as geographic proximity and cultural similarity) and repayment performance. Wydick (1999) finds a positive but statistically insignificant link between repayment and physical distance between borrowers. One clear reason for the divergent results is the fact that the different studies span a wide range in terms of the quality of their data, the definition of default, and the variables that are used to proxy for social capital. However, our model suggests that the hypothesis is not justified in the first place.

In order to relate repayment performance to the level of social capital, we need to construct a measure for it within the context of the model. We want this measure to be similar to the delinquency rate measures reported by microfinance institutions and used in the empirical literature. The difficulty is that the type of limited enforcement model that we examine has no explicit default (in the sense of a deviation from the prescribed contract) along the equilibrium path. We propose to use, as a proxy for the fraction of non-performing or delinquent loans, the probability that in  $D \geq 2$  consecutive periods the realized net transfer flows from the lender to the village. That is, the lender makes a “loan” in one period and does not receive any repayment in the next  $D - 1$  periods.

Consider the case where the outside lender offers the optimal joint liability contract, paying out  $c_J^*$  to each agent and receiving  $N \cdot \bar{y}_t$  in every period. In this setting the probability that a loan is delinquent can be expressed as

$$\text{delinquency rate} = \left[ F_{\bar{y}}(c_J^*) \right]^D,$$

where  $F_{\bar{y}}$  is the cumulative distribution function of average village income. We continue to assume that Condition FRS holds and therefore social capital can be measured as

$$\text{social capital} = \frac{Eu(\bar{y})}{Eu(y^i)} - 1.$$

We investigate the behavior of the probability of the delinquency rate as the correlation between an individual's income and the average income of the rest of the village varies.<sup>6</sup> Social capital is decreasing in this correlation, because raising the correlation increases the variance of the group's average realized income  $\bar{y}$  and thus lowers  $Eu(\bar{y})$ . We show that the delinquency rate, on the other hand, is a non-monotonic function of this correlation. Therefore, there is no presumption that higher social capital must improve loan performance.

The intuition is as follows: The optimal  $c_J^*$  is less than the expected value of  $y^i$ , which is also the expected value of  $\bar{y}$ . (Otherwise, the lender could not make positive profits.) Decreasing the correlation between individual incomes reduces the variance of each period's sample average  $\bar{y}$ . That decrease in variance has two, conflicting effects on the delinquency probability. First, the realization of  $\bar{y}$  is more likely to be close to its mean and thus greater than  $c_J^*$ . On the other hand, lowering the variance of  $\bar{y}$  increases  $Eu(\bar{y})$ , the value of the group's alternative to borrowing from the outside lender. That change means that the lender must offer a higher  $c_J^*$ , which increases the probability that the realization of  $\bar{y}$  is less than  $c_J^*$ . Which effect dominates varies with the level of correlation. Furthermore, because the distribution of incomes has finite support, the delinquency probability is in fact not continuous with respect to the correlation, as Example 2 demonstrates. The general result is stated in Proposition 3.

**Example 2:** Suppose that  $N = 15$  and  $\delta = 0.95$ . Suppose also, as in Example 1, that utility is given by  $u(y) = -1/y$ , and that income is determined as follows: In each period, the state is either  $G$  or  $B$  with equal probability. In state  $G$ , an agent's income is  $y_H = 300$  with probability  $a \geq 0.5$  and  $y_L = 100$  with probability  $1 - a$ , and in state  $B$ , the probabilities are reversed; conditional on the state, agents' incomes are independent. The correlation between agents' incomes is increasing in the parameter  $a$ . Therefore, the level of social capital and the optimal  $c_J^*(a)$  are both decreasing in  $a$ . The level of social capital is high enough to sustain full internal risk sharing when  $a < 0.959448$ , and  $c_J^*(a) > Ey^i$  (so that lending is profitable) for all  $a > 0.503603$ . Let

$$P_n(a) \equiv \sum_{i=0}^n 0.5 \frac{15!}{(15-i)!i!} [(1-a)^{15-i} a^i + (1-a)^i a^{15-1}]$$

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<sup>6</sup> Because of the symmetry of the joint income distribution, that correlation is the same for all agents.

denote the probability that at most  $n$  agents receive income  $y_H$ , so that mean income  $\bar{y}$  is no more than  $\bar{y}(n)$ , defined as  $\bar{y}(n) \equiv \frac{1}{15}(300n + 100(15 - n))$ . When  $c_J^*(a)$  is at least  $\bar{y}(n)$  and below  $\bar{y}(n + 1)$ , then  $F_{\bar{y}}(c_J^*(a)) = P_n(a)$ . For example, the probability jumps, when  $c_J^*(a) = \bar{y}(7) = 180$  at  $a \approx 0.823327$ , from 0.482206 to 0.495567. As  $c_J^*(a)$  continues to increase from this level,  $P_7(a)$  decreases. When  $c_J^*(a)$  reaches  $\bar{y}(8) = 580/3$  at  $a \approx 0.685313$ , the probability jumps again from 0.430194 to 0.5, at which level it stays for all lower values of  $a$ .

Figure 1 shows the resulting relationship between social capital and the three-period delinquency probability ( $D = 4$ ). This probability decreases in the level of social capital except for three discrete jumps. The final jump is to  $(0.5)^4 = 0.0625$ .

**Proposition 3:** Let  $u$  and the marginal income distribution  $P(y)$  be given. Then there exists an integer  $\underline{N}$  such that if the number of agents  $N$  is greater than  $\underline{N}$ , the non-repayment probability satisfies the following condition: When the correlation between an individual's income and the mean income of the other agents is below the maximum level at which full risk sharing is sustainable and above the minimum level at which  $Ey^i - c_J^* \geq 0$ , then as the correlation is decreased the probability that  $\bar{y}_t < c_J^*$  for  $D \geq 2$  periods in a row in the optimal joint liability contract varies both non-monotonically and discontinuously. For smaller  $N$ , the probability is increasing in the correlation.

*Proof:* Let the marginal distribution  $P(y)$  of individual income be fixed, and let  $\rho$  be the correlation between own income and others' mean income. Let  $F(\rho): \mathbf{R} \rightarrow [0, 1]$  be the cumulative distribution function of the average income  $\bar{y}$ , given  $\rho$ . Because  $\bar{y}$  takes on values from a finite set  $\{\bar{y}(1), \dots, \bar{y}(S')\}$ ,  $F(\rho)$  is a step function. Let  $c_J^*(\rho)$  be the optimal level of guaranteed consumption under a joint liability contract, given  $\rho$ ;  $c_J^*(\rho)$  is decreasing in  $\rho$ .

For values of  $c$  that are not in the support of  $F(\rho)$  (that is, such that  $\bar{y}(s') < c < \bar{y}(s'+1)$  for some  $s'$ ), the derivative  $dF(\rho)(c)/dc$  equals 0. Points in the support are where the distribution jumps. Because decreasing the correlation  $\rho$  tightens the distribution of  $\bar{y}$ , the derivative  $dF(\rho)(c)/d\rho$  is non-negative for  $c < E(\bar{y})$ . Thus, for values of  $\rho$  such that  $c_J^*(\rho)$  is not in the support of  $F(\rho)$ , the derivative

$$\begin{aligned}
dF(\rho)(c_J^*(\rho))/d\rho &= dF(\rho)(c)/d\rho + dF(\rho)(c)/dc \cdot dc_J^*(\rho)/d\rho \\
&= dF(\rho)(c)/d\rho \\
&= 0
\end{aligned}$$

At values of  $\rho$  such that  $c_J^*(\rho)$  lies in the support of the distribution  $F(\rho)$ , however, a small increase in  $\rho$  will decrease  $c_J^*(\rho)$  enough that the probability  $F(\rho)(c_J^*(\rho))$  jumps down to the next step. At such values, increasing  $\rho$  infinitesimally results in a discrete drop in  $F(\rho)(c_J^*(\rho))$ .

Thus, as  $\rho$  decreases, the probability  $F(\rho)(c_J^*(\rho))$  that  $\bar{y} < c_J^*(\rho)$  is continuously increasing except at a finite number of points, where it falls discontinuously. The probability of default,  $[F(\rho)(c_J^*(\rho))]^D$ , follows the same pattern. As  $N$  grows, holding the marginal distribution  $P(y)$  fixed, the number of points near  $Ey^i$  in the support of  $F(\rho)$  increases. If  $N$  is large enough, there are points in the support of  $F(\rho)$  that lie in the range of values that  $(c_J^*(\rho))$  takes on for  $\rho$  between the minimum and maximum. For such  $N$ , the probability of non-repayment varies discontinuously and non-monotonically with  $\rho$ . Otherwise, the probability is increasing in  $\rho$ . *Q.E.D.*

We have used the per period surplus from internal risk sharing relative to autarky,  $[Eu(\bar{y})/Eu(y^i)]-1$ , as our measure of social capital. Alternatively, we could define social capital as the present discounted value of the stream of surpluses,

$$\frac{1}{1-\delta} \left( \frac{Eu(\bar{y})}{Eu(y^i)} - 1 \right).$$

By that definition, the derivative of the delinquency rate with respect to social capital is not well-defined. If social capital increases due to a decrease in the discount factor  $\delta$ , then the delinquency rate weakly declines, because  $c_J^*$  falls while  $F$  remains unchanged. On the other hand, if lower aggregate risk is responsible for the increase in social capital, then the effect on the delinquency rate is ambiguous, as explained in Proposition 2. Under this alternative definition of social capital, then, there is still no simple link between repayment performance and the level of social capital.

## V. Conclusion

We have presented a model of outside lending to a group of borrowers who face stochastic income and participate in internal risk sharing. We show that the lender can earn a higher profit by offering joint liability rather than individual liability contracts, although profit per borrower is still lower than in the absence of the risk sharing arrangement. There is a non-monotonic relationship between loan delinquency rates and the level of social capital, which is determined endogenously as the surplus of internal risk sharing over autarky. In concluding, we examine the robustness of our results to variations in modeling, and contrast them with the result of previous work.

In our model, the lender can condition his continued interaction with the villagers on each individual's history of transfers. In the equilibrium constructed, that conditioning rules out any incentive for other group members to make a deviating borrower's transfer payment for him. If, on the other hand, the lender conditions only on the total transfer from the group, then agents may want to cover for deviators in order to obtain continued access to outside lending. Imposing such a restriction on the lender's strategy does not affect the results of our model. The only potential difference is in the punishment strategies of the villagers. If there is a self-sustaining arrangement where the villagers divide  $N \cdot c_J^*$  in each period that Pareto dominates (with respect to the borrowers) the punishment equilibrium of Proposition 1, then the villagers may react to an agent's deviation by making his transfer for him (so that the lender does not abandon the contract) and switching to that new punishment equilibrium.

Another extension is to incorporate moral hazard or asymmetric information. We show that even when the villagers have no exogenous advantage over the lender in terms of monitoring, the lender can still do better by issuing joint rather than individual liability contracts. Intuitively, giving some such monitoring advantage to the villagers can only increase the superiority of group lending. However, we believe that an even stronger conclusion holds: The mechanism through which joint liability loans can outperform individual loans in our model is still present when the borrowers have better monitoring ability than the lender. Suppose, for example, that the income distribution depends on the agents' effort levels, and that effort is costly. Spear and Srivastava (1987), among others, study such repeated moral hazard with a single agent. With multiple agents, each of whom can monitor the effort levels of the others and

who can jointly (subject to sustainability) collude against the lender, the optimal contract must involve state-contingent consumption by the villagers, unless there are perfectly revealing signals of effort or the optimal contract specifies the lowest effort level – otherwise the agents would always exert low effort and report that they had all exerted high effort. Although calculating the optimal lending arrangement in such a situation is beyond the scope of the current paper, in general the optimal contract entails the villagers giving up mean consumption to the risk neutral lender in exchange for lower variance. The basic result of our model, then, still holds: A contract that the villagers will accept if the offer is all-or-nothing may not be preferable to a mix of that contract and the status quo that they can achieve through a coordinated deviation by one or more group members. The potential for increasing mean income when a fraction of the agents deviate may be even greater if the optimal contract in the presence of moral hazard specifies a lower effort level than the perfect monitoring outcome. A similar conclusion holds if income does not depend on effort, so that there is no issue of moral hazard, but income realizations are observed only by the villagers and not by the lender.

Our results are not robust to weakening the assumption of risk averse villagers. The mechanism through which joint liability loans outperform individual liability loans in our model (by preventing the group members from consuming a mix of outside funds and their own stochastic income) relies on strict risk aversion on the part of the borrowers. Many papers on joint lending, including Besley and Coate (1995), Conning (1996, 2000), Andersen and Nina (1998), Armendariz de Aghion (1999), Laffont and N'Guessan (2000), Sadoulet (2000), Rai and Sjoström (2001), and Che (2002), consider risk neutral agents, so our result disappears.

Our result also fails to hold if borrowers *require* outside financing, in the sense that the only source of income is the return on projects that the borrowers lack the capital to undertake on their own. In that case, clearly, the group cannot gain from having some members refuse outside lending. Papers such as Besley and Coate (1995), Armendariz de Aghion (1999), Madajewicz (1999), Rai and Sjoström (2001), and Che (2002), for example, make such an assumption. We believe that that assumption explains the contrast between our results and those of Ghatak and Guinnane (1999), who find in their section on enforcement problems that borrower behavior is identical under joint and individual liability contracts when the group of borrowers acts cooperatively.

Finally, if we drop the assumption of constrained efficiency on the part of the group members, and require only subgame perfect rather than subgame perfection plus proofness to the coalition of the group of borrowers, then individual liability contracts can provide the same profits as joint liability contracts. The intuition is that the punishment strategies used against a

borrower who defaults on a joint liability contract can also be used in a subgame perfect equilibrium against a defaulter with individual liability contracts, although that equilibrium is susceptible to a self-sustaining joint deviation. Without the requirement of limited coalition-proofness, individual loans can achieve the same outcome as joint liability ones. We suspect that other models of group lending, where borrowers can impose costless punishments on behalf of the lender, are also vulnerable to that criticism, although Besley and Coate (1995) address the issue by assuming that borrowers cannot punish anyone who, like a defaulter on an individual loan, does not directly harm them.

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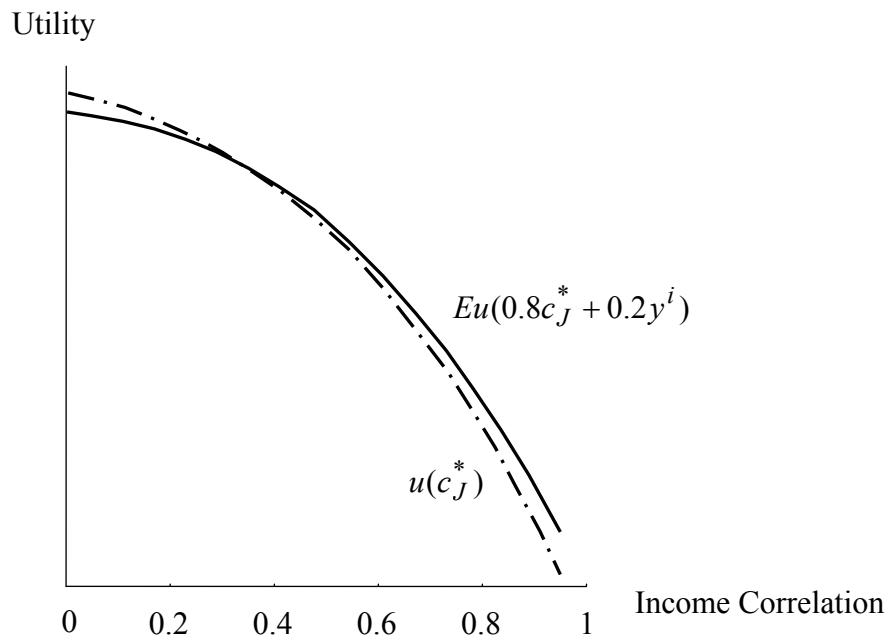
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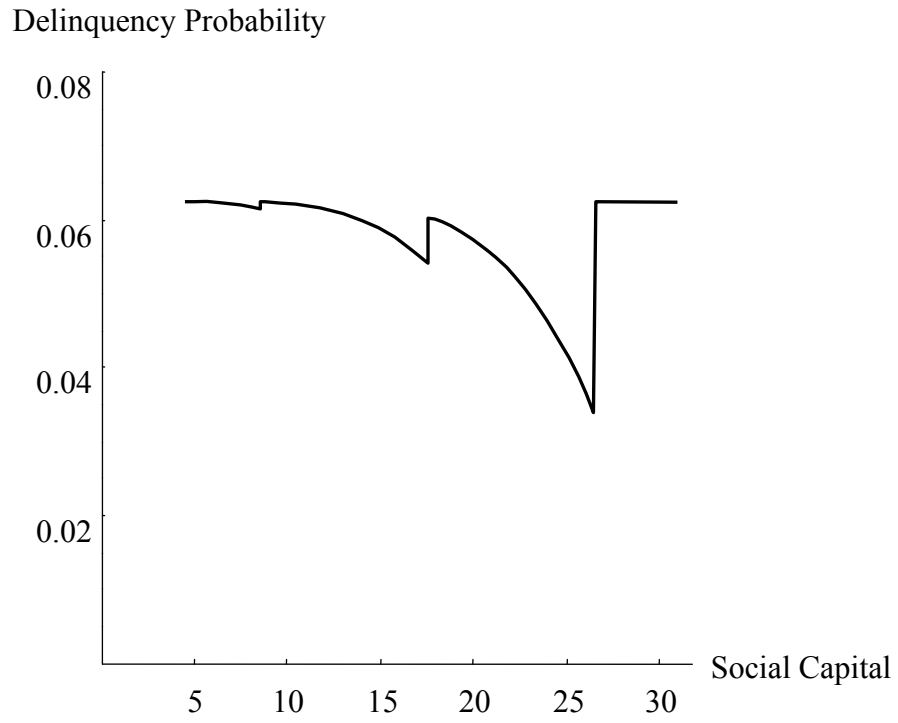
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## VII. Figures

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**Figure 1:** The utility from  $c_J^*$  versus the expected utility from  $0.8c_J^* + 0.2y^i$  as income correlation varies.



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**Figure 2:** Delinquency probability ( $D = 4$ ) as a function of social capital.