Is Group Lending A Good Enforcement Scheme for Achieving High Repayment Rates? Evidence from Framed Field Experiments in Vietnam*

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Abstract

Microfinance institutions employ various kinds of incentive schemes but estimating the effect of each scheme is not easy due to endogeneity problems. We conducted field experiments in Vietnam to capture the role of joint liability, monitoring, cross-reporting, social sanctions, communication and group formation in borrowers' repayment behavior. We find that joint liability contracts cause serious free-riding problems, inducing strategic default and lowering repayment rates. When group members observe each others' investment returns, participants are more likely to choose strategic default. Even after introducing a cross-reporting system and/or penalties among borrowers, the default rates and the ratios of participants who chose strategic default under joint liability are still higher than those under individual lending. We also find that joint liability lending often failed to induce mutual insurance among borrowers. Those who had been helped or who had repaid a little in the previous round were more likely to default strategically and repay a little again in the current round and those who paid large amounts were always the same individuals.

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1. Introduction

Following the success of the Grameen Bank in Bangladesh, a large number of institutions all over the world have replicated the "Grameen model": group lending or joint liability. During the last decade, however, some institutions have departed from group lending schemes. Even the Grameen Bank itself shifted to a new system known as Grameen II in 2002 and discarded joint liability schemes.

In 2005, *The Economist*(2005) drew attention to recent developments in microfinance and noted that a growing number of the institutions had discovered limitations of the group-lending model. The article pointed out that the members who expanded their businesses faster and required more capital felt constrained in what they could borrow, while those whose businesses grew more slowly found themselves guaranteeing big debts for other people. Besides, as group members developed personal credit histories through their loan repayments, the need for collective guarantees disappeared.

In the 1990s, most theoretical work focused on how joint liability lending can mitigate the problems of moral hazard (Stiglitz (1990), Varian (1990), Banerjee, Besley and Guinnane (1994)), adverse selection (Ghatak (1999), Van Tassel (1999)), and strategic defaults (Besley and Coate (1995), Armendáriz de Aghion (1999)). These studies attempted to clarify why group lending had succeeded in collecting money from the poor people who had been considered too poor to repay their loans while other traditional government banks lending money to the farmers and the poor with low interest rates had suffered high default rates.

Recently, light has been shed on other factors than joint liability as contributors to the success of microfinance in maintaining high repayment rates. Armendáriz de Aghion and Morduch (2000, 2005) argue that joint liability is just one element in successful microfinance schemes and consider other important aspects of microfinance success thus far, including dynamic incentives,[1] frequent repayment installments[2] and public repayments.[3] Chowdhury (2005) illustrates the importance of dynamic incentives in microfinance programs and shows that without dynamic incentives, group-lending schemes may involve under-monitoring with the borrowers investing in undesirable projects. Che (2002) points out that joint liability schemes create a free-riding problem and worsen the repayment rate, but when the projects are repeated many times over, joint liability becomes more attractive than individual lending. Rai and Sjöström (2004) stress the importance of cross-reporting in achieving efficiency in group lending. One important empirical study is Karlan and Zinman (2006), who conduct a consumer credit field experiment finding strong evidence of dynamic incentives and weaker evidence of adverse selection and moral hazard.[4] If these results hold generally, then it might be the case that even if joint liability reduces adverse

[1] Dynamic incentives mean that the banks make future loan accessibility contingent on full repayment of the current loan in order to deter the borrowers from defaulting strategically.

[2] In many microfinance schemes, loan repayments are made weekly, biweekly or monthly. By meeting frequently, loan officers can obtain information on the borrowers and can find out problematic borrowers or projects early enough to take necessary action to solve them. Armendáriz de Aghion and Morduch (2005) also argue that for borrowers who have difficulty in holding on to income (for instance, when neighbors and relatives drop by for handouts or when husbands take out the money to buy liquor), frequent repayment schedules help them to take the money out of the house soon after it is earned.

[3] Loan officers come to villages on a weekly, biweekly or monthly basis, and meet with borrowers. At these meetings, borrowers repay thier installments in public, a practice that strengthens the social stigma against not repaying the loan promptly. Group meetings also reduce microlenders' transaction costs to elicit information on problematic borrowers or projects from their group members. Armendáriz de Aghion and Morduch (2005) report that the Grameen Bank still runs group meetings and makes public repayments even after it shifts from joint liability lending to individual lending.

[4] Karlan and Zinman (2006) use the term of "moral hazard" and "repayment burden" instead of "dynamic incentives" and "moral hazard" we use here, respectively.

selection and moral hazard, this effect on repayment rates is not critical since adverse selection and moral hazard are not so serious in reality.

Another important randomized experiment is done by Gine and Karlan (2006). They randomly assigned pre-existing joint liability "centers" to individual lending centers in order to purge out the adverse selection effects and found that this conversion to individual lending does not change the repayment rates, which casts doubt on the myth of joint liability as a better incentive scheme than individual lending. This result, however, is a combined effect of moral hazard and strategic default. Since types of the lending schemes influence borrowers' decisions on investment (Stiglitz (1990)), effort levels (Che (2002)) and strategic default (Besley and Coate (1995)), we can not conclude how and which kinds of borrowers' behavior joint liability could affect.

One attempt to disentangle this composite effect is done by Gine, Jakiela, Karlan and Morduch (GJKM) (2006), who focus on the effect of joint liability on borrowers' investment decision by conducting experimental surveys of *investment games* in Peru, where subjects just choose risky investment or safe investment, and found that joint liability creates a free-riding problem, inducing borrowers to choose risky investment (moral hazard) with expectation that their partners will repay for them in case of no investment returns. But if participants were allowed to form groups by themselves, which is often the case with real microfinance schemes, the moral hazard was mitigated.[5]

Our study focuses on another issue: how joint liability affects borrowers' strategic default decision, an element of the determinants of repayment rates which is not dealt with by the experiment of GJKM. We employ experiments where investment

[5] Their another important finding is that dynamic incentives are powerful in reducing risky investment.

returns are determined randomly in order to exclude the moral hazard effect and measure the effect of joint liability on strategic defaults. In this sense, our work is complementary to GJKM.

Under the joint liability, participants would have higher incentives to help the other group members since if they don't then they themselves would be punished. But the fact that other members would help them if they default would give them incentives to default strategically. That is, the joint liability might cause a free-riding problem. If this is the case, whether the joint liability can achieve higher repayment rates or not depends on the magnitude of the effect of helping others and the effect of free-riding. To examine this, we implemented eleven different types of repayment games with dynamic incentives in Ho Chi Minh City (HCMC hereafter), Vietnam. Our results show that the joint liability contracts caused serious free-riding problems and this effect surmounted the effect of helping others, resulting in lower repayment rates. Even after introducing a cross-reporting system or punitive measures among borrowers, joint liability can not outperform individual lending. Moreover, joint liability schemes failed to induce mutual insurance among borrowers. Those who had been helped or who had repaid a little in the previous round were more likely to default strategically and repay a little again in the current round, while those who paid large amounts were always the same individuals. But cross-reporting and social sanctions can prevent borrowers from choosing such behaviors.

Field experiments to consider repayment decision have also been conducted by Cassar, Crowley and Wydick (2005). They conducted repeated public good games, which incorporated joint liability and dynamic incentives, in South Africa and Armenia, to investigate the role of social ties in group lending. The structure of their games is

based on Abbink, Irlenbusch and Renner (2002), who conducted an experimental study at the University of Erfurt, Germany and found that there is little difference in outcomes between self-formed groups and randomly matched groups. While these studies focus on the roles of social ties and other demographic factors in microfinance, our study focuses on how the joint liability, information structure and social environment affect the borrowers' repayment behavior.

In the following section, we describe the experimental design of the project. Section three provides our empirical results and section four offers concluding remarks.

2. Experimental Design

Locations

We conducted our experiments in Ho Chi Minh City (HCMC), the largest city in Vietnam. After the introduction of *doi moi* (meaning *renovation*) in 1986, the Vietnamese economy moved from a centrally-planned economy to a market-oriented one, a transition that has brought about rapid economic growth especially during the last 15 years. HCMC has been the center of Vietnam's economic development, mainly as a result of the expansion of the private sector and large inflows of foreign direct investment.

Income disparity between HCMC and other areas, especially rural areas, has been so conspicuous that a great number of people have migrated to HCMC to earn money, even though the Vietnamese government has taken various measures to discourage rural people from rushing to the city. For example, children from outside are

not allowed to enter public primary and secondary schools in HCMC. Individuals migrating to the city despite the restrictions are not registered and not counted in the official statistics. Most of the poor people in the city are illegal immigrants of this kind. Their presence in the city contradicts the Government official statistics, according to which almost all people in HCMC live above the poverty line.

Major microfinance providers in Vietnam are state banks, state-controlled mass organizations and International NGOs. For loans higher than a certain amount (about 10 million VND[6]), collateral-based individual lending is employed while below this level, formal financial providers use group lending. It should be noted that group lending does not necessarily mean joint liability lending.[7] For example, CEP (Capital Aid Fund for Employment of the Poor), a semi-formal microfinance provider, engages in group lending without joint liability. When interviewed, CEP officials said that borrowers' groups were used only to collect loan applications, to collect regular installments and to disseminate information so as to reduce lenders' transaction costs. Only in cases where borrowers are found to have defaulted strategically, are other group members penalized. Many borrowers whom we informally interviewed, however, did not monitor each other. Okae (2002) investigated microfinance in northern rural villages and found that almost all borrowers from the state banks did not realize that they were liable for other members' loans and did not have any bank savings. In Vietnam, microfinance has been popular but joint liability schemes seem not to be well executed.

[6] 1US$=15,900~15,910VND (Vietnamese dong) in our research period. A daily wage of unskilled workers in HCMC were 20,000 ~ 30,000VND.

[7] Duong and Izumida (2002) classify the lending groups of the Vietnamese Bank for Agriculture and Rural Development into joint liability groups (with joint liability) and joint borrowing groups (without joint liability). However, they did not find any cases where other members of joint liability groups repaid a defaulting member's loan.

We set up our experimental labs[8] in three districts, District 10, District Binh Thanh and District Tan Binh, in HCMC, in locations close to local markets and inhabited by many poor immigrants. We recruited participants on the streets and at the markets near our labs. We also asked participants to invite their neighbors and friends to participate in our experiments. In total we collected 500 subjects and each session consisted of 16 to 28 subjects. We conducted our survey in three districts so as to avoid individuals participating many times over, and in order to ensure that our samples were varied enough to reflect the character of the population.

Before the experiments began, participants filled out the questionnaires including questions related to demographic characteristics, education, occupation, and experiences in borrowing money. We also asked three attitudinal questions from the General Social Survey (GSS) that relate to trust,[9] which are also used in Cassar, Crowley and Wydick (2005) and Karlan (2005) and five questions measuring the *cooperation scale* as used by Carpenter, Daniere and Takahashi (2004).[10]

As we point out below, repayment decisions can be dependent on risk attitudes. Thus in the questionnaire, in order to measure their risk attitudes, we also asked respondents to choose one of the following five lotteries: (1) paid 10,500VND or 9,500VND with equal probability; (2) paid 14,000VND or 7,000VND with equal probability; (3) paid 17,000VND or 5,000VND with equal probability; (4) paid

[8] The experiment was programmed and conducted with the software z-Tree (Fischbacher (1999)).

[9] The three GSS question were as follows. (1) Trust question: "Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?" (2) Fairness question: "Do you think most people would try to take advantage of you if they got the chance or would they try to be fair?" (3) Helpfulness question: "Would you say that most of the time people try to be helpful or that they are mostly just looking out for themselves?".

[10] These questions ask the participants if they agree with the following five statements: (1) It is better to cooperate than compete; (2) People should listen to their conscience when making decisions; (3) People should forgive others when they are angry; (4) It is amusing to play tricks on other people; and (5) People should right the wrongs that are done to them.

21,000VND or 3,000VND with equal probability; and (5) paid 24,000VND or nothing with equal probability. If we assume a CRRA (constant relative risk aversion) utility function, $u(x)=x^{1-r}$, where x is the amount of money obtained and r is the relative risk aversion coefficient, then (1) is optimal for the individuals with $r>0.85$, (2) is optimal for the individuals with r in (0.43, 0.85), (3) is optimal for the individuals r in (0.26, 0.43), (4) is optimal for the individuals r in (0.09, 0.26) and (5) is optimal for the individuals with $r>0.09$. After the all games were completed, we rolled a die for each participant. If the cast of the die was 4, 5 or 6, then the participants would be able receive the larger amounts of money of their lottery choice. If the cast of the die was 1, 2, or 3, they would be able to receive the smaller ones.

After the all participants filled out the questionnaire, we conducted a social networks survey of the kind carried out by GJKM. We had participants stand up one at a time. While participant *J* was standing, other participants were asked on the computers if they knew participant *J*'s name, if they knew *J*'s hometown, if they knew where *J* lived or where *J* worked, if they often talked with *J*, and how they would describe their relationship with *J*. We then used the information provided by the answers to create a social connection index for each individual.[11] We conducted this social networks survey before the microfinance games with the purpose of enabling the participants to gain familiarity with the computers that were to be used throughout this session, our subjects being poor people some of whom had never before used computers. Almost all

[11] The social connection index is constructed by taking the avarage of the first four questions. The final question (how how they would describe their relationship with *J*) is not utilized to construct the social connection index because of complexity. We include this question in order that the participants gained familiarity with multiple questions.

the participants learned how to use computers by means of this session[12] and were able to play the subsequent microfinance games without our help. Some of them, however, needed our assistants' advice either because they were illiterate or because their eyesight was too poor for them to see letters on their screens. In such cases, the assistants explained to them what the screen said and helped them enter their decision with sufficient care not to pose any leading questions.[13]

Microfinance repayment games

The purpose of the games is to investigate how lending schemes and environmental factors affect borrowers' repayment behavior. In total, we conducted eleven kinds of repayment games described below. In most of the games, groups of four members are formed and group members are reshuffled when they play new games. In all of the games, we incorporated the dynamic incentive,[14] which is usually employed by microfinance institutions. If individuals or groups cannot repay their loans, then they cannot play in any further rounds in that game. The wealth accumulated in previous rounds cannot be used to repay the current round's loan. It should be noted that even if the participants are able to repay their loans, the games are supposed to finish at this round with a probability of 1/6. We did this in order to exclude the case in which no cooperation is the unique subgame perfect equilibrium in the finite repeated games. We told the participants that we would roll a die at the end of every round and if, and only if,

[12] On average we had 20 participants in a session and participants had to answer 5 social connection questions per individual. Thus in this session, each participant clicked a mouse 100 times, which would be enough for the participants to get used to the computers.

[13] In the pre-tests, the assistants often asked leading questions. I carefully listened to the way in which they explained matters and asked their questions, and repeatedly cautioned them to avoid asking leading questions. We organized pre-tests seven times so that the assisitants fully understood the structure of the games and how they should treat the participants.

[14] An important part of dynamic incentive schemes is increasing loan amounts. We exclude this factor in order to create symmetric game structures among the rounds for the ease of the analysis.

the cast of the die was one would the game finish. If the cast of the die was higher than one, those who repaid their loans continued playing in the next round.

In each round, participants receive "loans" of 3 million points to invest in risky projects whose returns are random, varying from 0 to 9 million points in increments of 1 million points with equal probability.[15] After investment returns realize, they decide whether to repay their loans or not. If individuals or groups repay their loans, then they can continue playing in the next round.

Participants were told that every 1 million points would convert to 1,000VND. They were also paid the prizes of the lottery described in the previous subsection. All payouts were made after all the games were completed. Participants received 36,000VND (about 2.3US$) on average, which is equivalent to one-and-a-half-day's earnings for a street vendor. We set the award level relatively low so that rich people would have less incentive to participate in our experiment and in order to ensure that only poor people, who are the targets of most microfinance programs, would take part.

Usually, participants played three to five types of repayment games in one session. We started with the baseline individual lending games because of easy understanding. In order to control the possibility that the order of playing the games has systematic effects on the players' behavior, we made the order of playing the games vary and had participants play the baseline individual games again after having them play some other games in some sessions. The results are unchanged if we exclude the observations in the first individual lending games when we conducted multiple baseline individual games in a session. In the analysis below, we only use the observation of the

[15] Since the maximum loan size provided by microfinance organizations in Vietnam is broadly speaking from 1.5 million to 3 million VND (100~200US$), we set the loan size in our experiment at 3 million to help the participants to readily imagine the circumstances.

first six rounds in order to minimize potential survivor biases. The results are robust to the change in this restriction on the rounds in which the observations are used for the analysis. One session, including filling out the questionnaires and conducting social networks survey, lasted for two and a half hours.

All rules were explained to all members in public, using large poster boards. Before starting the first baseline individual lending game and any joint liability game which was the first joint liability game for the participants, we let them play for a practice period during which the investment returns were 7 million points for every participant and another practice period where every participant received investment returns of 1 million points so that they could gain familiarity with the games.

In order to examine how borrowers' repayment decision changes when joint liability is introduced and other changes occur in the structure of the game, we organized the following eleven different types of games.

(A) Individual lending

In the baseline individual games, each participant simply decides whether he/she will repay his/her own loan of 3 million points after receiving the investment return. If the return is less than 3 million points, then he/she has no choice but to default.

In Appendix 1, we show that it is optimal for any individuals with CRRA utility functions choose to repay the loans regardless of risk-averseness whenever their investment returns are not less than 3 million points. If we changed the repayment amount from 3 million points to 4 million points, individuals would choose to repay the loans if their relative risk aversion coefficient were $r>0.39$ and would not repay otherwise. Besley and Coate (1995) show that joint liability can achieve higher

repayment rates than individual lending when the interest rates are low, which corresponds to the smaller repayment amount in our settings. Since our purpose is to challenge the validity of the argument that joint liability contracts can reduce strategic default, we decided to set the repayment amount at 3 million points rather than 4 million points in order to make games' environment favorable to joint liability lending.

(B) Joint liability

Every participant was allocated to a group of four individuals but he/she did not know who would be in his/her group, nor would they be told at the end. The group was liable to repay a total amount of 12 million points. If the group could not repay this amount, then none of the group members was allowed to play in further rounds of the game concerned. Information on the individual's investment return was kept private so that no other members of the group could ascertain whether a group member defaulted strategically or merely because of project failure.

After receiving the investment returns, which are unobservable to the other members nor the bank, participants had to simultaneously determine whether they would repay their own loans of 3 million points if the investment returns were not less than 3 million points, or how many points they would repay if the investment returns were less than 3 million points.[16] Those whose investment returns were not less than 3 million points but chose not to repay were asked how many points they were willing to contribute to the group. After these decisions were made, if any members did not repay

[16] In the experiments of Abbink, Irlenbusch and Renner (2002) and Cassar, Crowley and Wydick (2005), the investment returns only take two values: success or failure. The repayment amount of the borrowers who chose to repay is automatically determined by the number of the borrowers in their groups who chose to repay. In these settings, the bank can know the amount of the borrowers' investment returns once the bank observes that the borrowers choose to repay.

their own loans of 3 million points and the total repayment amount of the group did not reach 12 million points, then the members who had repaid 3 million points were informed how many members had not repaid their own loans and how much the deficit was, and were asked how many more points they were willing to contribute to the group for making up the outstanding debts of the other members. If the sum of the additional contribution exceeded the deficit, the surplus points were returned to those who contributed additional points in proportion to their additional contribution.[17] This modification made the games more similar to actual joint liability schemes and allowed borrowers to choose the amount of their additional repayments. Since the banks cannot observe their borrowers' investment returns, they only can collect the amount of the money the borrowers report.

At the end of each round, participants were able to see their group's total repayment amount and knew whether or not their groups could continue playing in the subsequent rounds. But they could not know how many points each member had contributed.

In games of this kind, since participants repeatedly interact with the same members in subsequent rounds of the game, there exist cooperative equilibria where each member chooses to repay the loan. On the other hand, if members do not take into account the payoffs in the subsequent rounds or if they believe that the other members will choose not to repay and that there will be no further rounds, then they will choose not to repay their loans. The individuals' beliefs in other members' behavior, as well as how they are altruistic and risk-averse, determine which equilibrium is achieved.

[17] For example, consider the case where the deficit is 2 million points and members A and B chose to additionally contribute 2 million points and 1 million points respectively, resulting in a total additional contrinbution of 3 millions. In this case, the actual repayment of A and B is two-thirds of the amount of their additional contribution.

Note that in the practice periods of the joint liability games, all the participants were matched with the pre-programmed computers whose behavior was totally identical for every participant to ensure that any decision in the practice periods did not affect the other participants' belief.

(C) Observing other members' repayment history

A distinguishing feature of the joint liability games described above is that borrowers could not observe how many points other group members have repaid. In this game, we labeled each member in the group and allowed them to observe each other's repayment at the end of each round while other members' investment returns are still unobservable. The repayment history is a kind of imperfect public signal of the members' strategies in the sense that when an individual repaid the loan, then the other members can know he/she cooperated, but when an individual did not repay the loan, then the other members can not know precisely whether he/she defaulted strategically or defaulted just due to the lack of fund.

Unless this game was played after other joint liability games, participants played practice periods as described above. This is true for the following treatments.

(D) Monitoring

If the other group members are neighbors or work in the same places, they might be able to monitor each other's income. Here we allow each participant to monitor the other group members' investment returns. Monitoring is cost-free and automatic. In this game, participants can know whether group members defaulted strategically or

defaulted owing to a failure in their investment, which can be regarded as a perfect public signal game.

The information structure of this game is corresponding to that of Besley & Coate (1995), though their model structure is much simpler than our manipulations. In their model there are only two borrowers in a group, the investment returns take only two values, and borrowers' actions are restricted to {repay, not repay} in the repayment decision stage and {help, not help} in the decision stage of helping other members. On the other hand, in our experiments, there are four borrowers in a group, the investment returns vary from 0 to 9 million points, and the action set of the borrower is {repay 3 million points, repay 2 million points, repay 1 million points, not repay} at the repayment stage and {help 1 million points, …, not help}[18] at the decision stage of helping other members.

(E) Cross-reporting

Rai and Sjöström (2004) argue that joint liability is not enough to efficiently induce borrowers to help each other and that when borrowers share information about productivity shocks that the bank does not possess, efficiency requires that borrowers send reports about each other to the bank. They build a simple two-borrowers model and construct an efficient cross-reporting mechanism.

Their mechanism was, however, too complicated to implement in our simple dynamic incentive schemes. On the other hand, their model was too simplified to replicate in our experiment. For example, investment returns take only two values. It is

[18] The size of the set depends on the remaining points of the borrowers.

not clear what the efficient cross-reporting mechanism will be when there are four borrowers who have repeated transactions.

We therefore used cross-reporting in a different way from Rai and Sjöström (2004), which will be easier for participants to understand. In our experiment, participants were asked to report any member who had a sufficient investment return but did not pay his/her own loan. If a member was reported by more than one member, then he/she would be automatically excluded from the group and would not be allowed to play any further rounds in that game. For risk-neutral individuals, the loss of being excluded was equivalent to 4.8 million points.

(F) Penalties

Besley and Coate (1995) point out the importance of social sanctions as a means of ensuring high repayment rates in group lending schemes. They argue that if social sanctions are sufficiently great, then the repayment rates under group lending exceed those under individual lending. In the experiments, we implemented games that incorporated penalties, with two different sanction levels, 1.5 million points and 3 million points. In these games, participants were asked whether there were any members whom they want to penalize. If more than one member agreed to penalize a certain member, then a penalty of either 1.5 or 3 million points was subtracted from the final amount awarded to the person being penalized. We impose no costs to penalize other group members in order to facilitate implementation of social sanction. Note that since the maximum benefit of strategic default is 3 million points when they do not repay any points, we believe the penalty of 3 million points will be high enough to deter them from choosing strategic default. In addition, if a member defaults strategically,

then the other members can punish the defaulting member repeatedly in the all following rounds, thus the penalty of 3 million points seems high enough.

The cross-reporting mechanism described above, and the mechanism for administering penalties, have a similar effect in the sense that both mechanisms penalize those who have played uncooperatively and selfishly. But in the games equipped with penalizing mechanisms, participants still have to play with members who have not played cooperatively while in the cross-reporting games they can exclude such members completely.

(G) Introducing voluntary transfer among group members in individual lending

Though Besley and Coate (1995) and Abbink, Irlenbusch and Renner (2002) compare the repayment rates under basic individual lending and group lending, this comparison may not be fair since in the latter category, players can share risk among the members but in the former, players have no means of coping with risk. In the real world, people might enter side contracts with relatives and neighbors so as to cope with income shocks (see Townsend (1994) and Grimard (1997) for evidence of risk-sharing - though imperfect - in rural villages and ethnic groups). Ghatak and Guinnane (1999) point out that if the group maximizes joint welfare, then members will always share net incomes and be voluntarily jointly liable for each other's loans regardless of whether the formal terms are those of joint or individual liability. Rai and Sjöström (2004) also argue that if the borrowers can sign binding *ex ante* side contracts, then individual loans and joint liability loans are both efficient and result in the same outcome. They also argue that when borrowers cannot write such state-contingent side contracts *ex ante* but are able to

write binding interim side contracts after having observed the state of the world, then any efficient mechanisms must rely on cross-reports.

In order to allow for such side contracts among borrowers, we conducted individual lending games with groups where participants could transfer their points to unsuccessful members in their groups but they were not liable for the other members' loans. They were informed of their own and the other members' investment returns at the beginning of the rounds and decided whether and how many points they would transfer to whom. Unsuccessful members could not ask successful members to transfer points to them. Moreover, we did not impose any enforcement mechanism for ensuring that those who lent points could collect those points in subsequent rounds. Therefore lending points in this game was totally voluntary and non-binding, representing the weakest type of the side contracts among borrowers. We chose this weakest form of the side contracts since one of the purpose of this study is to challenge the validity of the argument that the joint liability is a better enforcement incentive scheme.

Each member was able to observe whether other members repaid their own loans or not. The other rules were the same as in the individual lending games.

The information structure of this game corresponds to the joint liability game with monitoring where each member knows the other members' repayments. We can judge whether individual lending or joint liability lending results in higher repayment rates by comparing these two different games.

(H) Communication

In the games described earlier in the paper, participants could not know who their group members were. We introduced face-to-face communication into joint

liability games, so as to shed light on the role of communication to induce coordination and altruistic behavior.

(I) Group formation

As GJKM argue, cooperation is easier to achieve with self-formed groups. We examine how the introduction of self group formation affects repayment rates. Before starting the games, we let the participants communicate with each other to form groups of exactly four members. There were no individuals who were excluded from any groups. Thus group forming proceeded rather smoothly. In every round, after communicating with each other, each group member made the decision by themselves.

Ghatak (1999) stresses the role of group formation in group lending, arguing that borrowers form groups with same type of borrowers. But this mechanism would have relevance for repayment rates only when risky or easy-to-be-tempted-to-free-ride individuals were to be excluded from the games. As all individuals were allowed to participate in our games, the changes in repayment rates in the first rounds in our experiment cannot be explained by such adverse selection models. In the following rounds on, however, the group formation will reduce the rates of strategic default by dropping off the group of risky or easy-to-be-tempted-to-free-ride individuals and induce the existing group members, who are safe and less easy-to-be-tempted-to-free-ride, to cooperate.

3. Experimental Results

Table 1 summarizes the eleven games described above and shows the numbers of players, ratios of the individuals who defaulted strategically, and ratios of the groups (or individuals in the case of the individual lending games) who ended in default in each game. Strategic default refers to cases where individuals obtained investment returns of over 3 million points but repaid less than 3 million points. In total, we have 5,084 observations. 3,544 observations had investment returns not less than 3 million points and 539 observations of them chose strategic defaults, resulting in the overall strategic default rate of 15.2%.

The table shows that the strategic default rate and the default rate under joint liability (B) were much higher than those under individual lending (A), by 12.3 percentage points and 22.5 percentage points respectively. Arranging for borrowers to be informed of other members' repayments (C) does not seem to have had a strong influence on the strategic default rate. When participants were able to observe other members' investment returns (D), more participants chose to default strategically but the default rate decreased relative to the basic joint liability games. If cross-reporting (E) or a penalty of 3 million points (F2) was introduced, the ratio of those who chose strategic default decreased, but was still higher than under individual lending. A weak social sanction (a penalty of 1.5 million points, F1) seemed insufficient to induce borrowers to choose repaying their own loans. Allowing successful borrowers to voluntarily transfer their points to unsuccessful borrowers in the individual lending games (G) seems to have helped to reduce the default rate. As noted in the previous section, comparison between individual lending and joint liability lending should be based on the results of individual lending with voluntary transfer among group members (G) and that of the group lending with monitoring where participants were informed of

other members' repayments (D). Judged from this table, individual lending seems to be superior to joint liability lending in terms of both the low default rate and the low strategic default rate.

Table 2 shows basic estimation results. The dependent variable is the dummy variable which takes one if the participant repaid their own loans and zero otherwise. Here we only use the observations that had investment returns sufficient for repayment of the loan, that is, not less than 3 million points. Thus the dummy variable being zero means that this individual defaulted strategically. As for explanatory variables, we include dummy variables for joint liability, observing repayment history, monitoring, cross-reporting, penalty of 1.5 million points, penalty of 3 million points, voluntary transfer, communication, and group formation. Table 1 provides the full listing of these dummy variables. For example, the dummy variable for joint liability is equal to one in nine games: B, C, D, E, F1, F2, H1, H2 and I. The reference case is A, corresponding to the individual lending game. The coefficient of the dummy variable for repayment history represents the additional effect of allowing participants to observe other members' repayment history.

Column (1) of Table 2 represents the results when we regress the dummy variable of repayment decision on the game type dummy variables stated above with district and round dummy variables. Column (2) provides the results of fixed effect estimation.[19] The coefficients of joint liability are negative and significant at the 99% level. Individuals were 11.3~11.4 percentage points more likely to choose strategic

[19] We report the results of OLS and fixed effect estimation here. Probit, Logit and fixed effect Logit estimation also yield the similar results. All the estimation results are available upon request.

default under joint liability lending, relative to individual lending. Introducing joint liability clearly caused free-riding problems.

Allowing borrowers to observe their group members' repayment history and investment returns does not seem to have had significant effects on the incidence of strategic default. On the other hand, introducing cross-reporting or imposing penalties of 3 million points, which we regard as social sanctions, significantly decreased strategic default significantly, by 7.5~9.7 percentage points. If the penalty was not large enough, that is, 1.5 million points, then it does not seem to have affected borrowers ' behavior. We can see cross-reporting as the introduction of a penalty as regards strategically defaulting members by the bank. Where there are only a few social sanctions, borrowers are tempted to default strategically, leading to low repayment rates. In such cases, the bank can discourage borrowers from defaulting strategically and enhance repayment rates by introducing cross-reporting mechanisms. It should be noted, however, that borrowers are still more likely to choose strategic default even we introduce cross-reporting or a penalty of 3 million points, by 5.4 and 4.4 percentage points respectively[20] than the baseline individual lending games if we employ the fixed effect model.

According to the OLS estimations, group formation had a positive impact on reducing strategic default by 7.4 percentage points, while the fixed effect estimation does not show a significant effect of group formation. We will argue this point later. Communication had no significant effect, although its sign is positive and t-values are relatively large.

[20] The coefficients are significant at 5% level and 10% level, respectively.

In Column (3), we include the investment return, its square value to capture the nonlinearity, and some demographic variables such as age, gender, years of education, riskiness, the points in the GSS questions, cooperation scale and the social connection index from the social networks survey.[21] We can find that demographic variables such as scores in GSS questions and the cooperation scale are positively associated with an increase in the probability of choosing to repay the loans. Interestingly, in our experiment, females were more likely to choose strategic default while some other empirical studies show that females are more likely to repay their loans (For instance, see Khandker, Khalily and Kahn (1994)). This might suggest that females' higher repayment rate is not due to some psychological attributes specific to females but due to social factors leading to higher social sanctions of strategic default such as higher interdependency with other community members. Borrowers who had higher investment returns were more likely to repay. Age, years of education and the social connection index did not have any significant influence on borrowers' repayment decisions.

The coefficient of monitoring under joint liability is not significant through the specification (1) to (3). But when borrowers can observe the investment returns of other group members, it should be important for their repayment decision how high investment returns of other members are and whether or not total investment returns of the group members were not less than 12 million points. If the total investment returns are less than 12 million points, then it is no use for the borrowers to repay their own loans because the group has no enough funds to repay the total loans and will not have access to the loans any more. If other participants have high investment returns and they

[21] Summary statistics of these demographic variables are presented inthe Appendix Table 1.

are likely to repay their own loans, then a borrower would be less worried about other members' default and would choose to repay. On the other hand, some borrowers might think it would be profitable to choose strategic default since other members have enough fund to help others. Theoretically, the effect of the other members' returns is ambiguous. In Column (4) we add other members' returns and a dummy variable which is equal to 1 if total investment returns of the group members were less than 12 million points and zero otherwise. The coefficient of the latter is negative and significant as expected while other members' investment returns are insignificant. Column (5) provides the result of the fixed effect estimation and shows that other members' return is also significant at 10 percent level, suggesting that borrowers are more likely to repay when the other members are more likely to have sufficient funds. This result seems to support the model of Besley and Coate (1995), arguing that when the returns are higher, the joint liability lending is more likely to outperform the individual lending. It should be noted that when we compute the difference in the probability of choosing repaying the loan between the baseline individual lending games and the joint liability monitoring games with all the borrowers having the average investment returns, 4.5 million points, then the difference is insignificant with point estimates and t-values being 0.015 and 0.20, respectively.[22]

The OLS result shows that introducing voluntary transfer significantly increased strategic default, while it is not significant in the fixed effect estimations. Thus we could say that the OLS results are derived by the heterogeneity of participants in these games, though the t-values in Column (3) and (5) are still relatively high.

[22] We also compute it when all the borrowers receive higher investment returns, but the difference is insignificant even when we assume that the all members' returns are 9 million points.

Thus far we have estimated whole observations at a time. But participants' behavior might be different between the first round and the following rounds because by the time the first rounds finished, participants had obtained some information on their members' behavior and attitude. In addition, groups including more easy-to-be-tempted-to-free-ride individuals would be more likely to result in default and finish their games at the first round.

Table 3 provides the result of estimation using the observations of round one and the following rounds separately. Almost all the results show similarity between the estimations for round one and the following rounds. Large differences can be found in the coefficients of the dummy variables for the games with penalties. In the first round, introduction of a penalty of 3 million points reduced strategic default, but in the following rounds, it does not seem to have been effective. Strangely, the fixed model estimation suggests that introducing a 1.5 million point penalty makes participants 11.3 percentage point more likely to choose strategic default in the rounds after round one (significant at 95% level), while it reduces strategic default by 7.5 percent in the first round. This significantly negative effect of a 1.5 million point penalty and insignificant effect of a 3 million point penalty are driven by the behavior in the second round. If we analyze the observations in the third round and on, which we do not report here, then the coefficient of a 1.5 million point penalty is insignificantly positive and that of a 3 million point penalty is significantly positive, replicating the results in table 2. We could not come up with specious hypothesis explaining why participants responded to a penalty very differently between the second round and the other rounds, which remains a puzzle. Another difference between the results of the first round and the following rounds is that other members' return is significantly positive in the following rounds but

is not in the first round, suggesting that borrowers after finishing the first round become to trust each other that they would repay their loans when they have sufficient funds.

The effect of group formation is significant only in the rounds after round one. This might be attributable to self-selection in forming the group, as argued by Ghatak (1999) and Van Tassel (1999). Participants formed groups consisting of participants similar to themselves, and such groups, which consisted of those who were easily tempted to choose strategic default, were more likely to default in the first round. Thus only the groups whose members were more likely to repay their own loans survived in the following rounds. The result that the coefficients in the fixed effect model in Table 2 (Column (2) and (5)) are not significant supports this argument. Therefore screening out those borrowers who are more likely to choose strategic default could be a substantially important means of reducing default rates.

If the players cooperate with each other, it is optimal for them to share income risk perfectly, with the successful members providing assistance to the unsuccessful ones. If such transactions are not of the gift-giving type, members' contributions, which are equal to the repayment of their own loans and the transfer to the other members (or contributions to the groups), should be correlated with the amount of assistance they received from others past rounds, on the principle that that those who had been helped by others in previous rounds help others in the present round. Table 4 provides the results in which we include the amounts of members' own contributions in the previous round as an explanatory variable. Unlike Table 2 and 3, this Table excludes the observations of the basic individual lending games since in the basic individual lending games, participants did not form groups and there are no elements of risk sharing among borrowers. Thus in Table 4, the base line case is individual lending with voluntary

transfer. We also include the interaction term of past contributions and the dummy variable for the joint liability. Since we include the variable of past contributions, we only use observations of the rounds after round one.

The results show that the coefficients of the past contribution are negative, but insignificant with relatively high t-values. This implies that under the individual lending with voluntary transfer, those who had been helped in the previous round (those whose contributions in the past period were less) might be more likely to choose to repay their own loans in the current round. On the other hand, the linear combination of "Past Contribution" and "JL*Past Contribution" is positive and significant at 5% level, while it becomes insignificant in the fixed effect estimation with t-value being -0.01. This implies that under joint liability, those who had been helped or who had repaid a little in the previous round were more likely to choose strategic default in the current round and the same individuals, who tended to choose strategic default in other games as well, behave in such a self-interested way. These players were really free riders. Under individual lending, other members do not have to repay for such members. But under the joint liability lending, if members do not repay for free riders, then they themselves also cannot borrow money any more. Expecting this, borrowers have greater incentives to free ride under the joint liability lending. If we introduce cross-reporting system or a penalty of 3 million points, however, such free riding behavior was effectively alleviated. This also suggests the importance of incorporating social sanctions and cross-reporting system into joint liability schemes.

Table 5 shows the results of regression where the dependent variable is whether an individual helped other defaulting members or not. As in Table 4, the observations of the basic individual lending games are excluded and the reference case here is the

individual lending with voluntary transfer. It should be noted that unlike the previous regressions, we now use all observations, whereas to consider strategic default, we only use the observations of individuals with investment returns not less than 3 million points in the previous analyses.

Columns (1) and (2) show the results using all observations. Participants were more likely to help other defaulting members under joint liability than under individual lending. But this very fact induces some borrowers to choose strategic default as we see above. Group formation further induces borrowers to help each other, while it does not induce them to choose strategic default.

Columns (3) and (6) show the results using observations from round two onwards. Columns (3) and (4) use the same specification as Columns (1) and (2) and the specifications of Columns (5) and (6) are similar to those in Table 4.

We have found that the introduction of the joint liability induces borrowers to default strategically (free-riding) while it also encourages them to help each other. Whether the joint liability can achieve higher repayment rates than the individual lending is determined by which effect is stronger, free-riding or helping each other.

To see this, we analyze the group performance in Table 6. As in Tables 4 and 5, the reference case is individual lending with voluntary transfer. Columns (1), (2), and (3) indicate that defaults are more likely to occur under joint liability lending than under individual lending. This implies that the free-riding effect is stronger than helping-each-other effect. Introducing cross-reporting mechanisms and a sufficient level of penalty among borrowers can mitigate the free-riding problems and improve repayment rate.

Column (4) presents the results where the dependent variable is the variance of each member's profit within groups. Our aim in this estimation is to see which schemes

achieve a good risk-sharing performance since sharing risk perfectly and all the members getting the equal payoff is the *ex ante* most preferable contract in the context of our games.[23]. In the regression, we add the variance of investment returns within groups to the explanatory variables.

The results show that introducing joint liability itself did not change the variance of profit but introducing cross-reporting decreased the inequality of profit distribution, which is caused by the fact that selfish members were excluded in the early rounds, a procedure that leads to reduction in variance of members' profits in the following rounds. On the other hand, a 3 million point penalty has no significant effect on the variance of members' profit. Since the amount of penalty payment is not included in the profit here, this insignificance will be due to the difference in punishment procedure from cross-reporting: selfish members can still play in the following rounds with paying a penalty. The positive and significant coefficient of variance of investment returns within groups indicates the imperfectness of risk sharing.

4. Concluding Remarks

Our microfinance field experiments in Vietnam suggest that joint liability creates serious free-riding problems and reduces repayment rates. Introducing penalties or a cross-reporting system would be helpful to enhance repayment rates, but the repayment rates and the ratios of those who did not choose strategic defaults were still

[23] In our experiments, perfect risk-sharing cannot be achieved because those whose investment returns were under 3 million points cannot obtain positive profit even when other members' were willing to allow that

higher under individual lending. We also find that under joint liability lending, people often failed in the sharing of risk: those who had been helped or who had repaid a little in the previous round defaulted strategically again in the current round and those who paid large amounts were always the same individuals. The opposite was true under individual lending with voluntary transfer, where risk sharing was achieved to a certain degree. Our experiment shows how important cross-reporting systems and social sanctions are in order to alleviate such problems of the joint liability. We also find that group formation can be effective in the sense that it induces self-selection among borrowers and excludes those who are easily tempted to default strategically.

We introduced penalties in order to capture the effect of social sanctions on the repayment decision, however, in our experiment penalties were no longer exacted once the group ended in default. In the real world, people can punish their neighbors even after the default. This might explain the reason why in some specifications, the coefficient of the penalty of 3 million points is not significantly positive.

Usually repayment decisions in microfinance are made through face-to-face communication so comparison between joint liability lending games with communication, and individual lending games with voluntary transfer and communication should be done, too. We tried to conduct individual lending games with voluntary transfer and communication but the participants easily became confused because they had to enter how much they would lend to whom on the computers. The best way to conduct individual lending games with subcontracting and communication would be to carry out experiments without computers. In this study we had to use computers in order to clarify how incentive s work under joint liability. It will be fruitful to conduct another experiment without computers for purposes of comparison between

joint liability lending games with communication and the individual lending games with voluntary transfer and communication. Allowing face-to-face communication would also help to clarify what roles the social networks play in both joint liability lending and individual lending with groups.

It also should be noted that even if the joint liability does not help prevent borrowers from strategic default effectively, it still has other merits. An often cited advantage of them is that they shift the burden of monitoring from the lender to the borrowers and reduce lender's cost, which allows lenders to be active in rural areas that would otherwise not have access to financial intermediation. To evaluate the cost aspect of individual vs. joint liability, we need to consider various aspects of their advantages and disadvantages.

Appendix 1. Repayment Decision in the basic Individual lending game

Let θ_t be the investment return from the project at round *t*. Since the probability that the game continues after any given round is equal to 5/6, the individual's expected payoff at round *t*, EU_t, can be expressed by

$$EU_t = u_t(\theta_t - 3R_t(\theta_t)) + \sum_{i=1}^{\infty}\sum_{\tilde{\theta}_{t+i}=1}^{9}\left(\frac{5}{6}\right)^i \Pr(\theta = \tilde{\theta}_{t+i})\, u_{t+i}(\tilde{\theta}_{t+i} - 3R_{t+i}(\tilde{\theta}_{t+i})) \times \prod_{j=1}^{i-1} R_{t+j}(\tilde{\theta}_{t+j}),$$

where $u(\cdot)$ is an individual's utility function, $R(\cdot)$ is an individual's repayment decision function, and $\Pr(\theta = \tilde{\theta}_t)$ is equal to 1/10 for every $\tilde{\theta}_t$. The last term $\prod_{j=1}^{i-1} R_{t+j}(\tilde{\theta}_{t+j})$ is equal to one if this individual did not default until round $t+i$ and zero otherwise.

Note that the individual's decision problems have the same structure in every period. Thus we can reduce the individual repayment decision problem to the decision problem on the threshold investment return level θ^H, where he/she would repay the loan if his/her investment return θ is not less than θ^H and not repay otherwise. Then the borrower's maximization problem can be expressed as

$$\max_{\theta^H} EU_t = u_t\left(\theta_t - 3I(\theta_t \geq \theta^H)\right) + \sum_{i=1}^{\infty}\left(\frac{5}{6}\right)^i \sum_{\tilde{\theta}_t=1}^{9}\left(\left(1-\frac{\theta^H}{10}\right)u_{t+i}\left(\tilde{\theta}_{t+i} - 3 \mid \tilde{\theta}_{t+i} \geq \theta^H\right) + \frac{\theta^H}{10}u_{t+i}\left(\tilde{\theta}_{t+i} \mid \tilde{\theta}_{t+i} < \theta^H\right)\right) \times \left(1-\frac{\theta^H}{10}\right)^{i-1},$$

where $I(\theta \geq \theta^H)$ takes the value of 1 when $\theta \geq \theta^H$ and zero otherwise. Numerical calculation shows that it is optimal for any individuals with CRRA utility functions to set θ^H equal to three regardless of risk-averseness: whenever the investment returns are not less than the amount of the loans, individuals choose to repay the loans.

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Table 1. Number of observations, the rates of strategic default, and default rates in each manipulation

	Game type	IL	JL	RH	M	CR	P	VT	C	G	Observations	Strategic default (choice)	Default (result)
A.	Individual lending (IL)	O									1,490	8.3%	36.6%
B.	Joint liability (JL)		O								724	20.6%	59.1%
C.	JL + Repayment History		O	O							284	19.5%	63.4%
D.	JL + Repayment History + Monitoring		O	O	O						628	23.4%	50.3%
E.	JL + Repayment History + Monitoring + Cross- reporting		O	O	O	O					384	18.7%	53.1%
F1.	JL + Repayment History + Monitoring + Penalty of 1.5 million		O	O	O		O				240	22.1%	48.3%
F2.	JL + Repayment History + Monitoring + Penalty of 3 million		O	O	O		O				320	16.5%	42.5%
G.	Individual lending + voluntary transfer	O		O	O			O			466	13.9%	29.9%
H1.	JL + Repayment History + Monitoring + Communication		O	O	O				O		120	14.0%	40.0%
H2.	JL + Repayment History + Monitoring + Communication + Cross report		O	O	O	O			O		120	11.8%	36.7%
I.	JL + Repayment History + Monitoring + Communication + Group formation		O	O	O				O	O	312	6.7%	23.1%
	Total										5,084	15.2%	43.8%

IL: Individual lending
JL: Joint liability
RH: Repayment history
M: Monitoring
CR: Cross-reporting
P: Penalty
VT: Voluntary transfer
C: Communication
G: Group formation

Table 2. Determinants of not choosing strategic default (1)

Dependent variable: Choose to repay the loan (=1 if loan is repaid to the bank; 0 otherwise)

	(1) OLS	(2) Fixed Effect	(3) OLS	(4) OLS	(5) Fixed Effect
Age			-0.000	-0.000	
			(0.05)	(0.05)	
Female			-0.029	-0.029	
			(1.48)	(1.51)	
Years of education			-0.001	-0.001	
			(0.45)	(0.43)	
Riskiness			-0.003	-0.005	
			(0.59)	(0.86)	
GSS questions			0.054***	0.051***	
			(2.99)	(2.88)	
Cooperation scale			0.021	0.026*	
			(1.34)	(1.73)	
Social connection			0.000	0.000	
			(0.04)	(0.10)	
Investment Return			0.140***	0.123***	0.122***
			(6.19)	(5.49)	(6.19)
(Investment Return)^2			-0.010***	-0.009***	-0.008***
			(5.36)	(4.88)	(5.23)
Other member's return				-0.001	-0.007
				(0.22)	(1.29)
Total Return < 12				-0.035	-0.043
				(1.25)	(1.59)
Joint Liability (JL)	-0.114***	-0.113***	-0.116***	-0.120***	-0.118***
	(5.31)	(5.69)	(5.42)	(5.62)	(6.01)
JL_Repayment History	0.014	0.013	0.012	0.013	0.014
	(0.42)	(0.43)	(0.36)	(0.39)	(0.47)
JL_Monitor	-0.048	-0.042	-0.041	-0.054	-0.077
	(1.41)	(1.35)	(1.20)	(0.92)	(1.55)
Other member's return * JL_Monitor				0.008	0.015*
				(0.87)	(1.75)
(Total Return < 12) * JL_Monitor				-0.323***	-0.291***
				(5.00)	(6.34)
JL_CrossReport	0.075***	0.088***	0.076***	0.085***	0.102***
	(2.77)	(3.47)	(2.82)	(3.12)	(4.17)
JL_Penalty of 1.5 million	0.017	0.001	0.023	0.024	0.009
	(0.48)	(0.04)	(0.63)	(0.69)	(0.29)
JL_Penalty of 3 million	0.087***	0.097***	0.087***	0.076**	0.087***
	(2.80)	(3.27)	(2.81)	(2.52)	(3.03)
JL_Communication	0.038	0.052	0.039	0.041	0.059*
	(1.25)	(1.52)	(1.33)	(1.59)	(1.77)
JL_Group Formation	0.074*	0.051	0.074**	0.067**	0.047
	(1.94)	(1.05)	(1.98)	(2.08)	(1.01)
Individual lending + voluntary transfer	-0.060***	-0.036	-0.061***	-0.065***	-0.035
	(2.67)	(1.48)	(2.76)	(2.94)	(1.46)
Observations	3544	3544	3506	3506	3544
R-squared	0.04	0.03	0.08	0.11	0.10

Only observations that had investment returns not less than 3 million points (i.e. that were able to repay) are used.
Cluster adjusted robust t statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at1%.
Specifications (1), (2) and (3) include district and round dummy variables, which are not reported in the table.

Table 3. Determinants of not choosing strategic default (2)

Dependent variable: Choose to repay the loan (=1 if loan is repaid to the bank; 0 otherwise)

	Round = 1		Round > 1	
	(1) OLS	(2) Fixed Effect	(3) OLS	(4) Fixed Effect
Age	0.001*		-0.002**	
	(1.68)		(2.47)	
Female	-0.025		-0.028	
	(0.95)		(1.42)	
Years of education	-0.003		0.001	
	(0.81)		(0.60)	
Riskiness	-0.009		0.000	
	(1.22)		(0.03)	
GSS questions	0.053**		0.049**	
	(2.14)		(2.55)	
Cooperation scale	0.043*		0.006	
	(1.94)		(0.39)	
Social connection	0.001		-0.001	
	(0.35)		(0.33)	
Investment Return	0.102***	0.123***	0.148***	0.114***
	(3.22)	(4.20)	(4.83)	(3.73)
(Investment Return)^2	-0.007***	-0.009***	-0.010***	-0.008***
	(2.78)	(3.59)	(4.38)	(3.11)
Other member's return	-0.002	-0.010	-0.001	-0.008
	(0.31)	(1.26)	(0.07)	(0.82)
Total Return < 12	-0.010	-0.019	-0.039	-0.078**
	(0.20)	(0.36)	(1.14)	(2.02)
Joint Liability (JL)	-0.126***	-0.117***	-0.109***	-0.110***
	(5.09)	(4.71)	(3.28)	(2.76)
JL_Repayment History	0.006	0.022	0.031	0.048
	(0.17)	(0.60)	(0.52)	(0.84)
JL_Monitor	0.032	-0.089	-0.162**	-0.136
	(0.36)	(1.24)	(2.13)	(1.62)
Other member's return *	-0.008	0.011	0.029**	0.025*
JL_Monitor	(0.51)	(0.88)	(2.43)	(1.84)
(Total Return < 12) *	-0.299***	-0.254***	-0.339***	-0.336***
JL_Monitor	(2.90)	(3.23)	(4.35)	(4.89)
JL_CrossReport	0.081**	0.117***	0.077*	0.060
	(2.47)	(3.69)	(1.82)	(1.29)
JL_Penalty of 1.5 million	0.060	0.075*	-0.049	-0.113**
	(1.43)	(1.80)	(0.90)	(2.12)
JL_Penalty of 3 million	0.124***	0.172***	0.003	-0.042
	(3.01)	(4.30)	(0.07)	(0.86)
JL_Communication	0.054	0.077	0.021	0.005
	(1.48)	(1.62)	(0.53)	(0.09)
JL_Group Formation	0.010	0.029	0.113**	0.090
	(0.19)	(0.42)	(2.44)	(1.20)
Individual lending + voluntary transfer	-0.078**	-0.034	-0.053**	-0.042
	(2.26)	(0.99)	(1.99)	(1.12)
Observations	1884	1908	1622	1636
R-squared	0.10	0.08	0.17	0.16

Only observations that had investment returns not less than 3 million points (i.e. that were able to repay) are used.
Cluster adjusted robust t statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%.
Specifications (1) and (3) include district and round dummy variables, which are not reported in the table.

Table 4. Determinants of not choosing strategic default (3)

Dependent variable: Choose to repay the loan (=1 if loan is repaid to the bank; 0 otherwise)

	(1) OLS	(2) Fixed Effect	(3) OLS	(4) Fixed Effect
Joint Liability (JL)	-0.195***	-0.097	-0.207**	-0.062
	(2.68)	(1.06)	(2.09)	(0.60)
JL_Repayment History	0.044	0.052	0.033	0.017
	(0.73)	(0.78)	(0.22)	(0.13)
JL_Monitor	-0.193**	-0.113	-0.275**	-0.198
	(2.30)	(1.10)	(2.00)	(1.30)
Other member's return *	0.032**	0.026	0.033**	0.028
JL_Monitor	(2.27)	(1.53)	(2.28)	(1.64)
(Total Return < 12) * JL_Monitor	-0.358***	-0.411***	-0.359***	-0.403***
	(3.77)	(4.47)	(3.78)	(4.38)
JL_CrossReport	0.093**	0.057	0.362***	0.294**
	(2.07)	(1.06)	(4.13)	(2.53)
JL_Penalty of 1.5 million	-0.046	-0.126**	0.085	-0.071
	(0.84)	(2.07)	(0.82)	(0.66)
JL_Penalty of 3 million	0.018	-0.048	0.262**	0.140
	(0.44)	(0.84)	(2.13)	(1.22)
JL_Communication	0.015	-0.019	-0.006	-0.033
	(0.38)	(0.27)	(0.06)	(0.27)
JL_Group Formation	0.100**	0.003	0.202	0.040
	(2.14)	(0.03)	(1.43)	(0.25)
Past Contribution	-0.030	-0.031	-0.030	-0.032
	(1.54)	(1.32)	(1.54)	(1.36)
JL * Past Contribution	0.049**	0.031	0.054*	0.021
	(2.26)	(1.24)	(1.83)	(0.74)
JL_Repayment History			0.004	0.013
* Past Contribution			(0.09)	(0.34)
JL_Monitor * Past Contribution			0.027	0.023
			(0.74)	(0.65)
JL_CrossReport			-0.088***	-0.074**
* Past Contribution			(3.51)	(2.34)
JL_Penalty of 1.5 million			-0.045	-0.018
* Past Contribution			(1.44)	(0.64)
JL_Penalty of 3 million			-0.082**	-0.063*
* Past Contribution			(2.52)	(1.91)
JL_Communication			0.005	0.004
* Past Contribution			(0.17)	(0.13)
JL_Group Formation			-0.033	-0.014
* Past Contribution			(0.85)	(0.35)
Observations	1104	1116	1104	1112
R-squared	0.20	0.18	0.22	0.20

Only observations that had investment returns not less than 3 million points (i.e. that were able to repay) are used.
Cluster adjusted robust t statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%.
Specifications (1) and (3) also includes the following control variables appeared in Table 2 and 3: Age, Female, Years of education, Riskiness, GSS questions, Cooperation scale, Social connection, Investment Return, (Investment Return)^2, Other member's return, (Total Return < 12) and district and round dummy variables.

Table 5. Determinants of helping others

Dependent variable: Helping others (=1 if an individual helps defaulting members; 0 otherwise)

	All rounds		Round>1				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	Fixed Effect	OLS	Fixed Effect	OLS	Fixed Effect	Fixed Effect
Joint Liability (JL)	0.289***	0.189***	0.375***	0.427***	0.257*	0.230	0.312
	(5.67)	(3.25)	(5.90)	(4.46)	(1.89)	(1.36)	(1.64)
JL_Repayment	-0.025	-0.030	-0.128	-0.162	-0.128	-0.163	-0.409**
History	(0.50)	(0.54)	(1.48)	(1.39)	(1.53)	(1.40)	(1.89)
JL_Monitor	0.102	0.059	0.244	0.400**	0.222	0.390**	0.528**
	(1.00)	(0.61)	(1.53)	(2.21)	(1.39)	(2.16)	(2.17)
Other member's	-0.013	-0.003	-0.032	-0.067*	-0.027	-0.064*	-0.070**
return * JL_Monitor	(0.62)	(0.18)	(1.03)	(1.95)	(0.87)	(1.87)	(2.04)
(Total Return < 12)	-0.325***	-0.302***	-0.367**	-0.370**	-0.346**	-0.359**	-0.359**
* JL_Monitor	(3.03)	(3.00)	(2.56)	(2.38)	(2.40)	(2.31)	(2.32)
JL_CrossReport	0.042	0.037	0.061	0.050	0.054	0.050	0.374**
	(1.03)	(0.90)	(0.86)	(0.58)	(0.77)	(0.58)	(2.18)
JL_Penalty of 1.5	0.012	0.021	-0.071	0.008	-0.059	0.007	0.283
million	(0.23)	(0.38)	(0.84)	(0.07)	(0.70)	(0.06)	(1.45)
JL_Penalty of 3	0.058	0.098*	-0.009	-0.034	-0.004	-0.033	0.197
million	(1.16)	(1.85)	(0.12)	(0.33)	(0.06)	(0.33)	(0.98)
JL_Communication	-0.028	0.032	-0.084	-0.141	-0.074	-0.144	-0.086
	(0.48)	(0.45)	(1.04)	(1.01)	(0.91)	(1.03)	(0.42)
JL_Group	0.152**	0.151	0.233**	0.279	0.209**	0.283	0.110
Formation	(2.00)	(1.60)	(2.43)	(1.60)	(2.18)	(1.61)	(0.44)
Past Contribution					0.001	-0.069	-0.064
					(0.04)	(1.57)	(1.48)
JL * Past Contribution					0.040	0.065	0.043
					(1.07)	(1.42)	(0.80)
JL_Repayment							0.088
* Past Contribution							(1.45)
JL_Monitor							-0.043
* Past Contribution							(0.77)
JL_CrossReport							-0.106**
* Past Contribution							(2.22)
JL_Penalty of 1.5 million							-0.095*
* Past Contribution							(1.75)
JL_Penalty of 3 million							-0.082
* Past Contribution							(1.27)
JL_Communication							-0.026
* Past Contribution							(0.45)
JL_Group Formation							0.050
* Past Contribution							(0.77)
Observations	1613	1633	687	691	687	691	691
R-squared	0.14	0.16	0.23	0.27	0.24	0.27	0.30

Only observations that had investment returns larger than 3 million points (i.e. that were able to help) are used.
Cluster adjusted robust t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.
Specifications (1), (3) and (5) also include the following variables appeared in Table 2 and 3: Age, Female, Years of education, Riskiness, GSS questions, Cooperation scale, Social connection, and district and round dummy variables.

Table 6. Determinants of group performance

Dependent variable	Not default			Var(Profit)
	OLS	Probit	Logit	OLS
	(1)	(2)	(3)	(4)
Age (Average)	0.002	0.006	0.008	0.023
	(0.88)	(0.80)	(0.69)	(0.89)
Female Ratio	-0.041	-0.127	-0.202	1.739***
	(0.81)	(0.76)	(0.72)	(2.64)
Years of education (Average)	0.012	0.033	0.057	0.067
	(1.43)	(1.29)	(1.31)	(0.61)
Riskiness (Average)	0.031*	0.095	0.167*	0.071
	(1.70)	(1.64)	(1.69)	(0.35)
GSS questions (Average)	0.269***	0.857***	1.424***	-1.012
	(4.95)	(4.73)	(4.64)	(1.31)
Cooperation scale (Average)	-0.039	-0.166	-0.232	-1.257**
	(0.81)	(1.06)	(0.86)	(2.24)
Social connection (Average)	-0.002	-0.011	-0.013	0.032
	(0.38)	(0.60)	(0.44)	(0.39)
Investment Return (Average)	0.075***	0.214***	0.364***	1.143***
	(5.27)	(5.10)	(4.92)	(5.17)
Var (Investment Return)				0.331***
				(7.27)
Total Return < 12	-0.137**	-0.505***	-0.785**	1.832**
	(2.35)	(2.72)	(2.45)	(2.44)
Joint Liability (JL)	-0.154***	-0.456***	-0.731***	-0.294
	(3.53)	(3.56)	(3.48)	(0.46)
JL_Repayment History	-0.034	-0.100	-0.179	0.497
	(0.55)	(0.52)	(0.56)	(0.77)
JL_Monitor	-0.213*	-1.133***	-2.068**	1.671
	(1.70)	(2.51)	(2.54)	(1.19)
Average return * JL_Monitor	0.072***	0.302***	0.550***	-0.376
	(3.22)	(3.51)	(3.43)	(1.39)
(Total Return < 12) * JL_Monitor	-0.110	-1.321***	-2.548**	1.494
	(1.35)	(2.74)	(2.37)	(1.49)
JL_CrossReport	0.132**	0.496**	0.828**	-1.635***
	(2.56)	(2.56)	(2.49)	(3.24)
JL_Penalty of 1.5 million	0.085	0.387	0.622	1.152
	(1.30)	(1.63)	(1.52)	(1.44)
JL_Penalty of 3 million	0.107*	0.426**	0.702**	-0.751
	(1.87)	(2.07)	(2.05)	(1.27)
JL_Communication	0.144**	0.690***	1.175**	-0.143
	(2.41)	(2.66)	(2.47)	(0.27)
JL_Group Formation	0.124*	0.309	0.561	-0.910
	(1.73)	(0.94)	(0.91)	(1.43)
Observations	1336	1336	1336	865
R-squared	0.26			0.36

Robust t statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%.
All the specifications include district and round dummy variables, which are not reported in the table.

Appendix Table 1. Summary statistics of demographic characteristics

	Mean	Std. Dev.	Min	Max
Age	33.323	13.60	15	76
Female	0.587	0.49	0	1
Years of education	9.207	4.56	0	16
Riskiness *	2.946	1.51	1	5
GSS questions	0.332	0.46	-1	1
Cooperation scale	1.368	0.54	-0.6	2.4
Social connection	3.753	3.51	0	19

* Riskiness: 1 = most risk averse; 5 = least risk averse