Moral Hazard and Peer Monitoring in a Laboratory Microfinance Experiment*

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Abstract

Most problems with formal sector credit lending to the poor in developing countries can be attributed to the lack of information and inadequate collateral. One common feature of successful credit mechanisms is group-lending, where the loan is advanced to an individual if he/she is a part of a group and members of the borrowing group can monitor each other. Since group members have better information about each other compared to lenders, peer monitoring is less expensive than lender monitoring. Theoretically this leads to greater monitoring and greater rates of loan repayments. This paper reports the results from a laboratory experiment of group lending in the presence of moral hazard and (costly) peer monitoring. We compare peer monitoring treatments when credit is provided to members of the group sequentially and simultaneously, and a case of individual lending with bank monitoring. Our results suggest that peer monitoring results in higher loan frequencies, higher monitoring and higher repayment rates compared to bank monitoring. Although the dynamic incentives provided by sequential leading generate the greatest equilibrium efficiency, simultaneous group leading provides equivalent empirical performance.

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Key words: Group Lending, Monitoring, Moral Hazard, Laboratory Experiment, Loans, Development

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1. Introduction

There now exists a significant body of research that examines the failure of formal sector credit lending programs aimed at the poor in developing countries. Evidence of this failure is shown in the inability to reach target groups and low overall repayment rates. This failure is attributed primarily to asymmetric information (both adverse selection and moral hazard) and inadequate enforcement.[1]

The last few decades have, however, witnessed the development of innovative and highly successful mechanisms for the provision of credit to the poor. The most common of these is group-lending. Rather than the bank (or the lender) making a loan to an individual who is solely responsible for its repayment, the bank makes a loan to an individual who is a member of a group and the group is jointly liable for each member's loans. In particular, if the group as a whole is unable to repay the loan because some members default on their repayment, all members of the group are ineligible for future credit. The Grameen Bank in Bangladesh is possibly the most well known of such group lending programs. The repayment rate in this lending scheme is around 92 percent, and less than 5 percent of loan recipients were outside the target group (Morduch, 1999). The success of the Grameen Bank has led policy makers and NGO's around the world to introduce similar schemes. Around 100 million people are estimated to have participated in some form of a microfinance project (see Gine, Jakiela, Karlan and Morduch, 2005). The 2006 Nobel Prize for Peace to microfinance pioneer Muhammed Yunus has also put the success of microfinance in the world spotlight. Micro-lending is also moving from non-profit towards a profit-making enterprise, with big banks such as Citigroup now backing such loans (Bellman, 2006).[2]

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[1] For example, it has been argued that the percentage of ineligible beneficiaries in the Integrated Rural Development Program (IRDP) in India, one of the largest programs of provision of formal sector credit to the poor in the world, was between 15 and 26 percent, with the highest reported being 50 percent. The repayment rate for IRDP loans was only about 40 percent for the whole country (see Pulley, 1989).

[2] While microfinance programs are most widespread in less developed countries they are by no means confined to them. Microfinance programs have been introduced in transition economies like Bosnia and Russia and even

The success of these group lending programs arises, in part, because they are better able to address the enforcement and informational problems that generally plague formal sector credit in developing countries. Group lending programs help solve the enforcement problem through peer monitoring. Stiglitz (1990) and Varian (1990) argue that since group members are likely to have better information compared to an outsider (the bank), peer monitoring is relatively cheaper compared to bank monitoring, leading to greater monitoring and hence greater repayment. Banerjee, Besley and Guinnane (1994) argue that explanations based on peer monitoring do a better job of explaining the success of group lending programs than other explanations. Ghatak and Guinnane (1999) develop a model of moral hazard and monitoring and find that if the social sanctions are effective enough or if monitoring costs are low enough, the joint liability provided by group lending improves repayment rates. Chowdhury (2005), by contrast, is less optimistic. He finds that in the absence of sequential financing or lender monitoring, group lending programs will typically involve under-monitoring with the borrowers investing in undesirable projects.[3]

The empirical evidence on these issues, unfortunately, is rather limited. The theoretical propositions and results are often supported by anecdotal evidence but these results have not been established as empirical regularities. In recent years researchers have called for well designed economic experiments to help examine the roles of various mechanisms that drive performance in microfinance programs (Morduch, 1999, Armendariz de Aghion and Morduch, 2005).

The aim of this paper is to understand specific aspects of group lending schemes, using controlled experimental methods. We report the results from a laboratory experiment of

in developed countries like Australia, Canada and the US. See for example Conlin (1999), Armendariz de Aghion and Morduch (2000, 2005), and Fry, Mihajilo, Russell and Brooks (2006).

[3] How group lending solves the problem of adverse selection is analysed by Ghatak (1999, 2000), Van Tassel (1999), Armendariz de Aghion and Gollier (2000). The argument is based on endogenous group formation (and positive assortative matching): group lending with joint liability will result in self selection with safe borrowers clubbing together and screening out risky borrowers.

group lending in the presence of moral hazard and (costly) peer monitoring.[4] We compare treatments when credit is provided to members of the group sequentially and simultaneously, as well as a benchmark treatment when loans are given to individuals and monitored by lenders.

Our work complements the growing body of research that can broadly be characterized as field experiments in microfinance (see for example Gine, Jakiela, Karlan and Morduch, 2006; Gine and Karlan, 2006, Kono, 2006, Cassar, Crowley and Wydick, 2007). The laboratory approach that we use in this paper can address issues in different ways compared to field experiments. It is difficult to vary specific properties of institutions in controlled experiments in the field due to problems of replicability, data accessibility and comparability (see for example Bolnik, 1988 and Hulme, 2000). Furthermore some relevant variables, such as actual monitoring costs, remain unobserved. The laboratory approach on the other hand can help us control for specific parameters and observe behavior in simulated microfinance institutions. In our case it can help in isolating and clarifying the impact of different design features on repayment rates and project choice, by implementing an environment that is carefully aligned with the theoretical models relating to moral hazard and peer monitoring in microfinance programs. Of course, the laboratory approach has some drawbacks. For example, while the laboratory experiment included human subject behavior, the subjects are university students making decisions for relatively low stakes.[5] In field experiments, by contrast, participants are often the actual borrowers who are involved in microfinance programs. This advantage of field experiments comes at the cost of some loss of experimental control, however. For example, spillover effects could exist from one village to another or from the treatment group to the control group, creating more noise in the data.

[4] In this paper, we focus on informational asymmetries due to moral hazard and not due to adverse selection. In particular we restrict ourselves to exogenously formed groups (with random re-matching) and leave the issue of endogenous group formation (positive assortative matching) for future research.

[5] We do, however, employ subjects both from a developed (Australia) and a developing (India) country to measure possible subject pool effects, and find virtually none.

Laboratory experiments that examine the impact of specific design features on performance of microfinance models are rare. Abbink, Irlenbusch and Renner (2006) and Seddiki and Ayedi (2005) both examine the role of group selection in the context of group lending. Both experiments are designed as investment games where each group member invests in an individual risky project whose outcome is known only to the individual, and both find that self-selected groups have a greater willingness to contribute. Neither of these papers analyze the role of peer monitoring.

Our experiment examines several aspects of group lending programs. The first is the argument that sequential lending is crucial to the success of group lending schemes. The Grameen Bank, for example, adopts this kind of a lending policy: groups have five members each and loans are initially given to two randomly chosen members, to be repaid in regular installments over a period of one year. If they pay their initial installments, then two more borrowers in the group receive the loan and so on. Ray (1998) argues that this kind of sequential lending minimizes the contagion effect associated with individual default. Sequential lending can also minimize the potential of coordination failure. Aniket (2006) and Chowdhury (2005) argue that in a simultaneous group lending scheme with joint liability and costly monitoring, peer monitoring by borrowers alone is insufficient and that sequential lending that incorporates dynamic incentives is required.[6] Our experiment examines the empirical validity of these predictions by comparing the performance of sequential lending and simultaneous lending in the presence of moral hazard and costly peer monitoring

The second issue is whether peer monitoring indeed does better than active lender monitoring. The bank or the lender in general is an outsider who often has less information about the borrowers. Therefore monitoring individual borrowers could be very expensive for

[6] Dynamic incentives mean that banks make future loan accessibility contingent on full repayment of the current loan to prevent strategic default.

the lender. Specifically, we study whether in the presence of moral hazard, group lending with peer monitoring does better than individual lending with bank monitoring.[7]

The third issue is the relative benefits of individual and group lending. Over the years there has been a discernible shift from group lending to individual lending in microfinance programs and there are a number of theoretical reasons that have been advanced to explain this shift.[8] First, clients often dislike tensions caused by group lending. Second, low quality clients can free-ride off high quality clients leading to an increase in default rates. Third, group lending can be more costly for the clients as they often end up repaying the loans of their peers. Theoretically the results are mixed.[9]

Our laboratory experiment is able to address each of these issues. Our results show that group lending (with peer monitoring) performs better compared to individual lending (with active lender monitoring), reflected in higher loan frequencies and repayment rates. This occurs even though repayment rates with individual lending considerably exceed the theoretical prediction, which may reflect social preferences such as reciprocity. These results differ from those observed in the field by Gine and Karlan (2006) and Kono (2006), who find high performance in individual lending schemes. Their explanation is based on the argument of Grief (1994), who argues that a more individualistic society requires less information among players and is thus able to grow faster.[10] We also find that within group lending it

[7] Peer monitoring and peer enforcement have been observed to deter free riding in several experiments relating to other social dilemma situations, such as common pool resource environments and the voluntary provision of public goods. See Fehr and Gaechter (2000), Barr (2001), Masclet, Noussair, Tucker and Villeval (2003), Walker and Halloran (2004), and Carpenter, Bowles and Gintis (2006) for experimental evidence.

[8] The terms individual and group lending as defined in this paper essentially correspond to the terms individual and group (joint) liability. We use the term group lending to describe the situation where individuals are both borrowers and simultaneously guarantors of their partners' loans.

[9] Armendariz de Aghion and Morduch (2000, 2005) argue that group lending (joint liability) is just one element in successful microfinance schemes. Chowdhury (2005) argues that mere joint liability does not work and he emphasizes the role of dynamic incentives: in his model a combination of joint liability and dynamic incentives work best in terms of project choice and repayment. Che (2002) argues that joint liability schemes create problems of free-riding and worsen repayment rates, but when projects are repeated multiple times, group lending dominates individual lending. Rai and Sjostrom (2004) emphasize the importance of cross-reporting in achieving efficiency in group lending.

[10] We would like to point out a specific design feature of the field experiment conducted by Gine and Karlan (2006), which could at least partly explain the different results. In that experiment, the existing field centres with

does not matter whether loans are made simultaneously or sequentially. Although the dynamic incentives provided by sequential lending can improve efficiency relative to simultaneous group lending, performance is equivalently high in the two group lending treatments because agents tend to play the efficient equilibrium in the simultaneous case.

2. Theoretical Framework

Consider a scenario where two borrowers require one unit of capital (say \$1) each for investing in a particular project. The bank, which provides this capital in the form of a loan, can either make the loan to an individual (individual lending) or it can loan to the borrowers as a group (group lending). Joint liability for the repayment of the loan exists in the case of group lending. Borrowers can invest in two different types of projects: one project has a large verifiable income and no non-verifiable private benefit, while the other has a large non-verifiable private benefit and no verifiable income. The bank prefers the first project, where it can recoup its investment, but the borrowers prefer the second one. In the absence of monitoring, the borrowers will choose to invest in the second project and the bank, knowing this, will choose not to make the loan.

Let us elaborate on the model, which follows Chowdhury (2005) and Ghatak and Guinnane (1999). Suppose that there are two borrowers: B_1 and B_2. Two projects are available to each borrower: project *S* (verifiable) and project *R* (non-verifiable). If Project *S* is chosen, the return is *H* (verifiable by monitoring) and if project *R* is chosen, then the return is *b* (not verifiable) with $b < H$. The 1 dollar cost of each project is financed by a loan from the bank (or a lender) since the borrowers do not have any funds of their own. When the two borrowers (B_1 and B_2) borrow together as a group, each borrower receives 1 dollar from the

group liability loans were converted to individual liability loans. Lenders therefore had prior information about the borrowers' characteristics from the group lending field sessions and this could be used in the individual lending sessions at no extra cost. As a result the monitoring costs did not necessarily change as they moved from group lending to individual lending. Furthermore, participants had some experience with group lending before branching off on their own in the individual lending schemes. These reasons could have contributed towards the higher performance outcomes in the individual liability programs in their study.

lender. The amount to be repaid is $r(>1)$ in the case of individual lending or $2r$ in the case of group lending. We assume that this r is fixed exogenously.

In the case of the individual lending, if the borrower chooses project *S* the return to the bank is r; otherwise it is 0. The return to the borrower is $H-r$ if the borrower chooses project *S*, and is b if the borrower chooses project *R*. We assume that $H-r<b$ so that borrowers prefer project *R*. Banks on the other hand prefer project *S*. In the case of group lending, if both borrowers choose project *S*, the return to each borrower is $H-r$ and the return to the bank is $2r$. If both borrowers choose project *R*, the return to each borrower is b and the return to the bank is 0. Finally if one borrower chooses project *R* and the other chooses project *S*, then due to joint liability the return to the borrower choosing project *S* is 0 while that of the borrower choosing project *R* is b and the return to the bank is H. We assume that $H \le 2r$. In the case of group lending it is therefore in the interest of both the bank and the borrowers to ensure that the other member of the group chooses project *S*.

An informational asymmetry arises because each borrower knows the type of his own project, but the lender or the other borrower in the group (the partner) can find out the borrower's project choice only with costly monitoring. The monitoring process works as follows: Borrower i can, by spending an amount $c(m_i)$ in monitoring costs, obtain information about the project chosen by the other borrower in his group with probability $m_i \in [0,1]$. This information can be used by borrower i to ensure that the other borrower in the group chooses project *S*. The bank (lender) can also acquire this same information by spending an amount $\lambda c(m)$. We assume that $\lambda \ge 1$ in order to capture the notion that peer monitoring is less expensive than monitoring by the bank. We assume a quadratic monitoring cost function so that $c(m_i) = m_i^2/2$. Monitoring level m costs the bank $\lambda m^2/2$. If the

borrower i chooses monitoring level m_i, then with probability m_i he can force the other borrower in the group to choose project *S*. [11]

Individual Lending

First consider individual lending (with bank monitoring). There are three stages to the game.

Stage 1: Bank chooses whether or not to lend \$1 to the borrower.

Stage 2: Bank chooses the level of monitoring, conditional on deciding to lend.

Stage 3: Borrower chooses either project *R* or project *S*.

It is straightforward to solve for the sub game perfect Nash equilibrium of the game by backward induction. If the bank lends, it chooses *m* to maximize $mr - \frac{\lambda m^2}{2} - 1$, which gives $m^* = r/\lambda$. Therefore the expected return to the bank is $\frac{r^2}{2\lambda} - 1$, so the bank will provide the loan if and only if $\frac{r^2}{2\lambda} - 1 > 0$ i.e. if $r^2 > 2\lambda$. This implies that individual lending is feasible only if the costs of monitoring relative to the return are sufficiently low: $\lambda < r^2/2$.

Group Lending: Simultaneous

The sequence of events in group lending is as follows:

Stage 1: Bank chooses whether or not to lend \$2 to the group. There is joint liability, so that if one borrower fails to meet his obligations, then if the other borrower has verifiable income he must pay back the bank for both borrowers.

Stage 2: The borrowers simultaneously choose the level of peer monitoring, m_i.

Stage 3: Both borrowers choose either project *R* or project *S*.

[11] We could think of different ways in which monitoring works in practice: information acquired by the borrowers about each other's project choice may be passed on to the lender who then uses this information to force the borrowers to choose project *S*. Alternatively, the borrowers can use some form of social sanctions or peer punishment to ensure that the other borrower chooses project *S*.

Note that here both monitoring and lending is simultaneous and we call this simultaneous group lending. Again the sub game perfect Nash equilibrium is solved by backward induction. Borrower i will choose monitoring m_i to maximize

$$m_i\left[m_j\left(H-r\right)+\left(1-m_j\right)b\right]+\left(1-m_i\right)\left[m_j*0+\left(1-m_j\right)b\right]-\frac{m_i^2}{2}$$

The first order condition is: $m_j\left(H-r\right)-m_i=0$. Likewise the first order condition for borrower j is: $m_i\left(H-r\right)-m_j=0$. Clearly $m_i^*=m_j^*=0$ is a Nash equilibrium. We call this the *inefficient* (*zero-monitoring/zero-lending*) *equilibrium*. In this case there is a strategic complementarity between the monitoring levels of the two borrowers. A particular borrower knows that if the other borrower monitors and he does not, then he will end up with a payoff of 0. If however the other borrower does not monitor then he has no incentive to monitor as well. Mere joint liability and peer monitoring does not solve the moral hazard problem.

Remember however that $m\in\left[0,1\right]$. Now consider the reaction function $m_i=m_j\left(H-r\right)$ of borrower i with respect to that of borrower j. Since $H-r>1$ (the return on project *S* exceeds the amount that must be repaid), then there exists a $m_j=\overline{m_j}<1$ (say) such that the best response is $m_i=1$ for $m_j\geq\overline{m_j}$. So the reaction function of borrower i with respect to that of borrower j can be written as:

$$m_i=\begin{cases}m_j\left(H-r\right)\text{ for }m_j\in\left[0,\overline{m_j}\right)\\1\text{ for }m_j\in\left(\overline{m_j},1\right]\end{cases}$$

In this case $m_i^{**}=m_j^{**}=1$ is also a Nash equilibrium. We can call this the *efficient* (*monitoring/lending*) *equilibrium*. Figure 1 presents the reaction functions for $H-r=1.75$. It is important to note that the reaction functions are upward sloping. We will return to this issue in our estimation results, below.

The bank's payoffs in these two monitoring game equilibria determine whether it will lend. For the inefficient $(0,0)$ case, the expected payoff to the bank is $-2<0$ and group lending is not feasible. The payoff to both borrowers in this case is 0. On the other hand, for the efficient $m_1^{**}=m_2^{**}=1$ case, the payoff to the bank is $2r>0$ and the payoff to both borrowers is $H-r-1/2$. Clearly $m_1^{**}=m_2^{**}=1$ is the payoff-dominant equilibrium. Although this also makes it a focal point equilibrium (Schelling, 1980, p. 291), previous experimental evidence indicates that this is not a sufficient condition for "behavioral" equilibrium selection (e.g., Van Huyck, Battalio and Beil, 1990).

Group Lending: Sequential

An alternative to simultaneous lending is to lend sequentially to group members with the order chosen randomly. Here initially only one (randomly chosen) member of the group receives a loan. Depending on whether this loan is repaid, the bank decides whether or not to lend to the other member of the group. This incorporates dynamic incentives, which have become increasingly popular among researchers and practitioners in microfinance. The sequence of events is as follows:

Stage 1: Bank chooses whether or not to lend \$1 to one of the members of the group. It puts the other dollar into alternative use, which yields $\tilde{r}$.

Stage 2: The borrowers simultaneously choose their levels of monitoring m_i.

Stage 3: One of the borrowers is chosen at random (with probability 0.5) to receive the loan, if the bank lends. This borrower B_i decides whether to invest in *R* or *S*.

If B_i invests in project *R*, then he gets *b* and neither B_j nor the bank receives anything. The game stops here. If B_i invests in project *S* the game continues to round 2. In this case borrower B_i receives $H-r$ and the bank receives r. This amount $H-r$ is

invested and gives $(H-r)\tilde{r}<1$, so that self financing among the borrowers is not possible. Of course if B_j is successful in her monitoring, then B_i has to invest in project *S*.

Stage 4: The game moves to round 2 only if B_i (the randomly chosen first borrower) invests in project *S* in round 1. The bank lends \$1 to B_j who invests in either project *R* or project *S* (of course if B_i was successful in her monitoring, then B_j has to invest in project *S*).

If B_j invests in project *R* then the bank gets $(H-r)\tilde{r}$ and B_j gets *b*. If B_j invests in project *S*, then the bank gets *r*. Total surplus is $(H-r)(1+\tilde{r})$ and this is allocated among the two borrowers. B_j gets $\alpha(H-r)(1+\tilde{r})$ and B_i gets $(1-\alpha)(H-r)(1+\tilde{r})$.

There is now positive level of monitoring irrespective of α and group lending (with joint liability) is a feasible and unique equilibrium outcome. Even though both borrowers still have an incentive to choose the non-verifiable project *R*, the sequential lending increases their incentive to monitor. In this case the reaction functions for the two borrowers are symmetric and are given by

$$m_k = \frac{1}{2\tilde{r}}\left[b + m_l\left\{\alpha(H-r)(1+\tilde{r}) - b\right\}\right]$$
$$m_l = \frac{1}{2\tilde{r}}\left[b + m_k\left\{\alpha(H-r)(1+\tilde{r}) - b\right\}\right]$$

Solving out we get

$$\overline{m}_k = \frac{b}{b + 2\tilde{r} - \alpha(H-r)(1+\tilde{r})} = \overline{m}_l = \overline{m}$$

The expected payoff to the bank is

$$\frac{m_k m_l r}{\tilde{r}} - \left(\frac{m_k + m_l}{2}\right)\left(r - \frac{1}{\tilde{r}}\right)$$

Therefore a unique and positive level of monitoring exists, irrespective of the value of α. This positive level of monitoring occurs because even if borrower B_j does not monitor,

B_i has an incentive to monitor. To see this, suppose that B_j receives the loan in round 1 (remember that the order of receiving the loan is determined randomly). If B_i does not monitor, B_j will invest in project *R* and then B_i will receive a payoff of 0. By choosing a positive level of monitoring, B_i can increase the probability that B_j invests in project *S* in which case the game continues onto the second round and B_i gets the loan. Moreover given that B_i is going to monitor, B_j has an even greater incentive to monitor due to the strategic complementarity of monitoring. So the sequential nature of the lending scheme and the simultaneous choice of the level of monitoring (before a borrower knows whether he is the first or the second borrower) leads to an *efficient* (*monitoring/lending*) *equilibrium*, as long as the equilibrium monitoring levels are sufficient to provide positive returns to the lender.

3. Experimental Design

We conducted 8 sessions in each of the three treatments with 12 subjects in each session. The 288 subjects were graduate and undergraduate students at Monash University and University of Melbourne, Australia and Jadavpur University, Kolkata, India. We conducted sessions in two countries to examine whether subjects in India, who are perhaps more exposed to issues relating to microfinance and who share more cultural similarities to targeted borrowers, would exhibit behavioral differences from the subjects in Australia.[12] All subjects were inexperienced in that they had not participated in a similar experiment. Compared to the Australian sample, the Indian sample had a lower proportion of females, a greater proportion of Business/Economics/Commerce majors, and a higher proportion of subjects that lived in a major metropolis when they were aged 15. The z-tree software (see Fischbacher, 2007) was used to conduct the experiment. Each session lasted approximately 2 hours, including

[12] Following Muhammad Yunus being awarded the Nobel Peace Prize in 2006, microfinance and Grameen Bank have received considerable media attention in India and in particular in Kolkata, which has cultural and linguistic similarities to Bangladesh.

instruction time. Subjects earned AUD 25 – 35 or its purchasing power equivalent on average.[13] The instructions (included for the simultaneous lending treatment 2 in the appendix) used the borrowing and lending terminology employed in this description.

We employed three treatments to examine the equilibrium predictions described in Section 2. In treatment 1 the 12 subjects were randomly divided into groups of two with each group consisting of one borrower and one lender. In treatments 2 and 3 the 12 subjects were randomly divided into groups of three with each group consisting of two borrowers and one lender. The role of each subject (as a borrower or as a lender) was determined randomly and remained the same throughout each session, which ran for 40 periods. At the end of every period participants were randomly re-matched. After reading the instructions and before the actual session began, the participants answered a set of questions relating to the instructions and they were paid in cash (at the end of the experiment in addition to their earnings from the actual experiment) $0.50 or Rs 5.00 for each correct answer.

The two projects available to borrowers, *S* and *R*, each cost $1, to be financed by a loan from the lender. In the individual lending treatment, the lender chose whether or not to invest $1 into this loan. In the group lending (simultaneous and sequential) treatments, the lender chose whether or not to invest $2 into the loan ($1 to each borrower). The lender could choose to make the loan to both borrowers or to neither. She could not make a loan to only one borrower in the group. If the lender chose not to make the loan, she earned $1.50 (or $0.75 in the individual lending treatment) for the period. In the group lending treatments, if the borrower received the loan, he could monitor the project choice of the other borrower in the group by choosing to pay a monitoring cost (*C*). Both borrowers could monitor each other. If borrower *X* incurred a cost *C* on monitoring, there was a chance of *M* that the other borrower *Y* would automatically be required to choose project *S*. Otherwise the other

[13] At the time of the experiment, 4 Australian dollars were worth about 3 U.S. dollars.

borrower could choose either project *R* or project *S*. In the sequential lending treatment, the borrowers were randomly determined to be the first or the second borrower in the group to receive the loan. In this case if the first (randomly chosen) borrower's actual project choice was *R*, then the lender's second dollar was automatically allocated to her savings account where she earned \$0.75 for this dollar. All monitoring decisions were made simultaneously.

We used the strategy method to elicit decisions from the borrowers.[14] The use of this method implies that the borrowers and lenders made decisions simultaneously and borrowers made their decision before they knew whether or not they had received the loan. In the case of sequential lending, the borrowers made monitoring decisions before they knew whether they were the first or the second borrower in their group to receive a loan. They did, however, know whether they were the first or the second borrower to receive the loan at the time of making their project choice. Panel A of Table 1 presents the relationship between *C* and *M* for treatments 2 and 3. Table 2 presents the earnings of the borrowers and the lender under the different project choice scenarios. Note that the even division for two S projects in the sequential lending (Panel B) indicates our choice of $\alpha = 0.5$.

In the individual lending treatment, if the lender decided to invest \$1 in a period (make the loan), she could monitor the project choice of the borrower by choosing to pay a monitoring cost (*C*). Panel B of Table 1 presents the relationship between *C* and M in this case, which is based on $\lambda = 4.5$. Lenders paid their selected monitoring costs whenever they made the loan, regardless of whether or not the monitoring was successful. If unsuccessful, the borrower could choose either project *S* or project *R*. All decisions were revealed to all members of the two- or three- person group at the end of each period.

4. Hypotheses to be Tested

[14] The strategy method simultaneously asks all players for strategies (decisions at every information set) rather than observing each player's choices only at those information sets that arise in the course of a play of a game. This allows us to observe subjects' entire strategies, rather than just the moves that occur in the game, and could help give insights into their motivation.

The experiments were designed to test the following theoretical hypotheses:

Hypothesis 1: Compared to the individual lending (treatment 1), the lending rate, the average level of monitoring and the average repayment rate are all higher in the group lending treatments (treatments 2 and 3).

Hypothesis 2: Compared to the sequential group lending treatment (treatment 3), the lending rate, the average level of monitoring and the average repayment rate are not higher in the simultaneous group lending treatment (treatment 2).

Note that the weak inequalities indicated in Hypothesis 2 follow from the theoretical predictions that the efficient (lend/monitor) equilibrium is unique in the sequential lending treatment, but both efficient and inefficient (no loan) equilibria exist in the simultaneous lending case.

5. Results

We present our results in the next four subsections, with each subsection dealing with a specific aspect of the program: lending, monitoring, repayment (and project choice) and finally efficiency. In each case we present conservative non-parametric tests for treatment differences which require minimal statistical assumptions and are based on only one independent summary statistic value per session. We also report estimates from multivariate parametric regression models which can isolate the contribution of different factors on lender and borrower behavior.

5.1: Lending

Figure 2 presents the average proportion of lenders making loans in the different periods, by treatment. Clearly the average proportion of lenders making loans is substantially lower at every period for treatment 1 (individual lending) but there is very little difference between treatments 2 and 3 (group lending), providing initial support for both hypothesis 1 and 2. These results are supported by non-parametric Mann-Whitney rank sum tests with the session

average as the unit of observation (see Table 3, Panel A). Compared to the initial 5 periods, the average proportion making loans is also significantly lower in the later 5 periods in treatment 1 (Wilcoxon signed rank test $S_n = 0$ for $n = 8; p - value < 0.01$), but is not significantly different between early and late periods in treatment 2 $\left(S_n = 12.5 \text{ for } n = 8; \text{ not significant}\right)$ and treatment 3 $\left(S_n = 10.5 \text{ for } n = 8; \text{ not significant}\right)$.

Subjects participated in the experiment over 40 periods, allowing us to examine their behavior over time more systematically using panel regressions. Table 4 presents the random effect probit estimation of the lender making the loan. These panel regressions incorporate a random effects error structure, with the subject (lender) representing the random effect. The dependent variable is the propensity to lend. The explanatory variables that we include are: dummies for simultaneous and sequential lending treatment (the reference category is individual lending); a dummy variable indicating whether the lender made a loss in the previous period; a dummy for the session being run at Jadavpur University in Kolkata (to capture subject differences across the two countries); and two variables that capture the effect of time on the propensity to make the loan in a particular period: $1/t$ and the interaction term $\left(1/t\right)\times\left(GROUP\right)$, where $GROUP$ is a dummy variable that takes the value of 1 if group lending treatment (simultaneous and sequential lending) and 0 if individual lending treatment.[15] We also include a set of demographic controls.

[15] Notice from Figure 2 that the time trend appears quite similar for the two group lending treatments but is very different for the individual lending treatment. The non-interacted term $\left(1/t\right)$ in this case captures the effect of time on the propensity of the lender to make a loan in the individual lending treatment while the interaction term captures the differential effect of time on the propensity of the lender to make a loan in the group lending treatment. To get the total effect of time in the group lending treatments we need to add the coefficient estimates of $\left(1/t\right)$ and $\left(\left(1/t\right)\times\left(GROUP\right)\right)$.

Table 4 presents the coefficient estimates and standard errors. Lending decreased over time in treatment 1, but increased over time in the two group lending treatments.[16] The two treatment dummies are both positive and statistically significant indicating that the probability of lending is significantly higher in group lending compared to individual lending. This provides further support for Hypothesis 1. The difference in the probability of lending in the two group lending treatments is however statistically significant at the 10% level (using the test of equality across the two group lending treatment dummies), weakly contradicting Hypothesis 2. The probability of lending in period t is significantly lower if the lender received negative earnings in period $t-1$. The Jadavpur University dummy is not statistically significant implying that that there is no difference in the probability of lending across the two samples. Most of the demographic control variables are not statistically significant.

5.2: Monitoring

Figure 3 presents the average level of monitoring across periods. With the exception of the first few periods, average monitoring is highest in the sequential lending treatment and lowest in the individual lending treatment. Again using a rank sum test with the session average as the unit of observation, the difference in monitoring rate between treatments 2 and 3 is not statistically significant (Table 3, Panel B). The average monitoring rate is always significantly lower for treatment 1, however. This provides support for Hypotheses 1 and 2. In treatment 1 (individual lending) the monitoring rate is lower in the last 5 periods than in the first 5 periods (Wilcoxon signed rank test $S_n = 2$ for $n = 8; p - value < 0.05$), indicating a significant decline in monitoring rates. By contrast, monitoring rates increase between the first 5 and last 5 periods for treatment 2 (Wilcoxon $S_n = 4$ for $n = 8; p - value < 0.05$) and treatment 3 (Wilcoxon $S_n = 0$ for $n = 8; p - value < 0.01$).

[16] The coefficient estimates of $\left(1/t\right)$ and $\left(\left(1/t\right)\times(GROUP)\right)$ are jointly significant.

The monitoring decision is made by different agents in the individual and group lending treatments. Hence we analyze the level of monitoring chosen in the individual and group lending treatments separately.[17] The level of monitoring chosen is restricted in the range $(0,1)$ and is estimated using a tobit model.

Consider first the level of monitoring chosen (by the lender) in the individual lending treatment. The explanatory variables are the same as those in Table 4, except that here, by definition, we do not include the interaction term $\left(1/t\right)\times\left(GROUP\right)$. Table 5, Panel A, presents the tobit regression results with player fixed effects and the Hausman-Taylor estimates for error component models.[18] The level of monitoring in period $t-1$ has a positive and statistically significant impact on the level of monitoring in period t. The Jadavpur University dummy is not statistically significant, indicating no locational differences.

As mentioned above in the case of group lending (with peer monitoring) the payoff for an individual borrower depends both on her level of monitoring and also on the level of monitoring of her partner. Subjects could construct expectations for the level of monitoring of the other member of the group in different ways. Here we consider the following two simple alternatives:

(1) *Cournot expectations*: each subject expects the monitoring level of the other member of the group to be the same as that in the previous period (Lagged Other Monitoring);
(2) *Fictitious play*: each subject expects the monitoring level of the other member of the group to be the average over all the previous periods (Lagged Average Other

[17] The propensity to make the loan is significantly lower in the individual lending treatment, implying that the data on the level of monitoring is often not observed in the individual lending treatment. The panel in this case is therefore unbalanced: the observed number of monitoring choices varies from 2 (in only 2 of the possible 40 cases, did they choose to make the loan) to 37.

[18] The tobit regression results presented in column (1) fail to account for the possibility that the lagged dependent variable (lagged level of monitoring) can be correlated with the time invariant component of the error term (the unobserved individual level random effect). Ignoring this could result in biased estimates. One way of obtaining unbiased estimates would be to use instrumental variables estimation (see Hausman and Taylor, 1981). It is assumed that none of the covariates is correlated with the idiosyncratic error term. The results for the Hausman-Taylor estimation for error component models are presented in Table 5, Panel A, column (2). Qualitatively the results are very similar to the tobit regression results presented in column (1): in particular, the greater the level of monitoring in period $t-1$, the greater the level of monitoring in period t and the level of monitoring falls over time.

Monitoring). Hence each subject is assumed to have a long memory as opposed to the Cournot expectations case where each subject has a short memory.

Table 5, Panel B, presents the random effects tobit and the Hausman-Taylor estimation for error component models for both specifications of expectation formation in the group lending treatment. We find that monitoring increased over time. The positive and significant coefficient estimate of the other borrower's lagged monitoring level (in the Cournot expectations version) or its counterpart lagged average other borrower's monitoring (in the fictitious play version) is consistent with the upwardly-sloped reaction functions of the theoretical model. Note that the coefficient estimate on a borrower's own monitoring in the previous period is also positive, and is substantially larger than the reaction to the other borrower's monitoring level. The sequential lending treatment dummy is never statistically significant, consistent with Hypothesis 2. The Jadavpur University dummy is always negative but is statistically significant only in the tobit regressions implying that subjects in India choose a lower level of peer monitoring.[19] Finally turning to the demographic controls, we find that females choose a significantly lower level of monitoring, as do subjects with no previous participation experience.

5.3: Repayment Rate

Figure 4 presents the average repayment rates in the three treatments by period. Note that this repayment rate is not a choice variable but is the result of a combination of the *ex ante* project choice by the borrower, the level of monitoring chosen by the borrower, and the success of the monitoring process. Repayment occurs if the borrower chooses project *S* or if the borrower chooses project *R* and monitoring is successful. It is clear from Figure 4 that average repayment rates are lowest in the individual lending treatment. The results are again supported by a rank sum test with the session average as the unit of observation (Table 3,

[19] It is interesting to note that if we restrict the sample to those born in South Asia (whether residing in Australia or India), the Jadavpur University dummy is no longer statistically significant.

Panel C). The high repayment rates in the group lending treatments are essentially driven by the high monitoring rates and not by the borrowers *ex ante* choosing project *S*. Panel D of Table 3 presents the average proportion of borrowers choosing project *R ex ante*. The average proportion of subjects (*ex ante*) choosing project *R* is significantly lower in the individual lending treatment. Note also that the proportion of borrowers choosing project *R* is not different across treatments in the initial periods but becomes significantly different across all treatments by the later periods.

Recall that the earnings of the borrower are greater if he chooses project *R*, but the earnings of the lender are lower if the borrowers choose project *R*. In treatments 2 and 3, the borrowers are more likely to choose project *R*, but they are also more likely to choose a high level of monitoring to be able to switch the other borrower's project choice to *S*. In consequence the "actual project choices" are likely to be project *S* and the earnings of the lenders are positive and we move to an efficient (monitoring/lending) equilibrium. On the other hand in treatment 1 monitoring rates are lower (monitoring is also more costly $(\lambda > 1)$) and even though borrowers are more likely to choose project *S*, lenders choose not to make the loan. We end up at the inefficient (low monitoring/no lending) equilibrium. The results therefore imply that group lending with peer monitoring works better compared to individual lending with lender monitoring.

Table 6 presents random effect probit regression results for repayment and choice of project *R*. The explanatory variables are the same as in Table 4. The repayment rates (Table 6, column 1) are significantly higher in the group lending treatments compared to the individual lending treatment, consistent with Hypothesis 1. The sequential lending treatment has significantly higher repayment rates compared to the simultaneous lending treatment (the test of equality of treatment effects is significant, indicating that the two group lending treatments do not have similar effects on repayment), consistent with Hypothesis 2. The

Jadavpur University dummy is not statistically significant and finally repayment rates are significantly lower for subjects who had a higher proportion of correct answers in the quiz.

Column 2 presents the random effects probit regression results for choice of project *R*. The probability of choosing project *R* decreased over time in treatment 1, while the probability of choosing project *R* increased over time in the two group lending treatments.[20] The two treatment dummies are both positive and statistically significant, indicating that the probability of choosing project *R* is significantly higher in group lending compared to individual lending. The probability of choosing project *R* is no different in the two group lending treatments. In all three treatments, subjects who seek to maximize their own current period monetary earnings should always choose project *R*. We observe, however, that borrowers have a lower probability of choosing *R* in the individual lending treatment. One possible explanation is that reciprocal motivations are triggered more in a two person game than a three person game.

5.4: Efficiency

Finally we turn to efficiency, defined as the total surplus attained by the borrowers and the lenders as a proportion of the maximum possible surplus. Here efficiency is used as a measure of the overall performance of the market. Maximum surplus is attained when the lender provides the loan; the level of monitoring chosen is 0 and the borrowers choose project *S*. Panel E of Table 3 indicates that average efficiency is lowest in the individual lending treatment. The higher monitoring rates in the sequential lending treatment could lead to lower efficiency than the simultaneous group lending treatment, but the differences are only significant in the early periods.

6. Concluding Comments

[20] Again the coefficient estimates of $\left(1/t\right)$ and $\left(\left(1/t\right)\times\left(GROUP\right)\right)$ are jointly significant.

This paper reports the results from a laboratory experiment of group lending in the presence of moral hazard and costly lender or peer monitoring. We compare treatments when credit is provided to members of the same group sequentially and simultaneously, and when loans are given to individuals and monitored by lenders. Our results suggest that in the presence of moral hazard, peer monitoring results in higher loan frequencies, higher monitoring and higher repayment rates compared to bank monitoring. The differences are minor between simultaneous and sequential lending.

Results from this experiment can help shed light on the important policy issue of the optimal design for microcredit programs. Much of the success of microcredit programs has been attributed to self-selected groups and social ties in rural communities. However successful application of these programs in other scenarios and economies requires more than strong social ties. In urban contexts of developing and transitional economies, for example, it might be more difficult to form self-selected borrowing groups compared to the more closely knit rural communities. For this reason several authors and policy makers suggest that optimal design of microcredit programs look beyond the issue of self-selection and even look beyond group lending. In this experiment, we focus on informational asymmetries due to moral hazard and we restrict ourselves to exogenously formed groups. Our results show that in the presence of moral hazard group lending performs better compared to individual lending, even with no self-selection in group formation. Introducing dynamic incentives (within group lending) helps, but not significantly. What is important is peer monitoring, which works much better than active lender monitoring.[21] Optimal design of microcredit programs needs to take advantage of the fact that it is less costly for group members to monitor each other, which can result in better project choices and higher repayment rates.

[21] It has been observed that in the absence of peer monitoring the success of such programs is quite limited. See Bhatt and Tang (2002) for evidence using data from microcredit programs in the US..

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Table 1: Relationship between C and M

Panel A: Treatments 2 and 3 (Group Lending, Peer Monitoring)

Monitoring Cost (C)	M	Interpretation of M percentage:
$0.000	0%	Switch a borrower choice of R to S 0 out of 10 times
$0.005	10%	Switch a borrower choice of R to S 1 out of 10 times on average
$0.020	20%	Switch a borrower choice of R to S 2 out of 10 times on average
$0.045	30%	Switch a borrower choice of R to S 3 out of 10 times on average
$0.080	40%	Switch a borrower choice of R to S 4 out of 10 times on average
$0.125	50%	Switch a borrower choice of R to S 5 out of 10 times on average
$0.180	60%	Switch a borrower choice of R to S 6 out of 10 times on average
$0.245	70%	Switch a borrower choice of R to S 7 out of 10 times on average
$0.320	80%	Switch a borrower choice of R to S 8 out of 10 times on average
$0.405	90%	Switch a borrower choice of R to S 9 out of 10 times on average
$0.500	100%	Switch a borrower choice of R to S 10 out of 10 times

Panel B: Treatment 1 (Individual Lending, Bank Monitoring)

Monitoring Cost (C)	M	Interpretation of M percentage:
0.0000	0%	Switch a borrower choice of R to S 0 out of 10 times
0.0225	10%	Switch a borrower choice of R to S 1 out of 10 times on average
0.0900	20%	Switch a borrower choice of R to S 2 out of 10 times on average
0.2025	30%	Switch a borrower choice of R to S 3 out of 10 times on average
0.3600	40%	Switch a borrower choice of R to S 4 out of 10 times on average
0.5625	50%	Switch a borrower choice of R to S 5 out of 10 times on average
0.8100	60%	Switch a borrower choice of R to S 6 out of 10 times on average
1.1025	70%	Switch a borrower choice of R to S 7 out of 10 times on average
1.4400	80%	Switch a borrower choice of R to S 8 out of 10 times on average
1.8225	90%	Switch a borrower choice of R to S 9 out of 10 times on average
2.2500	100%	Switch a borrower choice of R to S 10 out of 10 times

Table 2: Earnings of Borrowers and Lenders

Panel A: Treatment 2 (Simultaneous Lending)

Actual project choice of borrower 1	Actual project choice of borrower 2	Earnings of borrower 1	Earnings of borrower 2	Earnings of lender
S	S	$\$1.75 - C_1$	$\$1.75 - C_2$	\$2.50
S	R	$\$0.00 - C_1$	$\$2.50 - C_2$	\$2.00
R	S	$\$2.50 - C_1$	$\$0.00 - C_2$	\$2.00
R	R	$\$2.50 - C_1$	$\$2.50 - C_2$	-\$2.00
No loan is provided		\$0.00	\$0.00	\$1.50

Note: C_1 and C_2 denote the monitoring costs incurred by borrower 1 and 2.

Panel B: Treatment 3 (Sequential Lending)

Actual project choice of the first borrower	Actual project choice of the second borrower	Earnings of first borrower	Earnings of second borrower	Earnings of lender
S	S	$\$1.75 - C_1$	$\$1.75 - C_2$	\$2.50
S	R	$\$0.00 - C_1$	$\$2.50 - C_2$	\$2.00
R	S	$\$2.50 - C_1$	$\$0.00 - C_2$	-\$0.25
R	R	$\$2.50 - C_1$	$\$0.00 - C_2$	-\$0.25
No loan is provided		\$0.00	\$0.00	\$1.50

Note: C_1 and C_2 denote the monitoring costs incurred by the first and the second borrower.

Panel C: Treatment 1 (Individual Lending)

Actual project choice of borrower	Earnings of borrower	Earnings of lender
S	\$1.75	$\$1.25 - C$
R	\$2.50	$-\$1.00 - C$
No loan is provided	\$0.00	\$0.75

Note: C denotes the monitoring cost incurred by the lender

Table 3: Selected Descriptive Statistics

Panel A. Average Proportion Making Loans

	Full Sample	First 5 periods	Last 5 periods
Individual Lending Treatment (Treatment 1)	0.4720	0.5875	0.2938
Simultaneous Lending Treatment (Treatment 2)	0.8138	0.7563	0.8047
Sequential Lending Treatment (Treatment 3)	0.7295	0.7000	0.8732
Rank sum Test			
Treatment 1 = Treatment 2	-3.256***	-2.107**	-3.376***
Treatment 1 = Treatment 3	-2.102***	-1.263	-3.258***
Treatment 2 = Treatment 3	0.684	0.582	-0.820
Individual Lending = Group Lending	-3.124***	-1.965**	-3.890***

Panel B. Average Level of Monitoring

	Full Sample	First 5 periods	Last 5 periods
Individual Lending Treatment (Treatment 1)	0.3268	0.4142	0.2466
Simultaneous Lending Treatment (Treatment 2)	0.5658	0.5094	0.6442
Sequential Lending Treatment (Treatment 3)	0.6178	0.5038	0.7213
Rank sum Test			
Treatment 1 = Treatment 2	-3.009***	-0.927	-3.009***
Treatment 1 = Treatment 3	-3.125***	-1.852*	-3.134***
Treatment 2 = Treatment 3	-0.840	-0.210	-0.811
Individual Lending = Group Lending	-3.541***	-1.604	-3.561***

Panel C. Average Repayment Rates

	Full Sample	First 5 periods	Last 5 periods
Individual Lending Treatment (Treatment 1)	0.4756	0.5000	0.3938
Simultaneous Lending Treatment (Treatment 2)	0.6555	0.6156	0.7242
Sequential Lending Treatment (Treatment 3)	0.6979	0.6500	0.7571
Rank sum Test			
Treatment 1 = Treatment 2	-2.836**	-1.631	-2.897***
Treatment 1 = Treatment 3	-3.361***	-2.209**	-3.258***
Treatment 2 = Treatment 3	-0.420	-0.423	0.0000
Individual Lending = Group Lending	-3.613***	-2.241**	-3.593***

Panel D. Average Proportion Choosing the Non-Verifiable Project R

	Full Sample	First 5 periods	Last 5 periods
Individual Lending Treatment (Treatment 1)	0.6293	0.6667	0.6646
Simultaneous Lending Treatment (Treatment 2)	0.7999	0.7219	0.8750
Sequential Lending Treatment (Treatment 3)	0.7951	0.6906	0.8643
Rank sum Test			
Treatment 1 = Treatment 2	-2.626***	-0.632	-2.370**
Treatment 1 = Treatment 3	-2.836***	-0.528	-2.437**
Treatment 2 = Treatment 3	0.053	0.053	0.582
Individual Lending = Group Lending	-3.185***	-0.675	-2.816***

Panel E. Efficiency

	Full Sample	First 5 periods	Last 5 periods
Individual Lending Treatment (Treatment 1)	0.4470	0.4841	0.3603
Simultaneous Lending Treatment (Treatment 2)	0.6616	0.6300	0.6715
Sequential Lending Treatment (Treatment 3)	0.5630	0.5389	0. 6547
Rank sum Test			
Treatment 1 = Treatment 2	-3.361***	-2.731***	-3.151***
Treatment 1 = Treatment 3	-1.890***	-1.050**	-3.125***
Treatment 2 = Treatment 3	1.470	1.890*	0.231
Individual Lending = Group Lending	-3.062***	-2.205***	-3.679***

Table 4: Random Effect Probit Regression for Making Loans

	Coefficient Estimate
1/t	1.9262***
	(0.3471)
1/t × GROUP	-2.4518***
	(0.4917)
Simultaneous Lending Treatment (Dummy)	1.3629***
	(0.2116)
Sequential Lending Treatment (Dummy)	0.9684***
	(0.2127)
Negative Earnings in Previous Period (Dummy)	-0.4416***
	(0.0593)
Session at Jadavpur University (Dummy)	-0.2914
	(0.1782)
Proportion of Correct Answer in Quiz	-0.0977
	(0.6236)
Age of Subject	-0.2953
	(0.1925)
Square of Age of Subject	0.0051
	(0.0037)
Female	0.2759
	(0.1759)
Business/Economics/Commerce Major	0.1195
	(0.1704)
Lived in a Suburb at Age 15	-0.0324
	(0.2514)
Lived in a Large City at Age 15	-0.1969
	(0.3153)
Lived in a Metropolis at Age 15	0.3811*
	(0.2093)
2nd Year	-0.0882
	(0.2063)
3rd Year	0.2710
	(0.2167)
No Previous Participation in Experiments	-0.3771
	(0.2428)
Constant	3.9590
	(2.5991)
Observations	4112
Number of group(session subject)	108
σ_u	0.7424***
	(0.0626)
ρ	0.3553***
	(0.0387)
LR Test for $\rho = 0$	624.63***
Equality of Treatment Effects	2.93*

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Level of Monitoring Chosen. Panel A: Individual Lending (Lender Monitoring)

	Tobit Regression with Player Fixed Effects	Hausman-Taylor Estimation for Error Component Models
1/t	0.1861**	0.1752**
	(0.0916)	(0.0870)
Lagged Monitoring	0.2848***	0.2449***
	(0.0515)	(0.0483)
Session at Jadavpur University (Dummy)	-0.0670	0.0549
	(0.0821)	(0.0653)
Proportion of Correct Answer in Quiz	-1.6822***	-1.4880
	(0.5033)	(1.2639)
Age of Subject	0.1043	-0.2617
	(0.6128)	(0.2877)
Square of Age of Subject	-0.0037	0.0049
	(0.0139)	(0.0052)
Female	0.1960	0.1519**
	(0.1811)	(0.0718)
Business/Economics/Commerce Major	0.1785**	0.0429
	(0.0778)	(0.0848)
Lived in a Suburb at Age 15	0.3329	0.0716
	(0.2091)	(0.0749)
Lived in a Large City at Age 15	0.1480	-0.0399
	(0.1938)	(0.0828)
Lived in a Metropolis at Age 15	0.3681***	0.0756
	(0.1381)	(0.0614)
2^{nd} Year	-0.4169*	-0.0979
	(0.2337)	(0.0848)
3^{rd} Year	-0.3329***	0.0222
	(0.1275)	(0.1087)
No Previous Participation in Experiments	-0.1483	-0.0929
	(0.1016)	(0.1250)
Constant	1.0901	4.7687
	(6.7142)	(4.8930)
Observations	477	477
Number of group(session subject)		41
σ	0.2077***	
	(0.0075)	
σ_u		0.0979
σ_e		0.1892
ρ		0.2111
Joint Significance of Player Fixed Effects	3.00***	
Left censored observations	64	
Uncensored observations	406	
Right censored observations	7	

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%;
ρ denotes the fraction of total variance due to the time invariant component of the error term.

Table 5 (Panel B): Group Lending (Peer Monitoring)

	Cournot Play		Fictitious Play	
	Random Effects Tobit Regression	**Hausman-Taylor Estimation for Error Component Models**	**Random Effects Tobit Regression**	**Hausman-Taylor Estimation for Error Component Models**
1/t	-0.1294***	-0.1559***	-0.1162**	-0.1414***
	(0.0497)	(0.0381)	(0.0503)	(0.0386)
Sequential Lending Treatment	0.0298	0.0277	0.0288	0.0257
(Dummy)	(0.0264)	(0.0210)	(0.0265)	(0.0211)
Lagged Own Monitoring	0.5149***	0.3616***	0.5026***	0.3493***
	(0.0192)	(0.0140)	(0.0194)	(0.0142)
Lagged Monitoring of the Other	0.1149***	0.0932***		
Borrower	(0.0164)	(0.0125)		
Average Lagged Monitoring of			0.2952***	0.2619***
the Other Borrower			(0.0507)	(0.0390)
Session at Jadavpur University	-0.0649**	-0.0349	-0.0575*	-0.0289
(Dummy)	(0.0309)	(0.0255)	(0.0306)	(0.0256)
Proportion of Correct Answer	-0.0608	-0.0561	-0.0759	-0.0646
in Quiz	(0.0776)	(0.0577)	(0.0770)	(0.0581)
Age of Subject	0.0761	-0.1673	0.0749	-0.1902
	(0.0858)	(0.1553)	(0.0913)	(0.1542)
Square of Age of Subject	-0.0020	0.0036	-0.0019	0.0042
	(0.0020)	(0.0036)	(0.0021)	(0.0035)
Female	-0.0768***	-0.0472**	-0.0898***	-0.0588***
	(0.0257)	(0.0198)	(0.0257)	(0.0201)
Business/Economics/Commerce	0.0051	-0.0042	-0.0037	-0.0105
Major	(0.0262)	(0.0204)	(0.0258)	(0.0206)
Lived in a Suburb at Age 15	-0.0558	-0.0681**	-0.0516	-0.0683**
	(0.0391)	(0.0314)	(0.0391)	(0.0316)
Lived in a Large City at Age 15	-0.0041	-0.0064	0.0015	-0.0011
	(0.0373)	(0.0299)	(0.0385)	(0.0301)
Lived in a Metropolis at Age 15	-0.0031	-0.0100	-0.0021	-0.0088
	(0.0316)	(0.0243)	(0.0309)	(0.0245)
2nd Year	-0.0039	0.0083	0.0001	0.0174
	(0.0312)	(0.0245)	(0.0317)	(0.0247)
3rd Year	-0.0123	0.0076	-0.0096	0.0136
	(0.0353)	(0.0316)	(0.0368)	(0.0318)
No Previous Participation in	-0.0822**	-0.0953***	-0.0858**	-0.1000***
Experiments	(0.0386)	(0.0315)	(0.0386)	(0.0317)
Constant	-0.2837	2.4053	-0.3530	2.5714
	(0.9138)	(1.6854)	(0.9749)	(1.6751)
Observations	4504	4504	4504	4504
Number of group(session subject)	120	120	120	120
σ_u	0.1186***	0.0934	0.1206***	0.0942
	(0.0101)		(0.0099)	
σ_e	0.3037***	0.2395	0.3041***	0.2398
	(0.0040)		(0.0040)	
ρ	0.1322***	0.1319	0.1358***	0.1336
	(0.0198)		(0.0195)	
LR Test for $\sigma_u = 0$	230.80***		247.60***	

Left censored observations	444	444
Uncensored observations	3360	3360
Right censored observations	700	700

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

ρ denotes the fraction of total variance due to the time invariant component of the error term.

Table 6: Random Effect Probit Regressions for Repayment and Choice of Non-Verifiable Project (R)

	Repayment	Non-Verifiable Project Choice
1/t	-0.0293	0.3701**
	(0.1719)	(0.1883)
1/t × GROUP	-0.2123	-1.3024***
	(0.2047)	(0.2244)
Simultaneous Lending Treatment (Dummy)	0.4639***	0.8871***
	(0.0892)	(0.1590)
Sequential Lending Treatment (Dummy)	0.6241***	0.7471***
	(0.0871)	(0.1537)
Session at Jadavpur University	-0.0473	-0.2414*
	(0.0799)	(0.1428)
Proportion of Correct Answer in Quiz	-0.4500**	1.3297***
	(0.2111)	(0.3826)
Age of Subject	-0.0189	0.1223
	(0.2461)	(0.4409)
Square of Age of Subject	0.0007	-0.0037
	(0.0057)	(0.0102)
Female	0.1173*	-0.2287*
	(0.0700)	(0.1274)
Business/Economics/Commerce Major	0.0046	0.0491
	(0.0734)	(0.1339)
Lived in a Suburb at Age 15	-0.0226	-0.1576
	(0.1045)	(0.1880)
Lived in a Large City at Age 15	-0.1513	0.1259
	(0.1065)	(0.1963)
Lived in a Metropolis at Age 15	0.0050	-0.0798
	(0.0867)	(0.1579)
2^{nd} Year	-0.2072**	0.1935
	(0.0848)	(0.1557)
3^{rd} Year	-0.1491	0.1749
	(0.0973)	(0.1763)
No Previous Participation in Experiments	0.0901	-0.2950
	(0.1060)	(0.1956)
Constant	0.4057	-1.2075
	(2.6438)	(4.7432)
Observations	6532	6532
Number of group(session subject)	168	168
σ_u	0.3734***	0.7226***
	(0.0280)	(0.0510)
ρ	0.1224***	0.3430***
	(0.0161)	(0.0318)
LR Test for $\rho = 0$	259.23***	825.31***
Equality of Treatment Effects	3.83**	0.87

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 1: Reaction Functions in Simultaneous lending. Note that reaction functions intersect in two places (at (0, 0) and at (1, 1)), which leads to multiple equilibria.

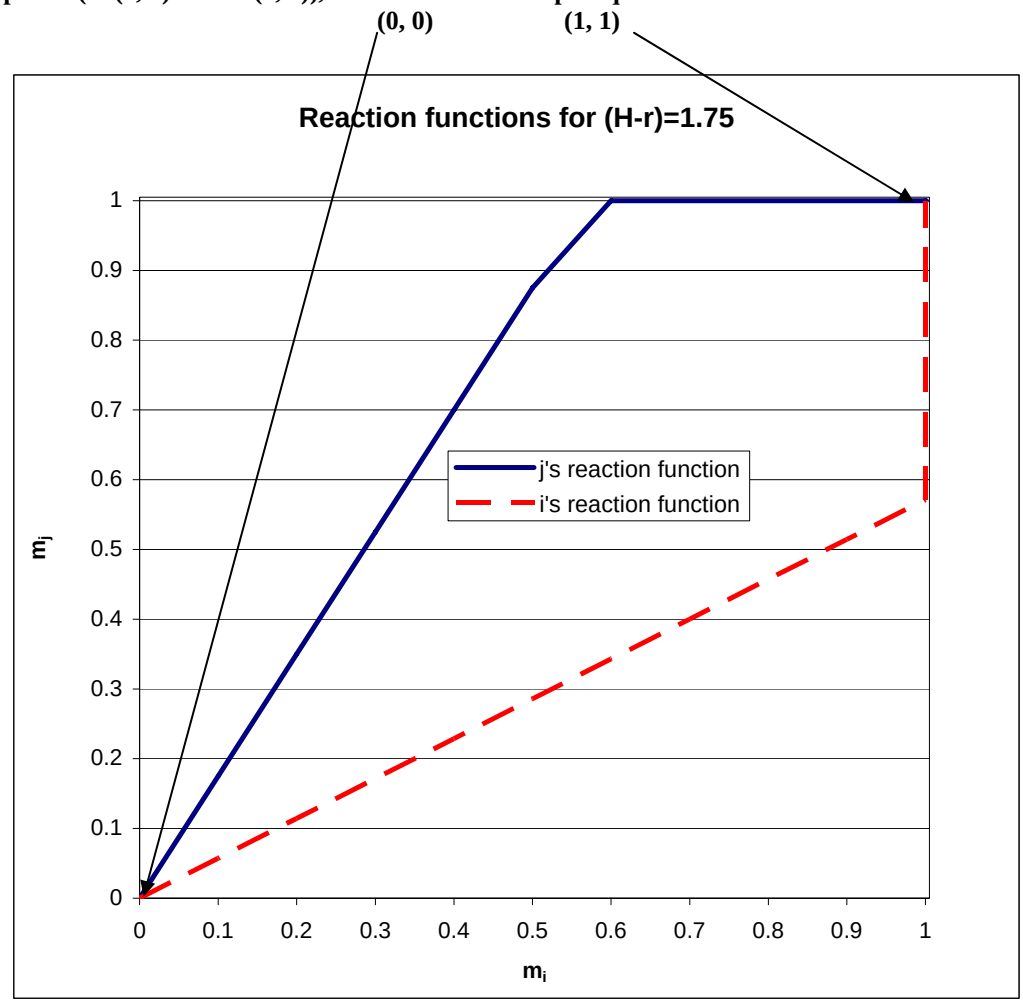


Figure 2: Average Proportion Making Loan, by treatment

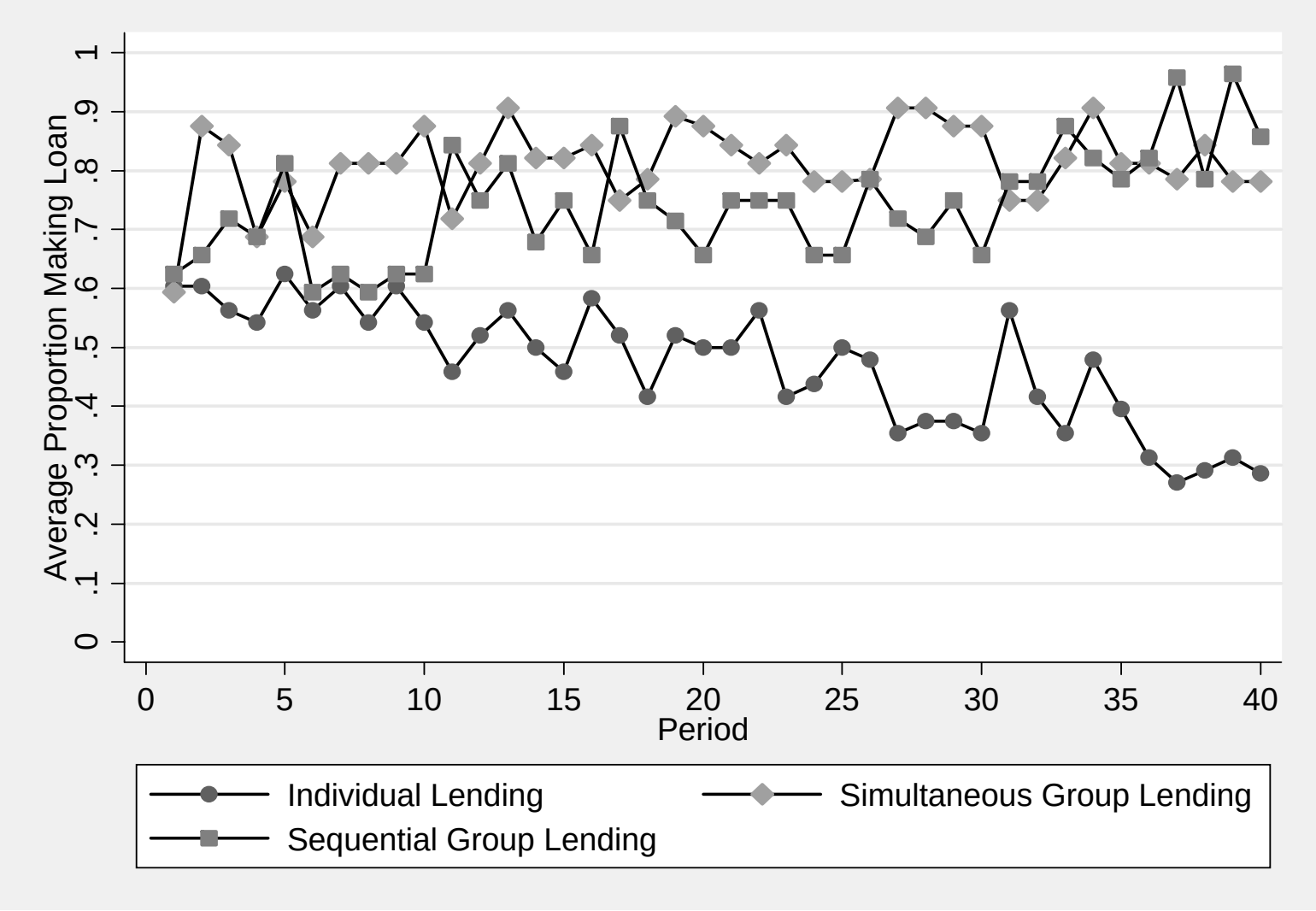


Figure 3: Average Monitoring Level, by Treatment

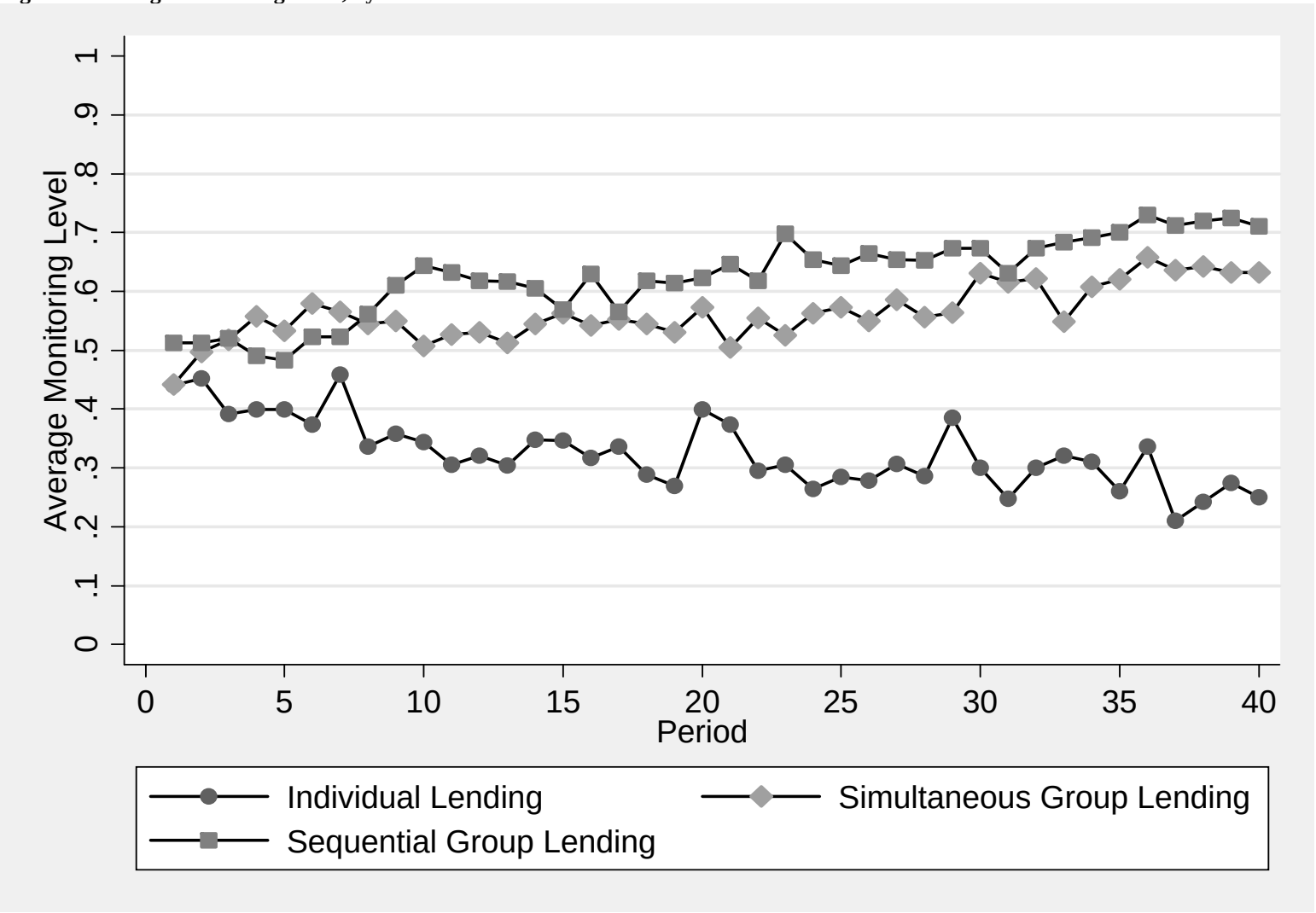
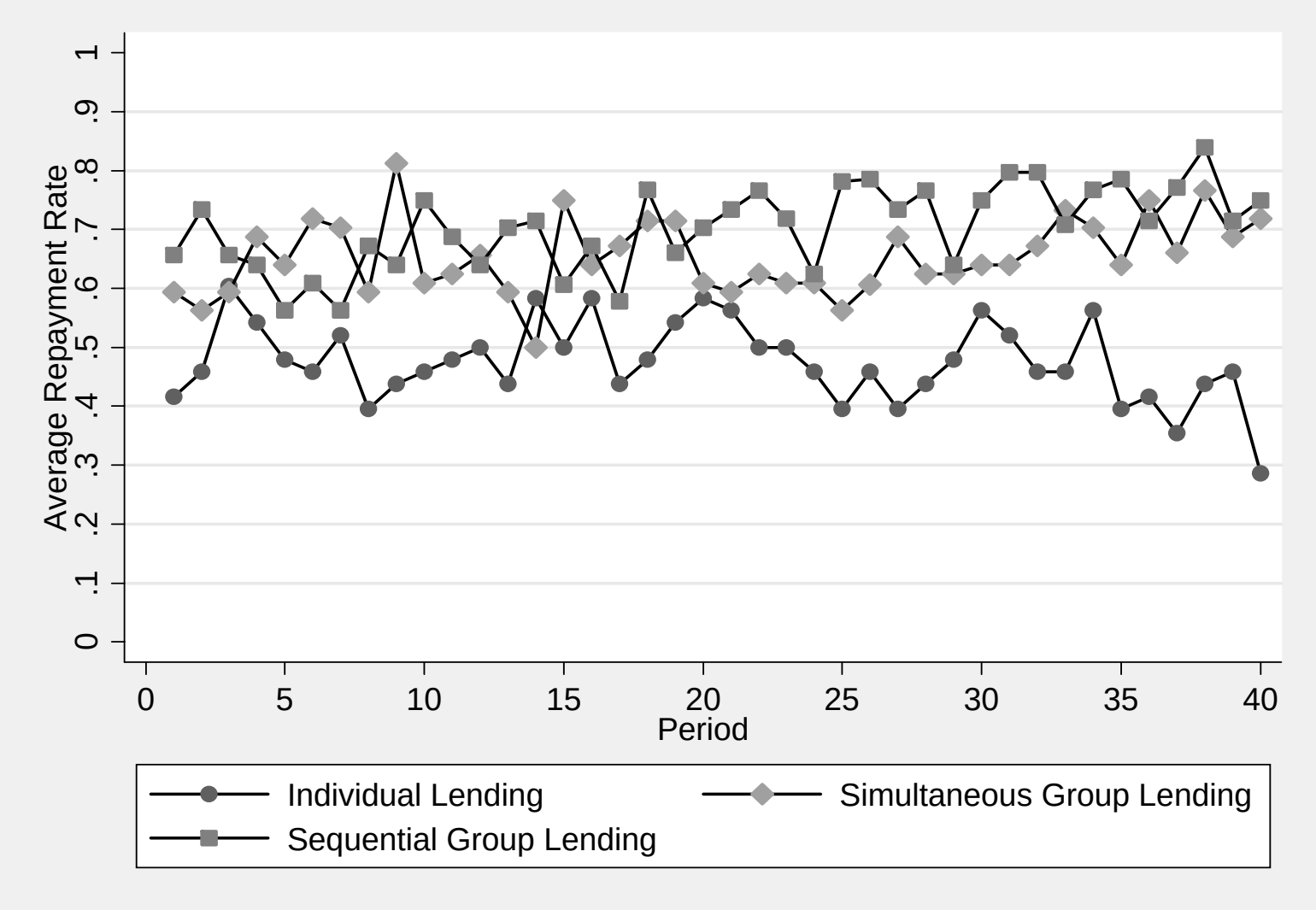


Figure 4: Repayment Rate, by Treatment



Instructions

General:

This is an experiment in the economics of decision-making. The instructions are simple and if you follow them carefully and make good decisions you will earn money that will be paid to you privately in cash at the end of the experimental session. Your earnings will be in experimental dollars and they will be converted into real dollars at the following rate: 1 Experimental Dollar = ____ Real Dollars. Notice that you earn more money by earning more experimental dollars.

After we finish reading the instructions and before we start the experiment, we would like you to answer a set of questions relating to these instructions. You will be paid in cash (at the end of the experiment, in addition to your earnings from the actual experiment) at the rate of $0.50 for each correct answer.

In today's experiment, you will be randomly divided into groups and each group will have three members. Each group consists of one lender and two borrowers. Your role—either borrower or lender—is determined randomly and will remain unchanged throughout the experiment. At the end of every period, participants will be randomly re-matched and so the other people in your group will typically change each period. You will make decisions for 40 periods.

Decision Making:

Two projects are available to each borrower every period: project S and project R. The cost of each project is $1 and it is to be financed by a loan from the lender.

Every period the lender can choose whether or not to invest her $2 into making loans to the borrowers. She must either make the loan to both borrowers or to neither borrower, and she cannot make a loan to a single borrower. If the lender chooses not to invest in the loans to the borrowers, she earns $1.50 for the period.

If the borrowers receive the loans, they can monitor the project choice of the other borrower in their group by choosing to pay a monitoring cost (C). Both borrowers can monitor each other. If borrower X incurs a cost C on monitoring, there is a chance of M that the other borrower Y will automatically be required to choose project S. Otherwise the other borrower can choose either project S or project R. Choices will be made simultaneously and the borrowers will not know whether the lender chooses to make the loans or not before making their choice of project. All decisions will be revealed after both the lender and the borrowers have made their decisions. Borrowers pay their selected monitoring costs whenever the lender makes the loan, regardless of whether or not the monitoring is successful.

The monitoring chances work in the following way. Suppose borrower X chooses M = 20%. In this case, imagine an urn (or the bingo cage the experimenter is holding) containing 10 total balls: 2 white balls and 8 red balls. One ball is drawn from this

imaginary urn, and if we draw a white ball then a borrower Y choice of R is switched to S; if we draw a red ball then a borrower Y choice of R remains R. If borrower Y chose S, then this choice of S is implemented regardless of the ball draw. Remember, borrower Y also makes monitoring choices in the same way to possibly switch borrower X choices from R to S.

To take another example, suppose borrower Y chooses M = 70%. In this case you should imagine an urn containing 7 white balls and 3 red balls. Again, a drawn white ball switches a borrower X choice of R to S, but a drawn red ball means that a borrower X choice of R remains R. Therefore, a higher choice of M, which is more costly as shown in the table below, increases the chances that the other borrower's choice of R is switched to S. A different ball draw, from a different imaginary urn, is conducted for every different group and borrower for every different period in the experiment. In other words, the random draws are all independent.

The relationship between C and M is as follows:

Monitoring Cost (C)	**M**	**Interpretation of M percentage:**
\$0.000	0%	Switch a borrower choice of R to S 0 out of 10 times
\$0.005	10%	Switch a borrower choice of R to S 1 out of 10 times on average
\$0.020	20%	Switch a borrower choice of R to S 2 out of 10 times on average
\$0.045	30%	Switch a borrower choice of R to S 3 out of 10 times on average
\$0.080	40%	Switch a borrower choice of R to S 4 out of 10 times on average
\$0.125	50%	Switch a borrower choice of R to S 5 out of 10 times on average
\$0.180	60%	Switch a borrower choice of R to S 6 out of 10 times on average
\$0.245	70%	Switch a borrower choice of R to S 7 out of 10 times on average
\$0.320	80%	Switch a borrower choice of R to S 8 out of 10 times on average
\$0.405	90%	Switch a borrower choice of R to S 9 out of 10 times on average
\$0.500	100%	Switch a borrower choice of R to S 10 out of 10 times

Earnings:

If they receive the loan, the earnings of the borrowers depend on the project choices made by the two borrowers and on the monitoring costs the two borrowers choose to incur. If the lender decides to make the loan, her earnings depend on the actual project choices made by the two borrowers. If she chooses not to invest in the loans to the borrowers, her money is allocated to a savings account and she earns \$1.50 for the period.

The earnings of the two borrowers and the lender in the different project scenarios are as follows. Here C_1 and C_2 denote the monitoring costs incurred by borrower 1 and 2 respectively.

Actual project choice of borrower 1	**Actual project choice of borrower 2**	**Earnings of borrower 1**	**Earnings of borrower 2**	**Earnings of lender**
S	S	$\$1.75 - C_1$	$\$1.75 - C_2$	\$2.50

S	R	\$0.00 – C_1	\$2.50 – C_2	\$2.00
R	S	\$2.50 – C_1	\$0.00 – C_2	\$2.00
R	R	\$2.50 – C_1	\$2.50 – C_2	-\$2.00
No loan is provided		\$0.00	\$0.00	\$1.50

Each borrower can increase the chances of the other choosing project S by investing in monitoring. Monitoring choices will have to be made simultaneously and before each borrower knows whether the lender actually makes the loan.

Examples:

Consider the following examples, which were chosen randomly and are not meant to suggest any particular decisions.

Example # 1:
1. Lender makes the loan.
2. Borrower 1 chooses project S and monitoring M of 70%. Monitoring cost C_1 = \$0.245.
3. Borrower 2 chooses project R and monitoring M of 30%. Monitoring cost C_2 = \$0.045
4. Monitoring results: Borrower 1's monitoring is unsuccessful and so borrower 2's actual project is project R. Borrower 2's monitoring is also unsuccessful, but borrower 1 already chose project S, and so his actual choice remains project S.
5. Earnings: Use the second row of the previous table to determine borrower 1's earning = \$(0.00 – 0.245) = –\$ 0.245; borrower 2's earning = \$(2.50 – 0.045) = \$2.445; and lender earning = \$2.00

Example # 2:
1. Lender makes the loan.
2. Borrower 1 chooses project R and monitoring M of 80%. Monitoring cost C_1 = \$0.320.
3. Borrower 2 chooses project S and monitoring M of 50%. Monitoring cost C_2 = \$0.125.
4. Monitoring results: Borrower 1's monitoring is successful, but borrower 2 already chose project S and so his actual project choice remains project S. Borrower 2's monitoring is also successful and this switches borrower 1's actual project choice to S.
5. Earnings: Use the first row of the previous table to determine borrower 1's earning = \$(1.75 – 0.320) = \$1.430; borrower 2's earning = \$(1.75 – 0.125) = \$1.625; and lender earning = \$2.50.

Summary of Decisions to be taken:
Lender:
1. In every period choose how you want to invest your \$2, using a decision screen shown in Figure 1.

Borrowers:

1. Indicate how much you wish to invest in monitoring the other borrower to possibly switch him or her to project S, as shown in Figure 2, in case you receive the loans.
2. Decide whether you want to invest in project S or project R, using a decision screen shown in Figure 3. Remember that if the other borrower chooses to incur a monitoring cost (shown as *other's C* on the figure), there is a chance of M that your project choice will be switched to S, even if you had actually chosen R.

Remember that choices are made simultaneously and the borrowers do not know whether the lender chose to invest in the loans or not before making their choices of a project. Once both the lender and the borrowers have made their decisions, the information shown in Figure 4 will be provided to all of the participants in the group:

- Borrower's project choices
- Did the lender choose to make the loan
- Borrower's monitoring level, if the lender chose to make the loan
- Actual projects chosen by the borrower, if the lender chose to make the loan
- Lender earnings
- Borrower earnings
- Your cumulative earnings over the experiment

Attached to these instructions is a record sheet where you are required to record your earnings and other details from every period.

Are there any questions before we start the experiment?

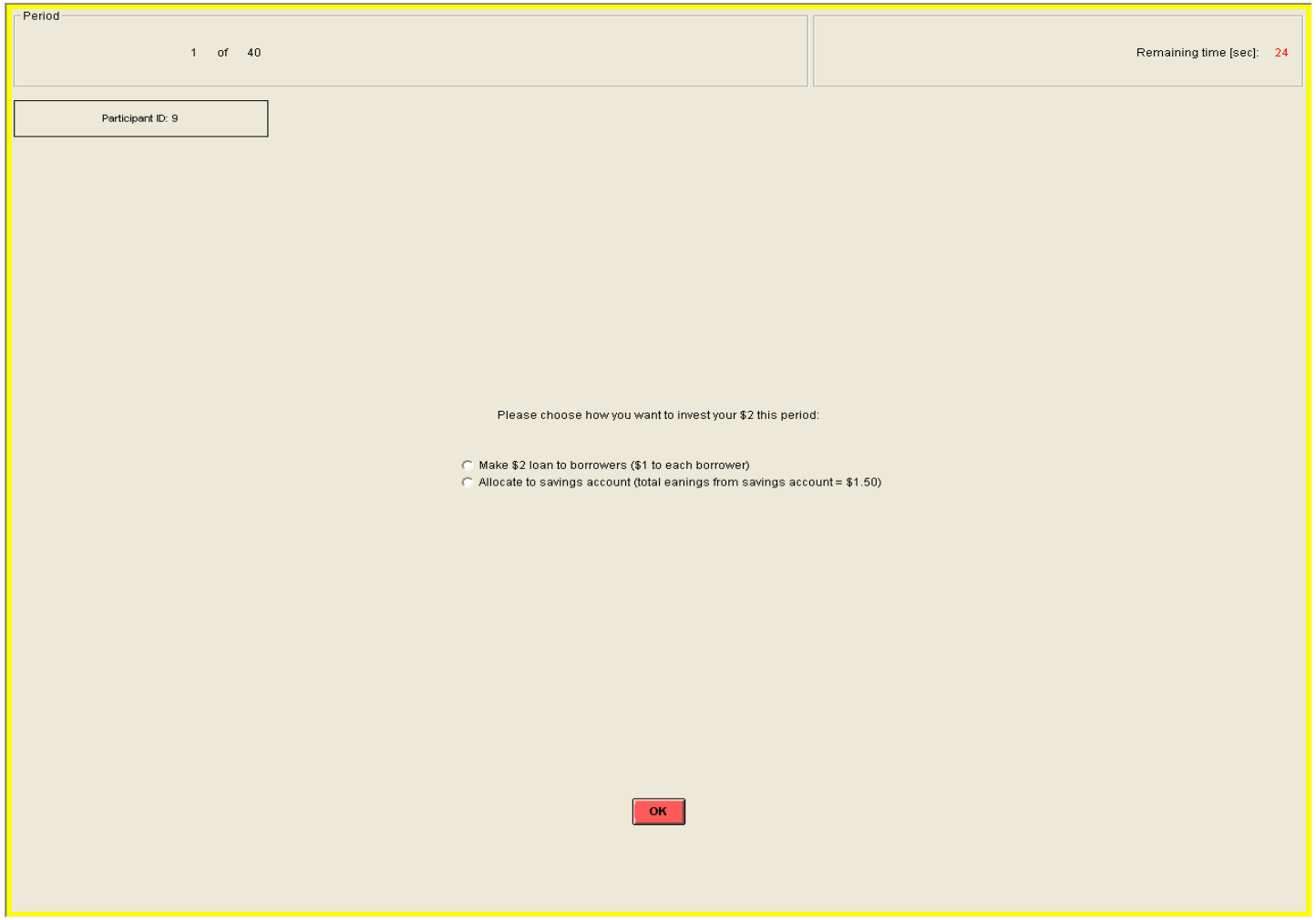


Figure 1: Lender's loan decision screen

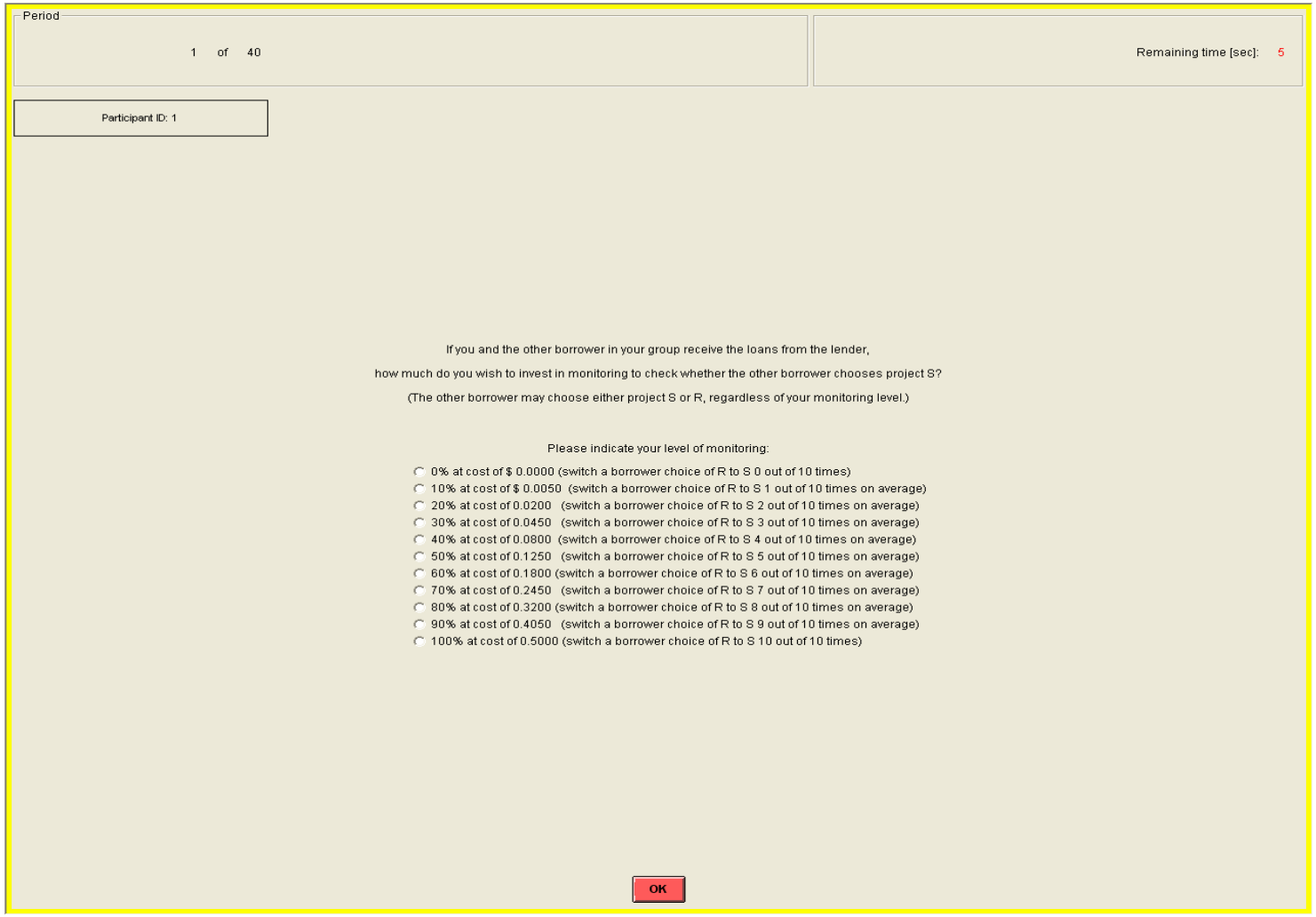


Figure 2: Borrower's monitoring decision screen

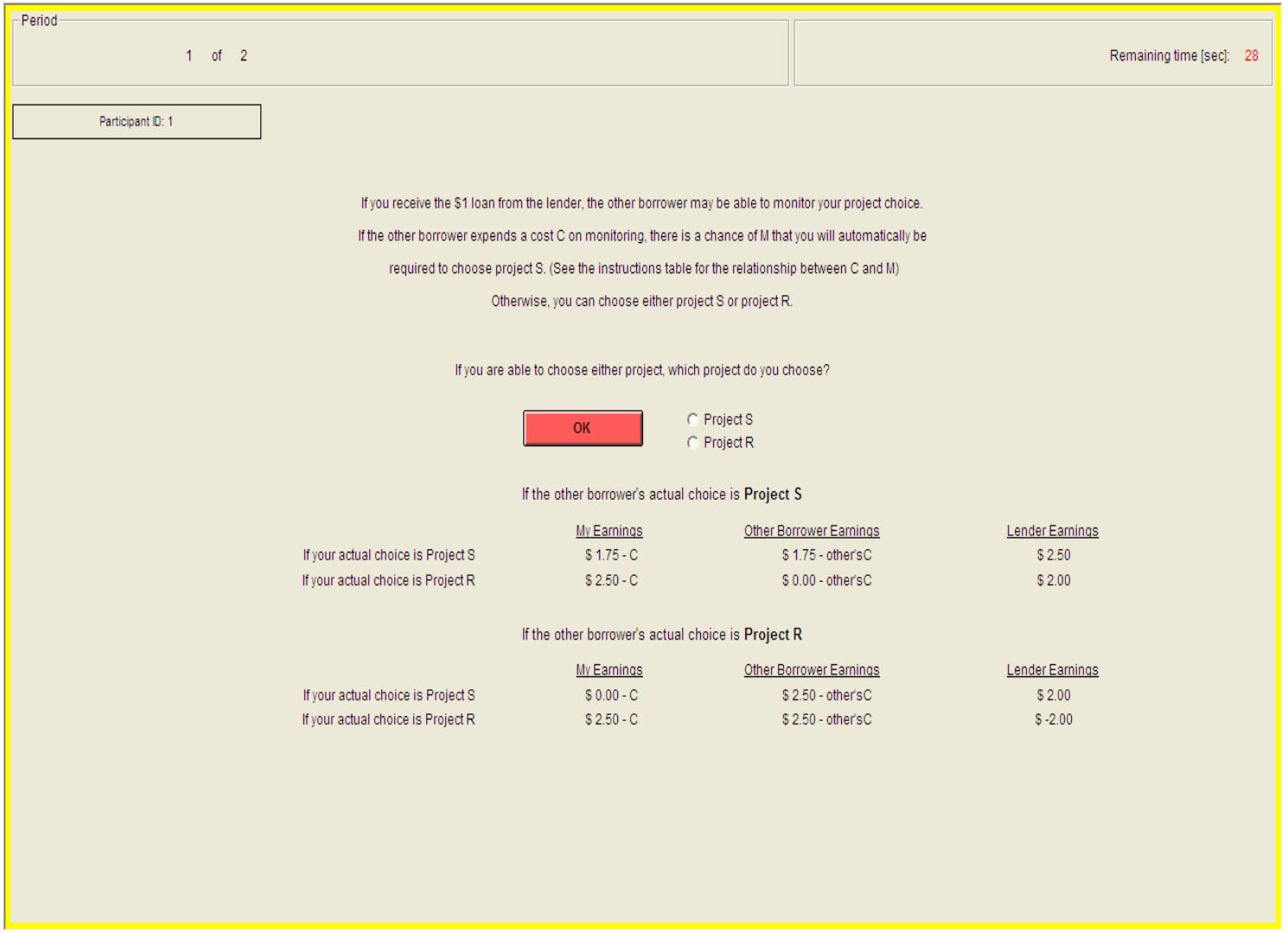


Figure 3: Borrower's project decision screen

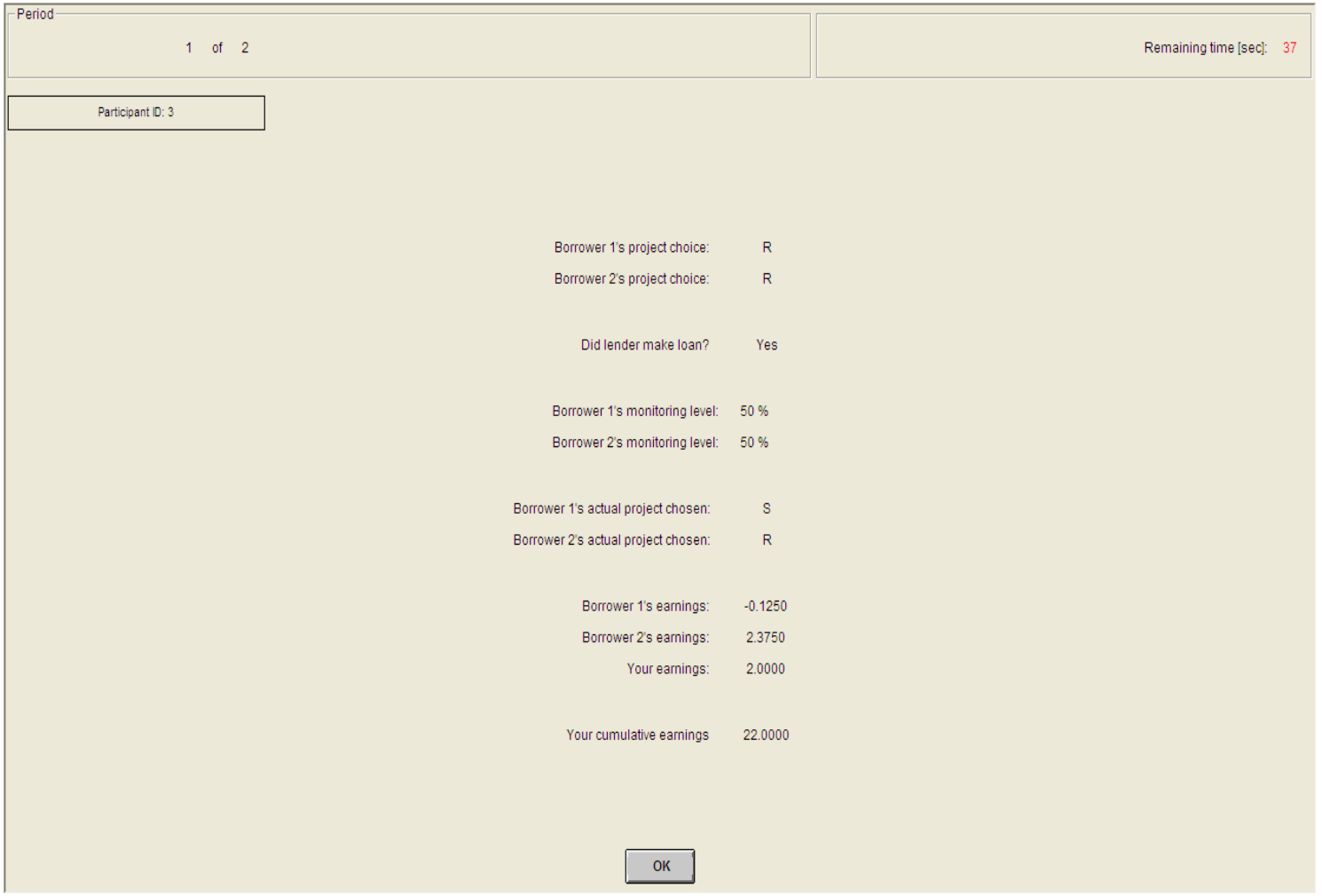


Figure 4: Example output screen

Quiz

Participant ID: _____

Total Number of Correct Answers:

Earnings: Total Number of Correct Answers × $0.50 =

Record Sheet

Participant ID: _____

Period	Borrower 1's Project Choice (circle one)	Borrower 2's Project Choice (circle one)	Did you make Loan? (circle one)	Borrower 1's Monitoring Level	Borrower 2's Monitoring Level	Borrower 1's Actual Project (circle one)	Borrower 2's Actual Project	Your Earnings	Borrower 1's Earnings	Borrower 2's Earnings	Your Cumulative Earnings
1	S R	S R	Yes No			S R NA	S R NA				
2	S R	S R	Yes No			S R NA	S R NA				
3	S R	S R	Yes No			S R NA	S R NA				
4	S R	S R	Yes No			S R NA	S R NA				
5	S R	S R	Yes No			S R NA	S R NA				
6	S R	S R	Yes No			S R NA	S R NA				
7	S R	S R	Yes No			S R NA	S R NA				
8	S R	S R	Yes No			S R NA	S R NA				
9	S R	S R	Yes No			S R NA	S R NA				
10	S R	S R	Yes No			S R NA	S R NA				
11	S R	S R	Yes No			S R NA	S R NA				
12	S R	S R	Yes No			S R NA	S R NA				
13	S R	S R	Yes No			S R NA	S R NA				
14	S R	S R	Yes No			S R NA	S R NA				

Period	Borrower 1's Project Choice (circle one)	Borrower 2's Project Choice (circle one)	Did you make Loan? (circle one)	Borrower 1's Monitoring Level	Borrower 2's Monitoring Level	Borrower 1's Actual Project (circle one)	Borrower 2's Actual Project	Your Earnings	Borrower 1's Earnings	Borrower 2's Earnings	Your Cumulative Earnings
15	S R	S R	Yes No			S R NA	S R NA				
16	S R	S R	Yes No			S R NA	S R NA				
17	S R	S R	Yes No			S R NA	S R NA				
18	S R	S R	Yes No			S R NA	S R NA				
19	S R	S R	Yes No			S R NA	S R NA				
20	S R	S R	Yes No			S R NA	S R NA				
21	S R	S R	Yes No			S R NA	S R NA				
22	S R	S R	Yes No			S R NA	S R NA				
23	S R	S R	Yes No			S R NA	S R NA				
24	S R	S R	Yes No			S R NA	S R NA				
25	S R	S R	Yes No			S R NA	S R NA				
26	S R	S R	Yes No			S R NA	S R NA				
27	S R	S R	Yes No			S R NA	S R NA				
28	S R	S R	Yes No			S R NA	S R NA				
29	S R	S R	Yes No			S R NA	S R NA				
30	S R	S R	Yes No			S R NA	S R NA				

Period	Borrower 1's Project Choice (circle one)	Borrower 2's Project Choice (circle one)	Did you make Loan? (circle one)	Borrower 1's Monitoring Level	Borrower 2's Monitoring Level	Borrower 1's Actual Project (circle one)	Borrower 2's Actual Project	Your Earnings	Borrower 1's Earnings	Borrower 2's Earnings	Your Cumulative Earnings
31	S R	S R	Yes No			S R NA	S R NA				
32	S R	S R	Yes No			S R NA	S R NA				
33	S R	S R	Yes No			S R NA	S R NA				
34	S R	S R	Yes No			S R NA	S R NA				
35	S R	S R	Yes No			S R NA	S R NA				
36	S R	S R	Yes No			S R NA	S R NA				
37	S R	S R	Yes No			S R NA	S R NA				
38	S R	S R	Yes No			S R NA	S R NA				
39	S R	S R	Yes No			S R NA	S R NA				
40	S R	S R	Yes No			S R NA	S R NA				