Institut für Höhere Studien (IHS), Wien
Institute for Advanced Studies, Vienna

Reihe Transformationsökonomie / Transition Economics Series No. 12

Group Lending and Its Implications in Credit Markets for Poor People

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September 1999

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Abstract

Group lending has proved to be a successful form of lending in credit markets for poor people. In this paper, the policy of the Grameen Bank in Bangladesh is modeled. It is shown that under certain conditions making borrowers jointly liable for their loans can induce repayment even in the absence of formal credit enforcement mechanisms. A distinction is made between ability and willingness to repay. Both aspects crucially depend on the social setting and on the loan size. If social ties are too loose, the social pressure generated by joint liability is not sufficient to induce borrowers to repay. This constraint is more binding in the case of micro-credits.

Zusammenfassung

Gruppenkredite erwiesen sich als erfolgreiche Instrumente zur Kreditvergabe in Kreditmärkten für arme Leute, speziell in Entwicklungsländern. In dieser Arbeit wird der spezielle Lohnmechanismus der Grameen Bank, einer privaten Bank in Bangladesch modelliert. Es wird gezeigt, dass unter bestimmten Bedingungen die gemeinsame Haftung zur Rückzahlung der vergebenen Kredite führt, obwohl formelle Instrumente zur Eintreibung der Kredite fehlen. Es wird hier zwischen zwei Aspekten der Rückzahlung unterschieden, der Zahlungsfähigkeit einerseits und der Zahlungsbereitschaft andererseits. Die Beschaffenheit der sozialen Bindungen und die Kreditgröße haben auf beide Aspekte großen Einfluss. Wenn das soziale Gefüge zu locker ist, so reicht der soziale Druck, welcher durch die gemeinsame Haftung erzeugt wird, nicht aus, um die Kreditnehmer zur Rückzahlung zu bewegen. Diese Einschränkung wird im Falle von kleinen Kreditsummen – sogenannten Mikrokrediten – noch verstärkt.

Keywords

Micro credit, group-lending, collateral, Bangladesh, Grameen Bank

Schlagworte

Mikrokredite, Gruppenkredite, Banksicherheit, Bangladesch, Grameen Bank

JEL Classifications

D82, G20, O16

Comments
This paper was written as the final paper for the Program in Economics at the Institute for Advanced Studies, Vienna. I want to thank Arno Riedl for supervising this paper. Many thanks also to Richard Hule, Klaus Ritzberger, Jean-Robert Tyran, and Jana Vyrastekova for helpful comments.

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1. Introduction

Credit-market imperfections, although existing everywhere in the world, are of greater importance and have more severe implications in developing or "poor" countries. This follows from the fact that people who live below the poverty line do not have any possessions that they could put up as a security for a bank loan. They tend to be more severely restricted in obtaining a bank loan. At the same time they need some initial capital to be able to gain their own living, as it is impossible to generate a sustainable income flow out of nothing. Obtaining a loan or not may become a question of life and death. Therefore credit markets for poor people and related problems deserve special attention. Poor people can be characterized by having little or no collateral and requiring loans of small sizes, which makes their monitoring very often extremely costly. It follows that they are in general not eligible for formal credits from banks or other institutions. Development bank lending and directed loan programs by international institutions such as the World Bank have often failed to induce lasting improvements or sometimes did not even reach their target groups (e.g., Odedokun, 1996).

The present paper models the example of a private bank in Bangladesh, the Grameen Bank,[1] which successfully directs funds exclusively to the very poor while using the concept of "group lending".

According to Jain (1996), the two most distinct features of Grameen Bank on the one hand are the highly structured, decentralized internal organization (the borrowers are members of the bank and so part of the organization) and on the other hand its lending procedure. The bank gives loans only for productive purposes and in the form of group lending. The borrowers form groups of five people who are mutually responsible for repayment. In the beginning only two members of a group get a loan (average loan size is about 75 USD), which has to be repaid in weekly installments over a year. After six weeks of regular repayments the next two members get their loan and once they start their repayments the person chairing the group receives his or her loan. All group members are required to meet

[1] Grameen Bank has been founded in 1983 by the economist Prof. Mohammed Yunus with a starting capital of 27 USD. Today the bank is operating in 34.000 villages and counts more than 2.1 million borrower-members (allewelt, 1998).

every week at the center meeting, where the members of 6 to 8 groups come together with a bank representative to discuss cases of delayed repayment or default, issuing of further loans, the use of a group fund, etc. Attendance of these meetings is essential to become eligible for a loan. The next-higher organization level is the so-called field organization. It is organized in branches, each branch being responsible for 120–150 centers. The employees of these branches attend the weekly center-meetings, collect repayments and savings and disburse new loans. Although all decisions about new loan requests are also discussed at the center meetings, the final approval is given by the area office, which is in charge of every 10–15 branches. At the top of the hierarchy is the support organization and the headquarters. They are responsible for personnel issues and the supervising and cross-checking of all activities at lower levels. Furthermore, the organization is characterized by the strongly routinized behavior of its agents[2] and a high degree of cross-checking and supervision between all levels, which leads to a good transparency and a culture of trust. With repayment rates of 98%, Grameen Bank stands in clear contrast to other financial institutions in Bangladesh, which sometimes have loan recovery rates as low as 25–50%.

The concept of group lending, which induces peer pressure and uses social sanctions as a way of enforcement, potentially establishes a social collateral for the bank and enhances the willingness to repay. This view is also supported in the literature. Rabin (1993) developed a model of reciprocal behavior, where he showed that incorporating fairness into a model may lead to qualitatively different outcomes than models which are based on completely selfish, rationally maximizing agents. Fehr, Gächter and Kirchsteiger (1997) confirmed his predictions in an experiment.

There are also some papers dealing specifically with the example of Grameen Bank. For instance, Stiglitz (1990) looks at the ability to repay and shows that the risk-transfer from the bank (which would be in a better position to bear risk, as it has the possibility to pool risks) to the borrowers – by making them jointly liable for the loan – is actually welfare improving. Besley and Coate (1995) show that group lending leads to higher repayment

[2] There exists a code of behavior including sixteen rules for bank workers and borrowers, which organizes the way how they interact. This code of behavior organizes the center-meetings and the disbursal of new loans, but also touches the private life of a bank member (i.e. people are obliged to help each other when someone is in need).

rates, when the interest rates charged are low and when social penalties are severe enough. However, they only look at the willingness to repay, and their model rests on the crucial assumption that project returns are perfectly uncorrelated. Varian (1990) models the same problem in the standard moral hazard framework and investigates whether the principal would prefer a monitor who can punish deviations to one who can reward desirable behaviour. He concludes that rewarding is better than punishing for both sides. A related stream of literature roots in the theory of social custom (e.g., Akerlof, 1980). It explains the emergence and stability of social norms and codes of behavior. Finally, two further results in favor of group lending over an individual lending scheme are given by Demski and Sappington (1984) and Van Dijk and van Winden (1997).

2. The Model

The present paper investigates the role of peer monitoring in connection with repayment behavior. For two reasons lending to poor people is extremely risky for a bank. Firstly, the borrowers are not able to offer any kind of collateral. Secondly, the bank may not find it worth to incur monitoring costs to track down a single borrower who required only a negligible amount of money. Thus, peer monitoring is used as a device to make up for physical collateral and to avoid the extremely high costs that monitoring would imply for the bank. The possible group pressure at the center-meetings may lead to a positive selection effect, in the sense that only loan applicants who honestly intend to invest the money into rather safe projects and repay the loan are attracted.

The model builds on Varian's first result and only includes rewards for desired behavior.[3] Individual utility depends on social pressure and other variables that are outside the agent's control. I want to show how the existence of social norms can be used in an incentive mechanism to solve a moral hazard problem. The strength of social connectedness is assumed to be given. As the degree of social connectedness also influences the utility function, one agent's action becomes dependent on the strength of social ties and feeds back into the utility of the other agent. In two ways the problem differs from the standard moral hazard problem. The incentive, i.e. the possibility of getting a new loan, firstly does not solely

[3] This corresponds to the procedure employed by the Grameen Bank.

depend on the agent's own action, but also on the partner's action, and secondly it does not necessarily represent a cost to the principal. As long as all future loans are also repaid, the bank incurs no costs by providing this incentive, on the contrary.

The focus here lies on the distinction between the two aspects of repayment, the ability to repay on the one hand – which depends on the individual effort level – and the willingness to repay on the other hand.[4] The latter is assumed to be strongly influenced by social pressure. In order to investigate the effect of joint liability on each of these two aspects separately, the game played by the agents is solved explicitly before dealing with the bank rather than following the standard mechanism design formulation.

The bank lends only to members of a group, where all members are made jointly liable for the repayment of all loans made to the entire group.

Each group consists of two people, both of whom get a loan. Full repayment of this loan is the prerequisite to become eligible for a new loan in the future. The incentive given by the bank is the possibility of a new loan. For simplicity and without changing the underlying mechanism, this future reward is transformed into a monetary reward which is increasing in joint repayment. This results in a one-shot game and facilitates calculation and interpretation of the results while keeping the essential point, i. e. an incentive that is increasing in joint repayment behavior of both agents. It is simply assumed that an agent can only repay his or her own loan and not his or her partner's loan. This is ensured by the fact that actual repayment is supervised by a bank manager at the weekly center meetings. Also, there is no incentive for an agent to repay his or her partner's loan. This would require him or her to work harder (so that his or her revenue is high enough) while the reward will be shared among both partners.

Both agents receive identical loans (with the same principal K and the same interest rate). The loan is invested into an investment project. The return of the project r_i determines the ability to repay and depends on the individual effort put into the project and on the amount K invested as well as on the state of nature q_k:

[4] Most papers dealing with Grameen Bank so far have looked only at one of the two aspects at a time.

$$r_i = K\, e_i\, \theta_{k,i} \qquad (1)$$

There are two possible states of nature: With probability p the agent is lucky and experiences the good state $\bar{\theta} = 1$ and with probability (1-p) he has bad luck and finds himself in the bad state $\underline{\theta} = 0$. To observe the states of nature the bank incurs very high costs. An agent can observe his partner's state of nature at much lower costs (depending on the strength of social ties, see below). So the agent's ability to repay depends on the state of nature, which he cannot control, as well as on his working effort e_i, which is a choice variable for the agent, where $e_i \in [0,1]$.

If return exceeds required repayment, the borrowers are fully able to repay. The question remains whether the lending procedure induces them to repay, i.e. whether they also want to repay and how much. Assuming rational, utility maximizing agents rules out a case where more than the loan K is repaid.

Thus, individual repayment is determined by the willingness times the ability to repay:

$$L_i = m_j * r_i = m_j\, K\, e_i\, \theta_{k,i} \qquad (2)$$

where $m_j \in [0,1]$ is the monitoring conducted by the partner. This parameter reflects the willingness to repay. The agents are assumed to respond to social pressure. Social pressure is modeled here via monitoring. The more a borrower monitors her partner the more she can tell about her and about her revenue at the weekly centermeeting. Thus, the community can put social pressure on an individual who defaults on her loan, when monitoring reveals that her default was not due to adverse circumstances, but due to lack of effort or willingness. People care about their reputation, therefore the agents' willingness to repay is enhanced through the monitoring conducted by their partners. Thus, m_j can be interpreted as generating pressure for repayment.

Interest rates are assumed to remain constant over time and are not a choice variable for the bank in this model. Therefore, they do not enter the model. This assumption is used for simplification and to isolate the effect of group lending as an incentive device.

Of course, monitoring bears a cost c, which depends on the strength of the social ties between the partners. The presence and the strength of social ties are given exogenously and modeled via a parameter λ that influences monitoring costs. In an environment with very strong social ties it will be easy to monitor one's neighbor, i.e. to exert social pressure, at only very low costs (λ will be low). In a different social setting, for example in a more anonymous urban area, where social ties are more loose, monitoring becomes more costly (high λ).

For simplicity (and to ensure the quasi-concavity of the objective function) monitoring costs are assumed to be quadratic in m_i:

$$c_i = \lambda m_i^2 \tag{3}$$

Reward for monitoring is received through the future loan v_i, whose size depends on joint repayment:

$$v_i = a K (m_j e_i \theta_{k,i} + m_i e_j \theta_{k,j}) \tag{4}$$

The rate of time preference is set to zero. Individuals are assumed to value future consumption equally high to present consumption. The parameter a determines the magnitude of the monetary reward and is the choice variable for the bank ($a > 0$). The agents take a as exogenously given.

Joint responsibility of the agents is established by the fact that their reward depends on joint repayment. As each agent's reward depends on his or her own actions (e_i, m_i) as well as on the actions of his or her partner (e_j, m_j), the agents' utilities become interdependent.

In this model, even if one group member does not repay anything, still both agents are eligible for further loans as long as one repays (i.e. they both receive the reward v_i). However, these future loans will be smaller in size, yielding a lower utility. In principle, as soon as one group member defaults on his or her loan, the bank should not give out any further loans to the entire group ($v_i = 0$ for all members of this group). But Jain [1996] observed that in practice new loans are still given out to those group members who have repaid their loans.

Utility of the borrowers is now a function of:

$u_i = u_i(e_i, m_i, \bullet)$,

where $\bullet$ stands for the list of parameters: loan size K, probability of experiencing the good state p, monitoring conducted by the partner m_j, strength of social ties λ, and the strength of the incentive a. The agents receive utility from the return of their investment projects r_i and from the reward they obtain for joint repayment v_i. However, monitoring as well as repayment represent costs to them . It is further assumed that they dislike working, where the disutility of working effort d_i is given by:

$$d_i = e_i^2 \tag{5}$$

So, the utility function becomes:

$$u_i = r_i(e_i) - L_i(e_i) - d_i(e_i) - c_i(m_i) + v_i(e_i, m_i) \tag{6}$$

Each agent maximizes his expected utility over his choice variables e_i and m_i, which yields the following expected utility function:

$$Eu_i = pKe_i(1 - m_j) - e_i^2 - \lambda m_i^2 + paK(m_j e_i + m_i e_j) \tag{7}$$

3. Analysis

3.1 Optimal Behavior of the Agents

Due to the symmetry between agents the optimal effort and monitoring levels are the same for agents i and j:

$$e_i^* = \frac{2Kp\lambda}{4\lambda - K^2 p^2 a(a-1)} \tag{8}$$

$$m_i^* = \frac{K^2 p^2 a}{4\lambda - K^2 p^2 a(a-1)} \tag{9}$$

Monitoring effort is increasing in a (see Appendix 1). In other words, the willingness to repay is increasing in the reward. As expected, monitoring effort decreases according to its

costs. In a social setting with very weak social ties (high λ) there will be only a limited amount of monitoring.

From equation 9 we can derive a restriction on a, such that full willingness to repay is always achieved. Full willingness to repay requires m_i to take its maximum value, namely one. Setting

$$m_i^* = \frac{K^2 p^2 a}{4\lambda - K^2 p^2 a(a-1)} \equiv 1$$

leads to the following condition:

$$a \geq \frac{4\lambda}{K^2 p^2} \tag{10}$$

This condition is increasing in λ. A higher λ corresponds to looser social ties, as monitoring costs for the partners are higher. Condition 10, thus, says that the incentive which makes people prepared to repay has to increase when the degree of social connectedness (and so the possibility of group pressure) is falling. This result is stated in Proposition 1:

Proposition 1:

The looser the social ties, the higher is the incentive that is needed to establish full willingness to repay.

But the willingness to repay only tells one half of the story. The incentive scheme is also designed to influence the ability to repay. The ability to repay is determined by the return function (equation 1) and requires return to equal or exceed the amount borrowed K. The influence of the parameter a on expected return is given by:

$$\frac{\partial(Kpe_i^*)}{\partial a} = 2\lambda K^4 p^4 \frac{1-2a}{\left[4\lambda - K^2 p^2 a(a-1)\right]^2} \tag{11}$$

Equation 11 makes clear that depending on the value of a, the ability to repay is either increasing in the incentive ($\forall a < \frac{1}{2}$) or decreasing ($\forall a > \frac{1}{2}$). For $a = \frac{1}{2}$, the ability to repay

is independent of the incentive scheme. The influence of a on the ability to repay is ambiguous. It depends on the solution to the bank's problem.

Again we can find a condition on a that guarantees full ability to repay. (For the derivation of this condition see Appendix 2.)

$$a \geq -\tfrac{1}{2} + \frac{\sqrt{K^2 p^2 - 8\,\lambda(Kp^2 - 2)}}{2Kp} \tag{12}$$

Two remarks are in order here. Firstly, for this value to be a real number, condition 13 must hold:

$$\lambda < \frac{K^2 p^2}{8(Kp^2 - 2)} \tag{13}$$

The model only leads to real solutions for relatively small values of λ and for relatively strong social ties respectively. In a more anonymous, urban background the model cannot be applied, indicating that this kind of lending procedure is only suitable for situations where a certain degree of social pressure can be assumed to prevail a priori.

Secondly, the right hand side of equation 12 becomes negative for all $Kp^2 > 2$. In this case condition 12 becomes trivial, as it is always fulfilled ($a > 0$ by definition). Depending on the expectation of the good state of the world the loan size can always be adjusted such that the lending mechanism induces enough effort to enable the borrowers to repay their loans. In the case of micro-credits this condition, however, becomes binding. If the probability of experiencing a good state of nature is rather low, the incentive scheme will only induce a high enough working effort for relatively large loans.

The analysis so far suggests that group lending as an incentive mechanism is designed to increase the agents' willingness to repay rather than his or her ability. The ability to repay is not necessarily increased by raising the incentive scheme, the effect of the parameter a is ambiguous. The lower the incentive ($a \sim 0$), the stronger the positive impact on the effort level. Above a certain value (in our case $\frac{1}{2}$), effort is even decreasing in a. A closer look at the bank's optimization problem will determine the actual effect on the ability to repay.

3.2 The Bank's Optimisation Problem

Although the bank is taking the risk of lending to poor people, it still remains a profit maximizing rational agent. In general, the bank's profit consists of the interests which are earned on outstanding loans. As interest rates have been excluded from the analysis, maximizing profits is tantamount to making zero profit in this model. The bank disburses a loan to each agent and wants to be repaid the same amount. Furthermore it incurs the costs associated with the incentive scheme. Thus, in the one-shot game modeled here, the bank is even making a loss by paying the monetary reward for monitoring.[5]

The objective for the bank now becomes:

$$\max_a \pi = -2K + E(L_i + L_j)(1-2a) = -2K + K^4 p^4 4\lambda \frac{a - 2a^2}{\left[4\lambda - K^2 p^2 a(a-1)\right]^2} \qquad (14)$$

The FOC to this problem is given below:

$$\frac{4\lambda(1-4a) + K^2 p^2 a(-4a^2 + 3a - 1)}{\left[4\lambda - K^2 p^2 a(a-1)\right]^3} = 0 \qquad (15)$$

There exists a unique real solution to this problem:

$$a^* = \frac{1}{4} - \frac{192K^2 p^2 \lambda + 3K^4 p^4}{12\sqrt[3]{3}K^2 p^2 y} + \frac{y}{4\sqrt[4]{9}K^2 p^2} \qquad (16)$$

where $y = \left(-9K^6 p^6 + 2\sqrt{3K^6 p^6 (65536\lambda^3 + 3072\lambda^2 K^2 p^2 + 48\lambda K^4 p^4 + 7K^6 p^6)}\right)^{1/3}$.

Table 1: Numerical solutions for *a for different values of λ, p and K.**

[5] In the one-shot game modeled here the incentive $a(L_i+L_j)$ clearly represents a cost to the bank. In a more realistic sequential game, the provision of the new loan ($K_{new}=a(L_i+L_j)$) would not necessarily represent a cost to the bank. Only in case the borrowers default on this new loan, the bank bears costs.

λ	p=0,2 K=50	p=0,5 K=8	p=0,8 K=3,125
1	0,03803	0,15293	0,20564
10	0,18308	0,23781	0,24516
50	0,23485	0,24751	0,24903
100	0,24231	0,24875	0,24951
500	0,24844	0,24975	0,24990
1000	0,24922	0,24988	0,24995

Numerical simulations (see Table 1) suggest that a lies in the range $a \in \left[0, \frac{1}{4}\right]$. This can be shown (see Appendix 3). Thus, working effort and hence the ability to repay will always be increasing in a, ruling out the range of parameter values, where effort is decreasing in the strength of the incentive (see equation 11). Both, willingness as well as ability to repay are enhanced when the incentive is raised.

Proposition 2:

A rise in the optimal incentive a^* will always induce borrowers to increase working effort as well as monitoring effort.

The simulations further show that for fixed values of K and p, a is increasing in λ. For any loan size, holding the probability of being in the good state fixed, the bank will increase the reward offered for monitoring when social ties deteriorate. On the other hand, in the presence of stronger social ties, the bank needs to provide a smaller incentive in order to minimize the default rate.

Proposition 3:

The looser the social ties, the higher is the optimal incentive set by the bank.

Propositions 1-3 lead to the conclusion that group lending is a powerful tool to achieve full repayment in the absence of formal credit enforcement devices. Social pressure can be used instead of financial or physical collateral by a bank to ensure repayment. The specific setting crucially influences the success of group lending. Relatively strong social ties and small loan sizes are two important requirements.

3.3 Special Case

When return exceeds required repayment, the ability to repay is given a priori. In this case, the agents always experience the good state of the world ($p = 1$), and their effort levels are sufficiently high. Thus, the only question remains whether the agents also want to repay. The incentive scheme now assumes the single task of establishing the willingness to repay.

Optimal effort and monitoring levels are again the same for both agents and are given by the following two equations:

$$e_i^S = \frac{K}{2} \tag{17}$$

$$m_i^S = \frac{aK}{2\,\lambda} \tag{18}$$

By construction, effort is now independent of the strength of the incentive. Monitoring (and thus social pressure) responds positively to an increase in a. As expected, monitoring effort is decreasing in its costs.

Setting $L_i^S \geq K$ leads to a restriction on a for full repayment:

$$a^S \geq \frac{2\,\lambda}{K} \tag{19}$$

The more costly the monitoring, the higher is the required incentive. If social ties are looser, people care less about their reputation on the one hand, and less social pressure is exerted on the other hand. Thus, a higher incentive is needed in order to have the desired effect because the incentive scheme appeals to the sense of solidarity. Proposition 1 holds equally true for the special case.

The bank's problem consists again of setting a such that the agents will repay their loans while keeping the costs that this parameter implies for the bank as low as possible:

$$\max_a \pi = -2K + (L_i + L_j)(1-2a) = K(-2 + K\frac{a-2a^2}{\lambda}) \tag{20}$$

In this case, the bank sets the incentive regardless of the social background or other variables:

$$a^S = \frac{1}{4} \tag{21}$$

and full repayment is only achieved as long as

$$l < \frac{K}{8}. \tag{22}$$

Equation 22 provides a simple condition for full repayment. In the special case, where effort levels and thus the ability to repay do not have to be considered, group lending only leads to full repayment in settings with rather strong social ties relative to the loan size. If monitoring costs are too high (social contact is too loose), people are not induced to repay although they could do so. Because of the fact that this value of λ is positively related to the loan size K, social ties are far more stringent in the context of micro-credits than in credit markets with larger loan sizes. It has to be stressed again that the success of group lending is very sensitive to the environment.

4. Conclusion

Credit markets for poor people are characterized by severe imperfections, especially so in developing countries. A major impediment to conventional forms of lending is raised by the absence of credible loan enforcement mechanisms (see also Stiglitz, 1990, Aryeetey, 1997, Banerjee and Newman, 1994). Usually, this leads to situations where the formal credit sector is not available to poor people and the interest rates charged in the informal sector are usuriously high and lead to continued dependence of the borrowers on the informal moneylenders. A way out of this dilemma has been presented by the Grameen Bank through the use of group loans, which is modeled in this paper.

In line with Stiglitz' result, the present model also leads to the conclusion that an appropriate incentive scheme is needed to establish the security a formal bank needs to continue lending to poor people: "... members of the peer group must be provided with incentives to monitor ..." (Stiglitz, 1990, p. 361). The distinction between ability and willingness to repay in my

model shows that the strength of social pressure in connection with the loan size are crucial determinants for the success of group lending.

It is further suggested that this mechanism has a deeper impact on the willingness to repay than on individual working effort, which is influencing the ability to repay. In the absence of any incentive, the agents default on their loans as they are not willing to repay anything.

The willingness to repay depends on the strength of social ties among the agents and is increasing in the strength of the incentive. The incentive scheme can induce full willingness to repay up to a certain amount of monitoring costs. But it is not as such sufficient to overcome the problem of limited or no loan enforcement possibilities. Only by simultaneously adjusting the loan size, full repayment can be achieved. When only small loans are demanded, however, the strength of social ties turns out to be a binding constraint.

Also the ability to repay is heavily influenced by the loan size besides the strength of social ties among agents. In the context of micro-credits, full ability to repay can only be achieved when the probability of experiencing a good state of nature is relatively high.

In contrast to the model by Besley and Coate (1995), I have perfectly correlated project returns. To my mind, positively correlated project returns are more realistic in a rural setting. I still find that an incentive scheme which builds on joint liability leads to full repayment with correlated project returns under certain conditions. However, these conditions are rather restrictive: If the agents are capable of full repayment, it depends on the strength of social ties, whether they will repay or default. There is a lower bound on the strength of social ties, and in a setting with even looser social ties people will not be induced to repay. This restriction is relaxed when the contract size increases. So, in the markets for micro-credits very close social relationships are necessary to achieve full repayment. If the incentive scheme is intended to induce at the same time the ability as well as the willingness to repay, not only the strength of social ties matters, but also the possibility of facing a good state of nature. The lower this probability, the less likely the agents will be in a position where they can and want to repay at the same time.

This concept is not easily transferable to different social backgrounds, for instance big cities, where the degree of social connectedness is rather low. As it makes use of social collateral in the absence of any physical collateral, it will only be successful in markets that are characterized by a high degree of social connectedness. Its success crucially depends on the social environment and on the loan size.

5. Appendix

5.1 Appendix 1

$$\frac{\partial m_i}{\partial a} = K^2 p^2 \frac{1 + K^2 p^2 a(2a-1)}{\left[4\lambda - K^2 p^2 a(a-1)\right]^2} \qquad \text{(A1.1)}$$

The above expression is positive for all $a \geq \frac{1}{2}$ and also for $a = 0$. Setting the derivative equal to zero yields a quadratic equation in a with one clearly negative solution. It thus follows that also the second solution must be negative, as for $a = 0$ and $a \geq \frac{1}{2}$ the derivative is always positive. The model is only meaningful for positive a, and in this range the derivative is positive, so m_i is increasing in a.

5.2 Appendix 2

Full ability to repay requires:

$$Kpe_i = \frac{2\lambda K^2 p^2}{4\lambda - K^2 p^2 a(a-1)} \geq K \qquad \text{(A2.1)}$$

Reshuffling leads to

$$a^2 + a + \frac{2Kp^2 - 4}{K^2 p^2}\lambda \geq 0 \qquad \text{(A2.2)}$$

This is fulfilled for all

$$a \geq -\tfrac{1}{2} + \frac{\sqrt{K^2 p^2 - 8\lambda(Kp^2 - 2)}}{2Kp} \qquad (12)$$

and all

$$a \le -\tfrac{1}{2} - \frac{\sqrt{K^2 p^2 - 8\,\lambda(Kp^2 - 2)}}{2Kp}$$

The latter range is irrelevant as a cannot be negative.

5.3 Appendix 3

Show that

$$a^* = \frac{1}{4} - \frac{192s\,\lambda + 3s^2}{12\sqrt[3]{3}sy} + \frac{y}{4\sqrt[4]{9}s} \le \frac{1}{4} \qquad \text{(A3.1)}$$

where $y = \left(-9s^3 + 2\sqrt{3s^3(65536\,\lambda^3 + 3072\,\lambda^2 s + 48\,\lambda s^2 + 7s^3)}\right)^{1/3}$

and $s = K^2 p^2$.

Plugging in the expression for y, it remains to show that:

$$\begin{aligned} &12\sqrt[3]{3}s(-9s^3 + 2\sqrt{3}s^{3/2}\sqrt{65536\,\lambda^3 + 30721\lambda^2 s + 48\,\lambda s^2 + 7s^3})^{2/3} < \\ &< (192\,\lambda s + 3s^2)4\sqrt[3]{9}s \end{aligned} \qquad \text{(A3.2)}$$

Setting $x = 2\sqrt{3}s^{3/2}\sqrt{355361\,\lambda^3 + 3072\,\lambda^2 s + 48\,\lambda s^2 + 7s^3}$, A3.2 becomes:

$$12\sqrt[3]{3}s(-9s^3 + x)^{2/3} < (192\,\lambda s + 3s^2)4\sqrt[3]{9}s \qquad \text{(A3.3)}$$

Some reshuffling of A3.3 gives:

$$-5184(-9s^3 + x)^2 + 15552s^3(64\,\lambda + s)^3 > 0 \qquad \text{(A3.4)}$$

At λ = 0 the above expression is positive. Furthermore, A3.4 is increasing in λ. Thus, A3.4 is fulfilled for all values of λ, implying that the optimal incentive a^* never exceeds ¼.

6. References

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