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The Applicability of Micro Finance to Higher Risk Business Ventures: An Experimental Study

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Abstract: This paper reports the results of a micro finance lab experiment that seeks first to replicate the difference in loan repayment rates between groups composed of high vs. low risk borrowers, and then to test a mechanism we propose to make micro finance work better for high risk borrowers. The mechanism involves revenue sharing among members of a borrowing group, above and beyond usual repayment bailouts that successful members can choose to make on behalf of unsuccessful members. Revenue sharing makes repayment of the total group loan optimal under more business outcome states, and thus increases the expected benefit of repaying the current loan to qualify for future ones. We compare loan repayment rates between high and low risk borrowing groups, with and without the option of entering into binding ex ante agreements to revenue share. For high risk borrowers, we further test the effect of allowing them to renege on revenue sharing agreements once individual business outcomes are known. We are able to capture the result that loan repayment rates are lower for higher risk borrowers than for lower risk borrowers. We also find that introducing the option of binding revenue sharing agreements modestly but significantly increases loan repayment rates. Most of this gain is lost, however, when successful individuals can renege on commitments to revenue share after learning individual business outcomes.

Keywords: Micro finance; Revenue sharing; Profit sharing; Risk

JEL Classifications: G21; O16; O17; O43

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I. Introduction

First advocated by Muhammad Yunus in the 1970's, microcredit has seen enormous growth as a means of lending to low income people in developing countries. Microfinance organisations such as the Grameen Bank in Bangladesh, Women's World Banking, Unitus, Opportunity International and others are estimated to have reached between 150 and 200 million borrowers (Banerjee and Duflo 2011, p. 166), with numbers continuing to climb rapidly. While the exact rules and objectives of microcredit vary greatly across countries and organisation, its principal objective has been to secure credit for low income people whom commercial banks will not serve, at interest rates far below what private money lenders would charge.

Much of the genius of microcredit lies in its ability to transfer the costs of information gathering regarding the credit worthiness of small scale borrowers from lending organisation to the borrowers themselves. Individuals who seek loans for consumption or to start or expand businesses can form borrowing groups with others they know, and be jointly liable as a group for regular repayment of an aggregate loan. Groups who successfully repay one loan are eligible to receive future loans, again at interest rates far lower than they could access individually. Borrowing groups are often required to meet and make repayment regularly. They thus keep informed about each other's progress and can support each other; successful members can bail out unsuccessful members on a temporary basis if they judge the reason for repayment shortfalls to be legitimate (exogenous). For their part, microfinance organisations need only ensure that approved borrowing groups repay an aggregate amount on schedule, greatly reducing the costs of due diligence and monitoring, and spreading the fixed costs of lending over fewer, larger aggregate loans. The benefit of microcredit is particularly large in societies where conventional lenders cannot rely on courts or other third parties to enforce repayment contracts. Contract enforcement relies instead on the social pressure and social norms for repayment that are fostered within borrowing groups, combined with pecuniary incentives for future loan eligibility.

Microfinance has been extensively described and analyzed in the development literature, both for its effects on low income borrowers, and causal explanations for those effects. Examples include the survey articles by Morduch (1999) and Brau and Woller (2004), a symposium on microcredit summarized by Hermes and Lensink (2011), and rigorous programme evaluations by Karlan and Zinman (2011), Angelucci, Karlan and Zinman (2015), Attanasio et al. (2015), Augsburg et al. (2015), Banerjee, et al. (2015), Crépon et al. (2015) and Tarozzi, Desai, and Johnson (2015).

One limitation of microcredit noted by Banerjee and Duflo (2011) has been its limited uptake by higher risk borrowers. For example, from surveys of slum neighbourhoods of Hyderabad India, Banerjee and Duflo (2011) found that even in areas with three or more microfinance institutions offering credit, only about one fourth of families borrowed from them, while more than one half borrowed instead from money lenders. Reflecting on these findings, Banerjee and Duflo (2011) identify a tension between 'the spirit of microcredit' and 'true entrepreneurship.' The joint liability, rigid repayment rules and social norm of 'zero default' may work against those needing credit whose business ideas involve more than negligible risk.

In this paper, we first propose a revenue sharing mechanism that could be added to group liability microcredit to increase its attractiveness to higher risk business borrowers, and the microfinance organisations who lend to them. We then design and implement a lab experiment to see if we can first replicate the limitations of microcredit for higher risk borrowers noted by Banerjee and Duflo, and test our revenue sharing mechanism.

Our proposal is to add an option within a borrowing group for each member to commit at the outset to share a fraction of their business revenues (net of all costs but loan repayment) with each of the other borrowing group members, whether they turned out to be high or low. If honoured after business outcomes are realized, revenue sharing would increase the amount that less successful members could then repay towards the loan, reducing the shortfall that more successful members would have to make up on their behalf. Facing downward adjusted revenues before loan repayment, more successful members would also face less incentive to keep all current revenue, and so abandon loan repayment and forfeit access to future loans. We demonstrate that such revenue sharing can create a "virtuous circle", whereby the aggregate loan will be repaid under more business venture outcome states. Increasing the number of states under which the group loan will be repaid in later periods creates greater incentives to ensure loan repayment in earlier periods, even without initially requiring the 'close commitment' of revenue sharing between borrowing group members. These benefits could unravel, however, if borrowers could renege on revenue sharing commitments after learning how their individual businesses have fared.

In our corresponding lab experiment, we find treatment effects consistent with our theory. Loan repayment rates are indeed lower among (full information) borrowing groups comprised of high risk rather than low risk borrowers. We next find that higher risk borrowers achieve significantly higher loan repayment rates when revenue sharing is made an option for later borrowing periods. Sadly however, much of this increase in loan repayment rates for higher risk

borrowers is lost when they gain the option to renege on revenue sharing agreements once business outcomes are realized.

The remainder of the paper is structured as follows. In Section 2 we provide a review of papers using experimental methods to improve the design of microcredit. In Section 3 we provide a simple game theoretic description of the loan repayment incentives of high and low risk borrowing groups, and how revenue sharing can change these, or not change them when commitments can be broken. In Section 4 we describe our experimental design, while Section 5 provides our results. In Section 6 we draw some conclusions from our findings.

II. Lab Experiments in Microcredit Design

While we are not aware of any proposals or experimental investigations of using revenue sharing in microcredit schemes, a number of researchers have used lab or field experiments to compare the performance of microcredit under different rules. More generally, group liability loan repayment can be thought of as a type of threshold public good (Bagnoli and Lipman 1989, Croson and Marks 2000), for which there is an extensive experimental literature (see, for example, Marks and Croson (1998) and Cadsby and Maines (1999)). We shall focus here, however, on experiments designed with microcredit in mind, and present these chronologically. Most focus on using group vs. more conventional individual liability for loans, but the implementations of microcredit also vary between papers.

Abbink, Irlenbusch and Renner (2006a) examine the effects of group size and social ties on group repayment rates, and also group vs. individual liability. For group liability, Abbink et al. ask subjects whether they would like to contribute to a group payment, structured as follows. For successful repayment, a group must raise n*420/2, where group size n is varied across treatments between two, four and eight. Subjects begin by rolling a die 10 times to determine a series of random numbers, which they assign to 10 rounds on their payoff sheets. In each round subjects choose whether or not to contribute, before the die is rolled afresh. If the role matches the number already entered on a subject's payoff sheet, he or she receives 420, and 0 otherwise. If, prior to learning outcomes, at least half of the group agrees to contribute the n*420/2, to be divided equally between all those who both agree to pay *ex ante* and earn 420 *ex post*, repayment occurs, and the group qualifies for another round. Thus, the more members who commit to contribute *ex ante*, and the more of those who earn 420, the less each has to pay. Payment is subtracted from the 420 received. If a group raises the required money they continue to another round, but otherwise the game is over for that group, and they must wait out the balance of the 10 rounds. Along with varying group size over three treatments, Abbink et al. include a fourth treatment where subjects in

groups of size 4 already knew each other. They also compare equivalent repayment rates for individuals.

Abbink et al. find that group liability outperforms individual liability, and that intermediate or smaller group size helped, while stronger pre-existing social ties made little difference. In round 1 individual 'yes' choices ranged from 81.3% in the largest groups to 98.1% in the intermediate groups of 4 who knew each other. Over periods, 'yes' payment choices remained generally high at around 80%, dropping off after round 8 for most treatments, but slightly earlier for the largest groups. Average rounds of successful payment ranged from 5.1 for the largest groups, to 7.0 for both types of 4 person group, to 7.5 for the smallest.

In a related paper, Abbink, Irlenbusch and Renner (2006b) also investigate the effect on group repayment of variations in the implicit interest rate charged. The authors find that a higher repayment burden intensifies free riding within groups, though this is offset by the reduced capacity of groups to "afford" free riding before repayment collapses.

A working paper by Seddiki and Ayedi (2005) use a framework somewhat like Abbink et al. (2006a), but use private information on investment outcomes, and in some treatments allow borrowers to investigate another's investment outcome, and punish free riders if repayment would have been possible. Seddiki and Ayedi differ in their design also by varying the revenues generated by each project, and the repayment required. These authors allow borrowers to decide on loan repayment after they know the value of their projects. Repayment can be zero, the amount borrowed, or twice the amount borrowed. Seddiki and Ayedi also increase loan size over rounds to simulate lenders increasing loans to serious borrowers. A drawback for Seddiki and Ayedi when testing the effect of punishment was that repayment rates were already quite high without punishment compared to what would be predicted using backward induction from the final round, just as they were for Abbink et al. (2006a). The investigation/punishment option raised loan repayment rates from roughly 70% to 74%, and groups continued repayment to between 6 and 7 rounds out of a maximum of 8.

More recently, Cason, Gangadharan and Maitra (2012) use a broader lab implementation of microcredit, testing theories originated by Chowdhury (2005) and Ghatak and Guinnane (1999) to vary several conditions. Here decisions are made by both microfinance lenders and single or group borrowers. To capture the moral hazard of repayment, borrowers can choose between an investment with a larger return that is verifiable by monitoring, and so liable for loan repayment, and a hidden investment with a smaller return that is not externally verifiable, and not claimable for

loan repayment. In group liability treatments, a borrower within a two person group can pay to "monitor" the other, implemented as creating a probability that the other borrower will be forced to choose the safe investment. Cason et al. compare group and individual loan liability, and for groups vary whether loan repayment contributions are made simultaneously or sequentially. They also vary the cost of monitoring the other borrower. In group treatments, subjects are randomly re-matched with others and continue for 40 rounds. Cason et al. find that group and individual loan liability works equally well when the cost of monitoring borrower behaviour is equivalent, but that group liability dominates when groups can monitor borrower behaviour more cheaply than lenders.

An even more ambitious evaluation of microfinance liability design has been made by Fischer (2013). Using women participants forwarded by microfinance organisations, Fischer compares repayment behaviour in treatments that gradually increase the interaction between pairs of borrowers who must each decide between safer and riskier investments before loan repayment. Interaction ranges from "autarky" (complete individual liability), to autarky plus the ability to make voluntary income transfers to the second person, to making continuation for either person contingent on both repaying W/2, to allowing borrowers to force the other person to adopt riskless investments, to enforcing equalized earnings with voluntary transfers still allowed. Fischer (2013) further compares outcomes under full and private information as to a partner's investment choices and outcomes. With a probabilistic stopping rule, Fischer finds low loan default rates across all treatments, ranging from 4.7% under autarky, to 0% under enforced equalisation. Voluntary transfers between borrowers were higher under private information than under full information.

Moving away from issues of liability design, Baland, Gangadharan, Maitra and Somanathan (2013) investigate the extent to which microcredit loan repayment incentives benefit from borrowing groups being able to exclude errant repayment free riders from associated public goods. They find that degree of gain from associated public goods provided by borrowing groups do indeed explain variation in individual decisions to contribute to loan repayment.

We turn now to examine more formally the predicted effects that optional revenue sharing could be expected to make on repayment rates in group liability microcredit schemes. For this initial foray, we assume full information between members of borrowing groups.

III. Theory

We consider i = 1,..,3 individual borrowers who each require a loan to fund their business ventures. Each borrower is risk neutral, and runs his or her business independently of the others.

Each business will generate high net benefits $b_{i,H}$ with probability p, or low net benefits $b_{i,L}$ with probability (1-p). We assume that an individual can afford to repay his or her single loan if earnings are b_{iH}, but not if they are $b_{i,L}$.

Under microcredit group liability, the group must pay back a combined amount W, the equivalent of three individual loans. Again, we assume individual earnings in the high (b_{iH}) and low ($b_{i,L}$) cases are sufficiently high relative to W that the group could repay the total loan if even one member earns b_{iH}. This would require successful borrowers to 'bail out' less successful borrowers. If W is repaid by the group in period t, the group would be eligible for another round of business activity at a favourable interest rate in t+1, and so on up to a known terminus T. If W is not repaid, each borrower retains b_i, (and any earnings from previous periods), but no further loans are made available. Since we will use 'stationary repetition' in our implementation, we assume borrowers can only use current period funds to repay the current period loan.

Differentiating between 'high risk' and 'low risk' borrowing groups can be done in several ways. Higher risk entrepreneurial borrowers might have a lower probability of generating high net benefits (a lower p_H) and generate a higher net benefit if they do succeed (a higher b_{iH}), but a lower net benefit if they do not (a lower b_{iL}). Intuitively, microcredit group liability would likely result in lower group loan repayment rates for higher risk borrowing groups, partly because cases where all borrowers 'fail' and cannot repay the loan is more likely than for low risk borrowing groups. In addition, in cases where some high risk borrowers do well, they would find the cost of bailing out repayment shortfalls of failed borrowers higher, and the revenue they could keep by refusing loan repayment would also be higher. These combined factors would lessen the appeal of bailing out others to qualify for additional loans.

To explore the incentives more formally, and to see how revenue sharing can improve loan repayment incentives, we introduce some additional structure and notation. For simplicity of exposition, we also move to the parameters used in the experiment. We define the revenue that borrower i can expect to earn from his/her group reaching period t as (π_{it}) , and the borrowers as Player 1, Player 2, and Player 3 (P1, P2, P3). We denote the business earnings outcome of the three borrowers as (HHH) if all earn high benefits, (LLL) if all earn low benefits, (HLL) if P1 succeeds while P2 and P3 fail, and so on. To keep predictions tractable and precise, we assume that a borrowing group must unanimously agree to a specific loan repayment rule for the overall loan to be repaid. The specific rule we use is that borrowers each pay $w_i = W/3$ if $b_i \geq W/3$ for i = 1, 2, 3. Otherwise, borrowers for whom $b_i < W/3$ repay what they can (b_i), while borrowers for whom $b_i > W/3$ make up the shortfall, symmetrically if there are two of them.

Table 1 Payoffs and Probabilities by Outcome

Outcome	Payoff	Probability
HHH	$b_{iH} - wC_{HHH}$	p^3
HHL or HLH	$b_{iH} - \left(w + \frac{w - b_L}{2}\right) C_{HHL}$	$2p^2(1-p)$
HLL	$b_{iH} - \left(w + 2(w - b_L)\right) C_{HLL}$	$p(1-p)^2$
LHH	$b_{iL} - b_{iL} C_{LHH}$	$p^2(1-p)$
LLH or LHL	$b_{iL} - b_{iL} C_{LLH}$	$2p(1-p)^2$
LLL	b_{iL}	$(1\text{-}p)^3$

III.1 Expected Payoffs

The incentives to pay back the loan depend on the net benefits of the three members of the group. There are eight possible cases of payoffs and probability which are enumerated in Table 1. Note that we use *c* as the indicator of whether an individual votes to repay the loan. Thus, we have a *c* for each individual in each of the eight possible business earning outcomes ($c_{ij} \in [0,1]$) where i indexes the individual and j the business earning outcome, and $c_{ij}=1$ in the case that individual i agrees to pay back the loan in state j and 0 if they do not. Recall that the decision to pay back the loan must be unanimous and so the payoff for each business earning outcome depends on the decisions of all three members of the group in that case. We denote this group outcome $C_j = \min(c_{ij})$, which will be equal to one if all of the members of the group vote to payback the loan, and zero otherwise.

Notice that in the LLL case the group cannot afford to pay back the loan and so each individual just receives his or her business earning outcome. This leads us to a one shot expected payoff function. It should be noted however, that this expected payoff function is from the point of view of an individual who is determining their strategy before they know the net benefits of their group. In our experiments subjects make their decisions with full information about the net benefits of themselves and the other two members of their group. That said, in any round, the business earning outcomes of future rounds are uncertain.

$$
\begin{aligned}
&E\left(\pi_i(c_i, c_j, c_k)\right) \\
&\quad = p^3(b_{iH} - wC_{HHH}) + 2p^2(1-p)\left(b_{iH} - \left(w + \frac{w - b_L}{2}\right) C_{HHL}\right) \\
&\quad + p(1-p)^2\left(b_{iH} - \left(w + 2(w - b_L)\right) C_{HLL}\right) + p^2(1-p)(b_{iL} - b_{iL} C_{LHH}) \qquad (1) \\
&\quad + 2p(1-p)^2(b_{iL} - b_{iL} C_{LLH}) + (1-p)^3(b_{iL})
\end{aligned}
$$

Note that group repayment outcome C always enters the expected payoff function negatively and so the solution to the one-shot game is that subjects should never vote to repay the loan. The incentive to repay the loan comes from the repeated nature of the game and the restriction that individuals only receive the loan in future periods if they have repaid all previous loans. In the experiment there is a final period (the sixth) where there is no incentive for individuals to repay the loan. Thus the expected payoff in period six is:

$$E(\pi_i(0)) = p^3(b_{iH}) + 2p^2(1-p)(b_{iH}) + p(1-p)^2(b_{iH}) + p^2(1-p)(b_{iL}) + 2p(1-p)^2(b_{iL}) + (1-p)^3(b_{iL}) \quad (2)$$

which is the expected payoff to not repaying the loan. Equilibria can be identified by backwards induction. In period 5 given the net benefits of the group a subject should vote to repay the loan if and only if the expected payoff to paying back the loan in the current period plus the expected payoff to not paying back the loan in period 6 exceeds the benefits from not paying back the period 5 loan:

$$E(\pi_{i5}(1)) + E(\pi_{i6}(0)) > E(\pi_{i5}(0)) \quad (3)$$

Equivalently this can be rewritten as:

$$E(\pi_{i5}(0)) - E(\pi_{i5}(1)) < E(\pi_{i6}(0)) \quad (4)$$

which says that the cost of repaying the loan in round 5 must be less than the expected benefit of receiving the loan in round 6. Thus the decision to repay the round 5 loan depends on the amount which must be repaid

As Table 1 shows the required payoff is highest for borrowers who receive the high benefit when the other two people in their group receive the low benefit, and lowest when the borrower receives the low benefit. Once we introduce the parameters in section 4 below we will be more concrete regarding the cases where we expect borrowers to repay the loan.

Notice that this condition (repay as long as the cost of current repayment is less than future expected payoffs from continuation) generalizes to earlier rounds. So in round 4 the required repayment must be less than the expected payoff of receiving the loan in round 5. The expected payoff of receiving the loan in round 5 depends on the borrowers' expectation of whether the loan will be repaid in round 5 so that a loan will also be obtained in round 6:

$$E(\pi_{i4}(0)) - E(\pi_{i4}(1)) < E(\pi_{i5}) \quad (5)$$

where: $E(\pi_{i5}) = \begin{cases} E(\pi_{i5}(0)) \\ E(\pi_{i5}(1)) + E(\pi_{i6}(0)) \end{cases}$.

This generalizes in round t to:

$$E(\pi_{it}(0)) - E(\pi_{it}(1)) < \begin{cases} E(\pi_{it+1}(0)) \\ \sum_{k=t+1}^{5} E(\pi_{ik}(1)) + E(\pi_{i6}(0)) \end{cases}, t < 6 \quad (6)$$

Since the expected earnings in each round are non-negative ($E(\pi_{ik}(1)) > 0 \; \forall k$), the benefits from repaying the loan to secure continuation are increasing as we move closer to round 1. Whether or not theory predicts that the group will repay the loan depends on the parameterization. As discussed above we are interested in two parameterizations, one for high risk borrowing groups and one for low risk borrowing groups.

III.1a. High Risk Borrowing Groups Baseline

We assume that for each high risk borrower, b_{iH} = 820, b_{iL} = 80, and the probability of success p = .5. We set the total group loan repayment W = 900, such that loan repayment is possible for all group outcomes other than (LLL). With the probability of success independent across borrowers, repayment could occur on average 87.5% of the time (=1 – $(.5)^3$). For example, if earnings outcomes are (HLL), loan repayment would require P2 and P3 to repay 80 each, while successful P1 must pay 300 + 220 + 220 = 740 from his earnings of 820.

As noted above, with 6 potential rounds in total, there is no incentive for any borrower to vote to repay the loan in period T=6, since no additional revenue earning rounds are available, and repayment simply lowers final round net revenues. With {NNN} a weakly dominant strategy voting equilibrium for players of all possible group compositions, the profit that players can expect to receive in Round 6 by reaching the start of that round is

$$E(\pi_{i6}) = p_H^3(820) + 2p_H^2(1-p_H)(820) + p_H(1-p_H)^2(820) + (1-p_H)p_H^2(80) +$$

$$2p_H(1-p_H)^2(80) + (1-p_H)^2(80) = 450. \quad (7)$$

We summarize the payoffs in each of the potential group outcome categories in Table 2:

Table 2 Payoffs and Probabilities by Outcome for High Risk Borrowers

Outcome	Payoff		Required Repayment	Probability
	Repay	Do Not Repay		
HHH	$b_{iH} - wC_{HHH}$		w	p^3
	520	820	300	0.125
HHL or HLH	$b_{iH} - \left(w + \frac{w - b_L}{2}\right) C_{HHL}$		$\left(w + \frac{w - b_L}{2}\right)$	$2p^2(1-p)$
	410	820	410	0.25
HLL	$b_{iH} - \left(w + 2(w - b_L)\right) C_{HLL}$		$\left(w + 2(w - b_L)\right)$	$p(1-p)^2$
	80	820	740	0.125
LHH	$b_{iL} - b_{iL} C_{LHH}$		b_{iL}	$p^2(1-p)$
	0	80	80	0.125
LLH or LHL	$b_{iL} - b_{iL} C_{LLH}$		b_{iL}	$2p(1-p)^2$
	0	80	80	0.25
LLL	b_{iL}		NA	$(1\text{-}p)^3$
	80			0.125

In Round 5, to determine whether to repay the loan or not an individual compares his or her payoff from repaying plus the expected payoff from participating in round 6 with the expected payoff from not repaying the loan. The expected payoff from round 6 is 450 and so clearly only the H subjects in the HLL treatments should choose not to repay the loan (740 vs. 450).

In Round 4 the incentives are the expected payoff from Round 5 plus the expected payoff from Round 6 multiplied by the probability of getting to Round 6. Notice that the group will not get to Round 6 if they all earn the low net benefit in Round 5 or if only one of them earns the High net benefit in Round 5. Thus from the point of view of Round 4 the expected payoff from continuing is the Expected payoff from Round 5 ($E(\pi_{i5})$) plus the expected payoff from Round 6 ($E(\pi_{i6})$) times the probability of reaching round 6 which is .50 (The probability of HHH, HHL, HLH, or LHH). Thus the expected payoff to continuing is:

$$E(\pi_{i5}) + .5E(\pi_{i6}) = 0.125(520) + .25(410) + .125(820) + .125(0) + .25(80) + .125(80)$$

$$+.5(450) = 300 + 225 = 525 \qquad (8)$$

Since this expected payoff is increasing it is in the subject's best interest to continue in all of the cases they continued in the Round 5 in Round 4 as well. Also notice that the 525 is still not enough to overcome the benefit of not repaying the loan in the HLL case (costing 740).

In Round 3 the incentives to continue are:

$$E(\pi_{i4}) + .5E(\pi_{i5}) + .5^2E(\pi_{i6}) = 0.125(520) + .25(410) + .125(820) + .125(0) + .25(80) + .125(80) + .5(300) + .5^2(450) = 300 + 150 + 112.5 = 562.5 \quad (9)$$

Notice that the expected payoff for continuing in Round 3 is still not high enough to offset the 740 foregone payoff for the High subject to bail out the two Low subjects. The process continues and in Round 1 the incentives to continue are:

$$E(\pi_{i1}) + .5E(\pi_{i2}) + .5^2E(\pi_{i3}) + .5^3E(\pi_{i4}) + .5^4E(\pi_{i5}) + .5^5E(\pi_{i6}) = 300 + .5(300) + .5^2(300) + .5^3(300) + .5^4(300) + .5^5(450) = 595.3 \quad (10)$$

which again is not high enough to offset the loss to a high net benefit borrower from bailing out two low net benefit borrowers. This suggests that high net benefit borrowers should choose not to repay the loan whenever they are matched with two low net benefit borrowers.[1]

3b. Low Risk Borrowers Baseline

Repayment incentives are more favourable for borrowers whose low earnings are not as far below W/3, and whose high earnings are not as far above. Low earners are able to repay most of their (equal) share of a group loan, so that high earners have less to bail out if they vote to repay, and retain less by refusing repayment and instead taking immediate high earnings.

To illustrate, we assume for low risk borrowers that b_{iL} = 270, b_{iH} = 420, and the probability of high earnings is higher, at p = .6. With the probability of (LLL) outcomes reduced from 12.5% to 6.4%, we assume the microcredit lender can charge a lower implicit interest rate to cover costs, such that group repayment W = 840.[2] Equal share loan repayment would then be W/3 = 280. With these parameters, it remains the case that group repayment is possible for all but (LLL) outcomes.

[1] The expected gains to continuation grow at a decreasing rate moving back, so that in fact the predictions regarding repayment become very similar for finite or infinite horizon games for otherwise similar parameters.
[2] We originally set W = 840 for both low and high risk borrowing groups, but raised it for high risk groups to dampen loan repayment rates in our control baseline.

Table 3 Payoffs and Probabilities by Outcome for Low Risk Borrowers

Outcome	Payoff		Required Repayment	Probability
	Repay	Do Not Repay		
HHH	$b_{iH} - wC_{HHH}$		w	p^3
	140	420	280	0.216
HHL or HLH	$b_{iH} - \left(w + \frac{w - b_L}{2}\right) C_{HHL}$		$\left(w + \frac{w - b_L}{2}\right)$	$2p^2(1-p)$
	135	420	285	0.288
HLL	$b_{iH} - \left(w + 2(w - b_L)\right) C_{HLL}$		$\left(w + 2(w - b_L)\right)$	$p(1-p)^2$
	120	420	300	0.096
LHH	$b_{iL} - b_{iL} C_{LHH}$		b_{iL}	$p^2(1-p)$
	0	270	270	0.144
LLH or LHL	$b_{iL} - b_{iL} C_{LLH}$		b_{iL}	$2p(1-p)^2$
	0	270	270	0.192
LLL	b_{iL}		NA	$(1\text{-}p)^3$
	270			0.064

For low risk borrowers, the weakly dominant strategy equilibrium is still to vote {NNN} to loan repayment in the terminal round for all group compositions. This is because repaying lowers the subjects payoff in every case where it is possible. The expected payoff from reaching Round 6 is $E(\pi_{i6}) = 360$.

$$E(\pi_{i6}) = .6(420) + .4(270) = 360 \tag{11}$$

Starting with Round 5 it is clear that it is in an individual's best interest to pay back the loan in each case as the expected payoff in Round 6 (360) exceeds the difference between repaying the loan and not repaying the loan in each case. As a result for this treatment repayment is a dominant strategy in all rounds, as is summarized in Table 3. This leads us to our first hypothesis under these parameters:

Hypothesis 1: High risk borrowers are less likely to repay the loan than low risk borrowers.

This is consistent with the Bannerjee and Duflo (2011) discussion of the tension between microcredit and entrepreneurship. Clearly when projects are riskier, microcredit is less likely (at least theoretically) to be successful.

III.2 Expected Payoffs With Revenue Sharing

The above analysis suggests that the important difference between high and low risk borrowing groups is current required repayments being higher than the expected value of continuation for high risk groups. One way to reduce the required repayment is revenue sharing. Revenue sharing results in the adjusted earnings of high risk borrowers looking more like those from low risk borrowing groups. Borrowers who receive the low net benefit are adjusted upward and can pay more of their equal share of W, while those with high net benefits although adjusted downward are required to repay less, reducing the incentive to not repay the loan.[3]

An interesting feature of revenue sharing in this dynamic environment is that it can increase the reward from repayment and continuation in early rounds *even if it is not made available until later rounds*. This could be helpful if, for example, the members of newly formed borrowing groups do not trust each other enough to commit to share revenues until they gain some experience borrowing together using the lesser commitment required by optional bailouts. We illustrate revenue sharing below for the case where borrowers can vote to share 20% of their earnings revenues with each of the other two borrowers, prior to Rounds 3, 4 and 5, but not Rounds 1 or 2, nor the terminal Round 6. Unanimity is required for revenue sharing to take place, and borrowers are asked to vote on revenue sharing before they are told their net benefit and the net benefits of those in their group.

Specifically, borrowers are told that if the three members of their group all agree to do so, then before knowing how their individual businesses are doing, they can each commit to share 20% of their business venture revenues with each of the other two people in their group. (In other words, each would give up 40% of his or her business revenue whatever it turned out to be, but

[3] Microcredit is fundamentally a threshold public good, if the borrowers agree to repay the loan then they receive the benefit of future loans is analogous to a group deciding whether to contribute a given amount to receive the benefit of the public good. Cadsby et al (2008) show that the step return (ratio of group payoff to total cost) is best able to predict the likelihood of the public good being provided. In our environment the step return is the expected benefit of repaying the loan divided by the cost of repaying the loan. For high risk groups under the HLL condition the expected benefit of repaying the loan is less the cost of repaying the loan for the individual who receives the high return and as such has no incentive to repay the loan. For low risk groups the expected benefit of repaying the loan always exceeds the cost of repaying the loan and so individuals in the low risk treatment should always repay the loan. As we will show, our sharing contract is designed to reduce the required repayment without effecting the expected benefit of repaying the loan. This results in the expected benefit exceeding the cost of repaying the loan in all cases in the High risk treatment.

Table 4 Payoffs and Probabilities by Outcome after Revenue Sharing.

Outcome	Revenue After Sharing	Payoff	Probability
HHH	b_H	$b_H - wC_{HHH}$	p^3
HHL or HLH	ab_{HHL} $= b_H - .4b_H + .2b_H$ $+ .2b_L = .8b_H + .2b_L$	$ab_{HHL} - \left(w + \frac{\min(w - ab_{LHH}, 0)}{2}\right) C_{HHL}$	$2p^2(1-p)$
HLL	$ab_{HLL} = .6b_H + .4b_L$	$ab_{HLL} - \left(w + 2min(w - ab_{LLH}, 0)\right) C_{HLL}$	$p(1-p)^2$
LHH	$ab_{LHH} = .6b_L + .4b_H$	$\max(ab_{LHH} - wC_{LHH}, 0)$	$p^2(1-p)$
LLH or LHL	$ab_{LLH} = .8b_L + .2b_H$	$\max(ab_{LLH} - wC_{LLH}, 0)$	$2p(1-p)^2$
LLL	b_L	b_{iL}	$(1\text{-}p)^3$

receive 20% of the business revenue of each of the other two group members.) Thus, for borrower 1, adjusted net revenue is the borrower's net revenue minus 40% of that net revenue plus 20% of the net revenue from borrower 2 and 20% of the net revenue of borrower 3:

$$ab_i = b_i - .4b_i + .2b_j + .2b_k,\ i \neq j \neq k. \quad (12)$$

Notice that this has no effect on net revenue ($ab_i = b_i$) in the case where all borrowers receive the same net revenue (HHH or LLL). Note also that in the LLL case the group cannot afford to pay back the loan and so each individual just receives their business earning outcome. Also notice that for the low return cases borrowers may or may not be able to pay back their equal share of the loan depending on the parameters.

Since revenue sharing simply redistributes the initial revenues from those received the high net benefit to those who received the low, its only effect is to reduce the required amount of further repayment by the borrowers who receive the high net benefit. This should increase the likelihood of the group continuing into the 6th round. To verify this for our parameters we will next compare the expected payoff in round 5 with and without revenue sharing. Table 4 shows the effects of revenue sharing for each of the potential outcomes in general. Note that with revenue sharing, it may no longer be the case that those who receive the low outcome cannot afford to repay their share of the loan.

III.2a. Revenue Sharing for High Risk Borrowing Groups

The business outcome parameters for this treatment are the same as for the High Risk Borrowing Groups in the Baseline (III.1a). Again, b_{iH} = 820, b_{iL} = 80, and the probability of success p = .5. The total group loan repayment W is again 900, such that loan repayment is possible for all group

Table 5 Payoffs and Probabilities by Outcome for High Risk Borrowers

Outcome	Payoff		Required Repayment	Probability
	Repay	Do Not Repay		
HHH	$ab_{HHH} - wC_{HHH}$		w	p^3
	520	820	300	0.125
HHL or HLH	$ab_{HHL} - \left(w + \frac{\min(w - ab_{LHH}, 0)}{2}\right) C_{HHL}$		$\left(w + \min(\frac{w - ab_{LHH}}{2}, 0)\right)$	$2p^2(1-p)$
	372	672	300	0.25
HLL	$ab_{HLL} - \left(w + 2min(w - ab_{LLH}, 0)\right)C_{HLL}$		$\left(w + 2min(w - ab_{LHH}, 0)\right)$	$p(1-p)^2$
	80	524	444	0.125
LHH	$\max(ab_{LHH} - wC_{LHH}, 0)$		$\min(ab_{LHH}, w)$	$p^2(1-p)$
	76	376	300	0.125
LLH or LHL	$\max(ab_{LLH} - wC_{LLH}, 0)$		$\min(ab_{LLH}, w)$	$2p(1-p)^2$
	0	228	228	0.25
LLL	ab_{LLL}		NA	$(1\text{-}p)^3$
	80			0.125

outcomes other than (LLL). The probability of the group having at least one high net benefit borrower is also the same and so repayment could occur on average 87.5 % of the time (=1 – $(.5)^3$). With revenue sharing, if earnings outcomes are (HLL), then the high net benefit borrower would share 164 with each of the low net benefit borrowers who would in turn share 16 with each other and the high net benefit borrower. Thus the high net benefit borrower's adjusted revenues are 820-2(164)+2(16)=524, and the two low net benefit borrowers' adjusted revenues are 80-2(16)+164+16=228. As a result, loan repayment for HLL groups would require P2 and P3 to repay 228 each, while successful P1 must pay 300 + 72 + 72 = 444 from his adjusted revenues (of 524). Note that this repayment is much less than the 740 required in this case without revenue sharing. It is also less than the 450 expected payoff from continuation to the final round.

We summarize the payoffs in each of the potential categories in Table 5. Notice that under revenue sharing for high risk borrowing groups, the high net benefit borrowers only need to bail out low net benefit borrowers under the HLL outcome, and no longer under the HLH or HHL outcomes. In Round 5, to determine whether to repay the loan or not an individual compares their payoff from

repaying plus the expected payoff from continuing to round 6, with their expected immediate payoff from not repaying the loan. The expected payoff from round 6 remains 450, and so with revenue sharing it is now in the best interest of all (risk neutral) borrowers to repay the loan. Notice however that the 444 repayment required by high net benefit subjects in HLL groups is very close to the 450 expected benefit from continuation to round 6.

In Round 4 the incentives for continuation are again the expected payoff from Round 5 plus the expected payoff from Round 6 multiplied by the probability of getting to Round 6. Notice that the group will not get to Round 6 if they all earn the low net benefit in Round 5 as before, but now under revenue sharing we expect them to repay the loan if even one of them earns a high net benefit in Round 5. Thus in Round 4 the expected payoff from continuing is the expected payoff from Round 5 ($E(\pi_{i5})$) plus the expected payoff from Round 6 ($E(\pi_{i6})$) times a higher probability of reaching round 6 (.875 = (1- (the probability of LLL)). Thus the expected payoff to continuing is:

$$E(\pi_{i5}) + .875E(\pi_{i6}) = 0.125(520) + .25(372) + .125(80) + .125(76) + .25(0) + .125(80)$$

$$+.875(450) = 187.5 + 393.75 = 581.25 \quad (13)$$

Since this expected payoff is increasing moving backwards it is in the subject's best interest to continue in all of the cases they continued in the Round 5 in Round 4 as well. Similarly the incentives to repay are higher in Rounds 1, 2 and 3. Notice also the expected payoff from continuing to Round 5 is also higher than it was without revenue sharing (525), which verifies that borrowers should choose to revenue share when it is available.

Hypothesis 2: The option to revenue share raises loan repayment rates for high risk borrowers.

3b. Revenue Sharing for Low Risk Borrowing Groups

Revenue sharing does not in theory have much effect on low risk borrowers, but we include it for completeness. Again, we assume for low risk borrowers that b_{iL} = 270, b_{iH} = 420, and the probability of high earnings is higher, at p = .6. Group repayment remains W = 840, so that equal share loan repayment would then be W/3 = 280. With these parameters, it remains the case that group repayment is possible for all but (LLL) outcomes, and the weakly dominant strategy equilibrium is still to vote {NNN} to loan repayment in the terminal round for all group compositions. This is because repaying lowers the subjects payoff in every case where it is possible. The expected payoff from reaching Round 6 is $E(\pi_{i6}) = 360$.

$$E(\pi_{i6}) = .6(420) + .4(270) = 360 \quad (14)$$

Table 6 Payoffs and Probabilities by Outcome for Low Risk Borrowers

Outcome	Payoff		Required Repayment	Probability
	Repay	Do Not Repay		
HHH	$ab_{HHH} - wC_{HHH}$		w	p^3
	140	520	280	0.216
HHL or HLH	$ab_{HHL} - \left(w + \frac{\min(w - ab_{LHH}, 0)}{2}\right) C_{HHL}$		$\left(w + \min(\frac{w - ab_{LHH}}{2}, 0)\right)$	$2p^2(1-p)$
	110	390	280	0.288
HLL	$ab_{HLL} - \left(w + 2min(w - ab_{LLH}, 0)\right)C_{HLL}$		$\left(w + 2min(w - ab_{LHH}, 0)\right)$	$p(1-p)^2$
	80	360	280	0.096
LHH	$\max(ab_{LHH} - wC_{LHH}, 0)$		$\min(ab_{LHH}, w)$	$p^2(1-p)$
	50	330	280	0.144
LLH or LHL	$\max(ab_{LLH} - wC_{LLH}, 0)$		$\min(ab_{LLH}, w)$	$2p(1-p)^2$
	20	300	280	0.192
LLL	ab_{LLL}		NA	$(1\text{-}p)^3$
	270			0.125

As indicated in Table 6, revenue sharing by low risk borrowing groups eliminates the need for high benefit borrowers to bail out low benefit borrowers. Starting with Round 5 it is in an individual's best interest to pay back the loan in each case as the expected payoff from continuing to Round 6 (360) exceeds the difference between repaying the loan and not repaying the loan. As a result, for this treatment repayment is a dominant strategy in Round 5, and in all earlier rounds. This is not surprising as repayment is a dominant strategy in the treatment without revenue sharing.

Hypothesis 3: The option to revenue share does not affect the repayment rate of low risk borrowers.

Since revenue sharing is not predicted to affect the repayment rates or earnings of low risk borrowers, note they should be indifferent to adopting it or not, unlike high risk borrowers, who stand to gain from binding themselves to it.

III.3 Revenue Sharing When Borrowers Can Renege

A very plausible objection can be raised that microfinance offers the greatest benefit to

borrowers in precisely those developing countries where contracts are not readily enforceable by third parties. (Lack of contract enforcement is one of the reasons commercial banks will not lend to low income people.) In such environments, even with full information as to business outcomes, what is to stop borrowers from agreeing to revenue share *ex ante*, but then reneging on this agreement if it turns out they will have to be net contributors? To address this in theory and experiment, we next introduce an explicit requirement for borrowers whose group's have unanimously voted to revenue share to have to unanimously confirm their decision *after* learning their individual earnings. We will show that for our high risk borrowers, groups with even one borrower who receives the low net benefit will trigger high benefit members to renege on revenue sharing agreements.

III.3.a Revenue Sharing with Renege for High Risk Borrowing Groups

Notice that groups where all of the borrowers receive the same net return (HHH or LLL) are indifferent between revenue sharing and not. Next consider a high net benefit borrower in an HHL or HLH group in Round 5. In both cases it remains in the high benefit borrowers' best interest to repay the loan and continue to Round 6. Without revenue sharing the expected payoff to doing this is 410+450=860 (see Table 2). With Revenue Sharing the expected payoff is 372+450=822 (Table 4). Thus in this case it is in the high net benefit borrower's best interest to renege on revenue sharing, though still repay the loan. The same holds true in earlier rounds. More damagingly, renege incentives also hold for HLL groups, where it will also affect loan repayment incentives. In Round 5, without revenue sharing the sole high revenue earner will opt not to repay the loan and earn 820. With revenue sharing agree to and honoured, the high revenue earner would then opt to repay the loan but earn only 80+450=530 and so again he or she would be better off choosing to renege on revenue sharing and then voting not to repay the loan. Thus allowing high risk borrowing groups to renege on their revenue sharing agreements undermines the value of revenue sharing and moves us back to the predictions of the Baseline, where high risk groups choose not to repay the loan with only one high revenue earner.

Hypothesis 4: The option to revenue share and renege reduces the repayment rate for high risk borrowers.

Hypothesis 5: The option to revenue share and renege reduces the repayment rate for high risk borrowers to the levels observed without the option to revenue share.

Some group level predictions from our theory are summarized in Table 7.

Table 7: Summary of Theory Predictions for Group Outcomes Rounds 1-5

Treatment	Loan Repayment	Overall Group Repay Rate (%)	Choose Rev Sharing?	Confirm Rev Sharing?
High Risk – Baseline	Yes for (HHH), (HHL/ HLH/LHH) Groups; No for (LLL), (LLH/ LHL/HLL) Groups	50.0%		
High Risk – Rev Share	Yes for (HHH), (HHL/ HLH/LHH), (LLH/LHL/ HLL) Groups; No for(LLL)	87.5%	Yes	
High Risk – Rev Share w Renege	Same as High Risk Control	50.0%	Indifferent	Renege if L's in group
Low Risk – Baseline	Yes for (HHH), (HHL/, (HLH/LHH), (HLL/LHL/ HLL) Groups; No for (LLL)	93.6%		
Low Risk – Rev Share	Same as Low Risk Control	93.6%	Indifferent	

IV. Experimental Design

Our experimental design follows closely the structure and parameters already presented. We implement a group liability microcredit environment. We run five between-subject treatments:

1) low risk borrowers without revenue sharing (LR),
2) high risk borrowers without revenue sharing (HR),
3) low risk borrowers with a revenue sharing option (LRRS),
4) high risk borrowers with a revenue sharing option (HRRS),
5) high risk borrowers with revenue sharing and renege options (HRRSR).

Within each treatment, subjects are recruited for computerised sessions each containing 18 participants. We run three sessions for each treatment involving high risk borrowers (with 54 total participants in each), and two sessions for treatments involving low risk borrowers (with 36 total participants in each).

In a given session of any treatment, after reading instructions and seeing a summary Powerpoint presentation, subjects are randomly assigned into 6 borrowing groups of three members each. The members of each borrowing group receive a loan, which they put towards an individual "business venture" that may yield high or low revenues (420 vs. 270 tokens in low risk treatments, with a 60% probability of high revenues, and 820 vs. 80 tokens in high risk treatments, with a 50% probability of high revenues). After learning how their own and the other two people's business ventures have performed, low risk groups vote whether to repay 840 tokens in total to qualify for an additional round of loans and business venture activities, while high risk groups vote whether to repay 900 tokens. Each 100 tokens corresponds to 80 New Zealand cents. Loan repayment costs were assigned according to the fixed rule described earlier: each borrower would pay back an equal share if possible, otherwise they would pay all they could (from current round revenues), with more successful borrowers making up any shortfall, equally borne if there were two such successful borrowers. Loan repayment required unanimous agreement, and borrowers could communicate by typed chat within their groups prior to making the vote. In all cases, loan repayment is possible for all groups containing at least one high revenue earner. A given group could take part in up to 6 rounds of loans and business activity, with the 6^{th} round known to be terminal from the outset.

After one 'set' of up to 6 rounds, the six groups were reassigned such that each subject now had two new other people in his/her borrowing group. These new groups could again take part in up to 6 rounds of activity in the second set. Groups were then reassigned again, and the new groups took part in up to 6 rounds of a third and final set. Subjects never had the same group member with them in more than one set.

This sequence of receiving a loan, learning business outcomes, and then chatting and voting on loan repayment held for all treatments. In treatments where revenue sharing was introduced, these steps were preceded for rounds 3, 4 and 5 of each set with subjects first chatting and voting whether or not to "commit" to share 20% of their business revenues with each of the other two people in his/her borrowing group. As with loan repayment decisions, unanimous agreement was required for revenue sharing to take place. If revenue sharing was rejected by one or more group members, the round proceeded just as if revenue sharing were not available. If revenue sharing was adopted, then the individual revenues were adjusted after business outcomes were realized, and the

loan repayments required from each member were adjusted accordingly prior to the loan repayment vote. For example, for high risk groups where only one business did well (e.g. (HLL)), loan repayment would look as follows without and with revenue sharing:

Without Revenue Sharing				With Revenue Sharing			
	P1	P2	P3		P1	P2	P3
Revenue	820	80	80	Adjusted Rev	524	228	228
Repayment	740	80	80	Repayment	444	228	228
Round Profit	80	0	0	Round Profit	80	0	0

Finally, in the treatment where reneging on revenue sharing was possible, an additional "confirmation vote" was required after business venture outcomes were realized, if a group had unanimously voted to revenue share. We did not allow chat prior to the confirmation vote. In choosing the language to describe this vote, we tried to strike a balance between avoiding overly loaded language, while still recognizing that an implicit contract was being broken. To do this, in all treatments involving the revenue sharing option, we described this option as "committing" to revenue sharing. In the renege treatment, we used the language of "confirming" this decision, and the text super-imposed on the voting buttons read as "Yes, Confirm" and "No, Refuse After All".

Before moving to results, we will also describe several design features we incorporated after running early pilot sessions not included in the results we report. Consistent with prior lab experiments with microcredit mentioned in Section II, particularly when relative positions are randomly determined rather than 'earned', we found unexpectedly high levels of generous bailouts and loan repayment even for high risk borrowing groups in our baseline treatment without revenue sharing. While this might be of interest in its own right, it provided no potential "room for improvement" with our proposed mechanism. We therefore took the following steps to reduce baseline cooperation. First, we added a tournament component to subject earnings, such that the highest 6 of 18 token earners in each session would earn an additional $12. Second, we raised the group loan repayment cost in high risk treatments from 840 to 900. Third, we used language that emphasized individual achievement with the business ventures, rather than group 'success' in repaying loans. Fourth, we reduced the "boredom" penalty that subjects would impose on themselves and others within their borrowing group by refusing loan repayment and sitting out the

remaining rounds of a set. For each session we provided at each computer workstation a Word Search, two Sudoku puzzles, and a current issue of the official university student magazine.

V. Experimental Results

Thirteen sessions of the experiment were run at the University of Canterbury in New Zealand, with 234 participants in total. Three sessions were conducted in September 2015, and the remaining ten in March and April of 2016. Sessions were run in rotating order between treatments.[4] They took on average 75-90 minutes, and subjects earned NZ$23.38 on average (NZ$1 = US$.70).

Despite the use of "loan" and "repayment" language in our instructions, the standard game theory prediction that groups would not repay in the last round of each set was supported. Across all treatments, of the 64 groups still making loan repayment decisions in round 6 of a set, only 3 repaid the loan (a 4.7% repayment rate).[5] A higher proportion of individuals in these groups voted to repay (36 of 192, or 18.8%), but were vetoed by others in their groups under the unanimity rule. We shall thus focus on subjects' behaviour in Rounds 1-5 of each set.

Our approach will be to present both group outcomes and individual voting behaviour, first with regards to loan repayment, then to revenue sharing, and finally to reneging on revenue sharing agreements. We will test for differences between treatments using Mann Whitney tests, and by comparing the coefficients on treatment dummies in pooled cross section regressions.[6]

V.1 Loan Repayment Rates

A difficulty with analysing person or group results at round level within sets is that those borrowing groups who are more cooperative in repaying the loan (or who are lucky enough to avoid (LLL) business outcomes) continue for more rounds in each set, and thus generate more observations than less cooperative or lucky groups. To avoid this problem, we construct loan repayment rates at set level, either for group outcomes, or individual voting. For group repayment outcomes, we divide the number of rounds a given group in a given set unanimously voted to repay, by the number of rounds where repayment was possible. For example, a group who avoided (LLL) earnings outcomes for four rounds, and repaid the loan for the first three of these before refusing on the fourth, would have a repayment rate of 3/4 =.75. Whereas a group who repaid the loan in

[4] In particular, they were run in the order HR, HRRS, LR (2015), then LRRS, HRRSR, HR, HRRS, LR, LRRS, HRRSR, HR, HRRS, HRRSR (2016).

[5] 6 additional groups "survived" to Round 6 of a set, but earned (LLL) so could not repay the loan and so did not vote. Thus across all treatments and sets pooled, 70 out of a possible 234 groups survived to the start of Round 6, or 29.9%.

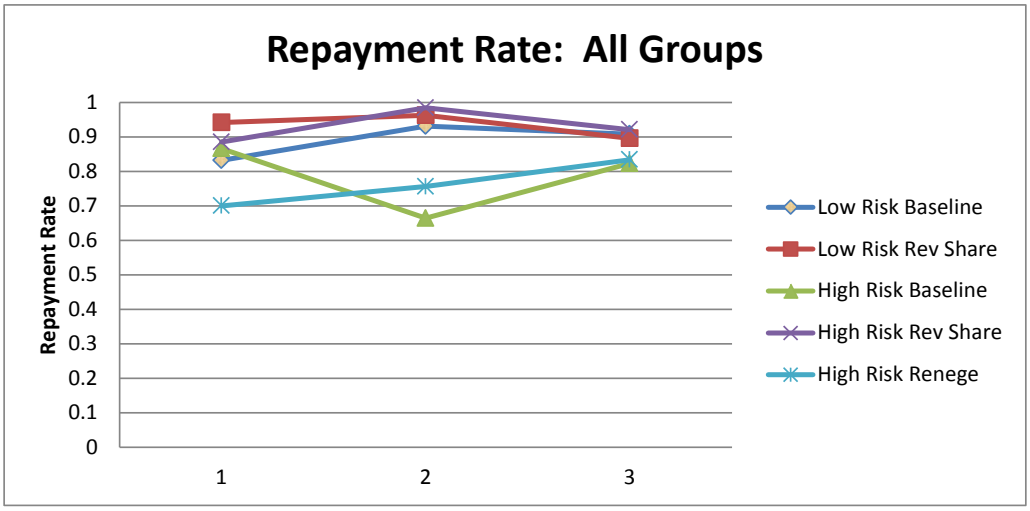
[6] These regressions include set dummies and include various demographic variables. Some demographic variables furthest from significance were dropped. See Appendices 1 and 2.

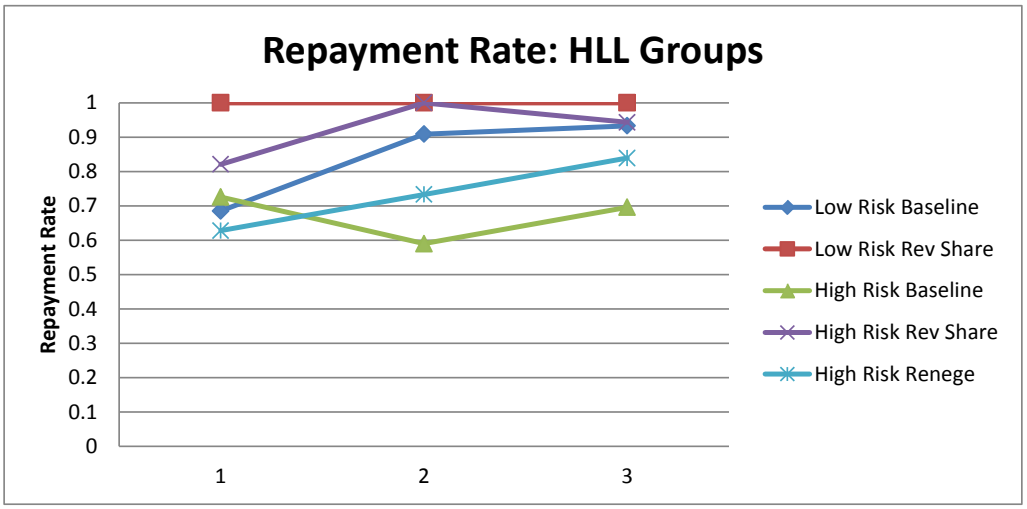
the first three rounds, but then could not repay in round 4 due to (LLL) earnings, would have a repayment rate of 3/3 = 1. Next, given that group repayment outcomes are predicted to depend on group earnings composition, we also construct repayment rates conditioned on this composition. For example, we define the HLL repayment rate as the number of rounds a group with one high earner and two low earners repays the loan, divided by the number of rounds the group had such a composition.

For individual repayment votes, we construct analogous rates. These are always made contingent on the earning status of the person casting the vote. Further, because voting is also predicted to depend on the earnings composition of the other two members, we further condition individual voting rates on this composition.

Figure 1 illustrates some of our key group repayment rates and individual voting rates in favour of repayment over the three sets. Table 8 presents a numerical summary of these repayment rates by group outcome and individual vote, broken down by set and treatment. We also provide outcomes pooled over sets. Note that, although group compositions were scrambled between sets, strictly speaking group outcomes or individual votes from one set of a session should not be thought of as independent of those from other sets of the same session. We focus particularly on the repayment outcomes and individual votes of high risk "HLL Groups", since theory predicts it is these groups who, if risk neutral, should not repay in the baseline, but repay when revenue sharing is available. The first thing to note from the lower panel of Figure 1, or Table 8 is that loan repayment rates are surprisingly high for sole high revenue earners in our high risk baseline Treatment 1, even without the revenue sharing option. Such groups have a mean loan repayment rate of 72.6% in Set 1, 59.0% in Set 2, and 69.6% in Set 3, or 67.3% overall, well above the predicted repayment rate of 0% from Table 7. At the individual voting level, the sole H members of such groups voted to repay on average 71.9% in Set 1, 66.7% in Set 2, and 81.5% in Set 3, or 72.8% overall, despite the theoretical prediction that they should never vote to repay. This 'excess repayment' echoes results found in previous microcredit lab experiments, particularly where high and low earning outcomes are known by the subjects to be randomly determined, and there is full information about others' earnings outcomes.

Despite the high baseline repayment rates for HLL groups in the high risk baseline treatment, there is still evidence that repayment rates are indeed lower than they are in the analogous low risk baseline treatment. The mean repayment rate for low risk HLL groups is 68.5%, 90.9% and 93.3% in Sets 1, 2, and 3, respectively, or 85.0% overall. The mean repayment vote rates by the lone H in such groups is 86.4%, 96.2%, 90.5%, and 92.6%. These differences in HLL group behaviour between high





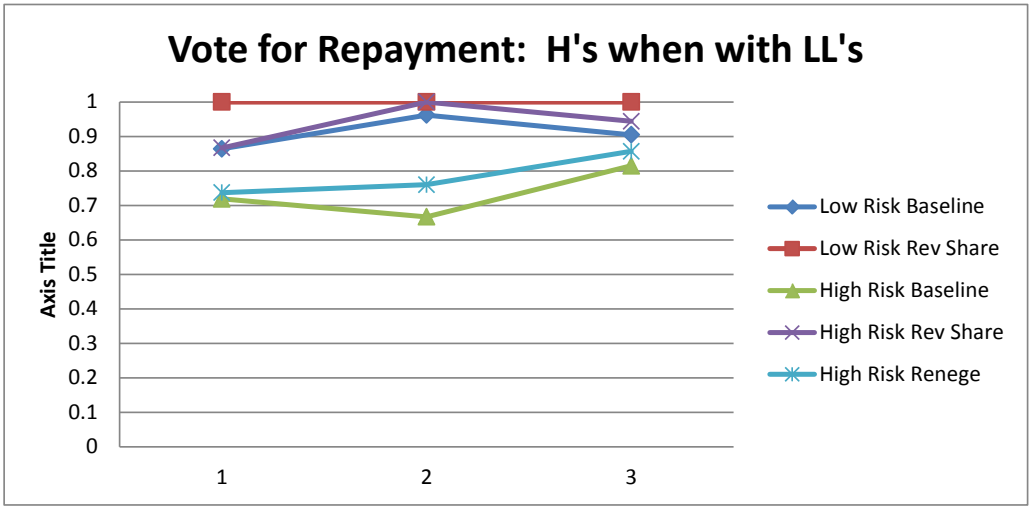


Figure 1: Repayment Rates by Set for All Groups, and for Pivotal HLL Groups and Individuals

Table 8: Loan Repayment Rates By Set, Treatment, and Composition (Excludes LLL Outcomes Where Repayment Not Possible)

Group Level Outcomes					Individual Level Voting								
I. All Groups (excl LLL)						**H with Anyone**				**L with Anyone**			
Treatment	**Set**	**N**	**Repay**	**Std. Dev.**	**Treatment**	**Set**	**N**	**Repay**	**Std. Dev.**	**Set**	**N**	**Repay**	**Std. Dev.**
1 High Risk	1	17	.866	.269	1 High Risk	1	44	.941	.188	1	36	.977	.099
Baseline	2	15	.664	.386	Baseline	2	39	.862	.294	2	35	1.000	.000
	3	16	.823	.266		3	41	.950	.130	3	38	.947	.226
Overall		48	.789	.315	Overall		52	.909	.185	Overall	52	.963	.168
2 High Risk	1	16	.885	.262	2 High Risk	1	40	.988	.055	1	34	.922	.247
Rev Share	2	16	.984	.063	Rev Share	2	44	.992	.050	2	40	1.000	.000
	3	17	.921	.112		3	45	.951	.121	3	42	.988	.054
Overall		49	.930	.169	Overall		53	.976	.059	Overall	54	.978	.072
3 Low Risk	1	12	.832	.132	3 Low Risk	1	33	.965	.098	1	33	.909	.264
Baseline	2	12	.931	.127	Baseline	2	34	.973	.089	2	28	.964	.189
	3	12	.908	.114		3	31	.933	.149	3	29	1.000	.000
Overall		36	.890	.128	Overall		36	.959	.072	Overall	36	.961	.117
4 Low Risk	1	12	.942	.151	4 Low Risk	1	34	.975	.081	1	28	.982	.094
Rev Share	2	12	.963	.088	Rev Share	2	35	.969	.107	2	29	.983	.093
	3	12	.896	.291		3	36	.963	.174	3	29	1.000	.000
Overall		36	.933	.192	Overall		36	.951	.171	Overall	35	0.988	.050
5 High Risk	1	16	.700	.385	5 High Risk	1	41	.907	.244	1	38	.945	.188
2 + Renege	2	16	.756	.388	2 + Renege	2	37	.860	.323	2	42	1.000	.000
	3	15	.834	.279		3	38	.908	.247	3	35	1.000	.000
Overall		47	.762	.352	Overall		53	.903	.187	Overall	52	.970	.147
II. HLL Groups						**H with LL**				**L with HL**			
1 High Risk	1	14	.726	.422	1 High Risk	1	16	.719	.446	1	30	.972	.108
Baseline	2	13	.590	.449	Baseline	2	18	.667	.454	2	30	1.000	.000
	3	14	.696	.351		3	18	.815	.296	3	32	.938	.246
Overall		41	.673	.402	Overall		36	.728	.356	Overall	51	.962	.169
2 High Risk	1	13	.821	.376	2 High Risk	1	15	.867	.352	1	27	.914	.271
Rev Share	2	13	1.000	.000	Rev Share	2	18	1.000	.000	2	30	1.000	.000
	3	16	.943	.124		3	24	.944	.212	3	38	.991	.054
Overall		42	.923	.229	Overall		38	.962	.124	Overall	51	.977	.088
3.Low Risk	1	9	.685	.429	3 Low Risk	1	11	.864	.323	1	20	.900	.308
Baseline	2	11	.909	.202	Baseline	2	13	.962	.139	2	23	.957	.209
	3	10	.933	.141		3	14	.952	.121	3	24	1.000	.000
Overall		30	.850	.288	Overall		26	.926	.209	Overall	31	.957	.136
4 Low Risk	1	10	1.000	.000	4 Low Risk	1	14	1.000	.000	1	21	1.000	.000
Rev Share	2	8	1.000	.000	Rev Share	2	11	1.000	.000	2	19	1.000	.000
	3	10	1.000	.000		3	15	1.000	.000	3	25	1.000	.000
Overall		28	1.000	.000	Overall		26	1.000	.000	Overall	33	1.000	.000
5 High Risk	1	13	.628	.462	5 High Risk	1	19	.737	.452	1	32	.922	.257
2 + Renege	2	15	.733	.402	2 + Renege	2	25	.760	.436	2	37	1.000	.000
	3	14	.839	.304		3	21	.857	.322	3	34	1.000	.000
Overall		42	.736	.393	Overall		40	.800	.346	Overall	50	.967	.158

Table 8: Loan Repayment Rates (Cont'd)

Group Level Outcomes					Individual Level Voting								
III. HHL Groups					**H with HL**					**L with HH**			
Treatment	**Set**	**N**	**Repay**	**Std. Dev.**	**Treatment**	**Set**	**N**	**Repay**	**Std. Dev.**	**Set**	**N**	**Repay**	**Std. Dev.**
1 High Risk	1	14	1.000	.000	1 High Risk	1	33	1.000	.000	1	21	1.000	.000
Baseline	2	11	.818	.405	Baseline	2	27	.926	.267	2	17	1.000	.000
	3	13	1.000	.000		3	29	1.000	.000	3	17	1.000	.000
Overall		38	.947	.226	Overall		46	.957	.206	Overall	34	1.000	.000
2 High Risk	1	13	.923	.277	2 High Risk	1	33	1.000	.000	1	20	.950	.224
Rev Share	2	14	.964	.134	Rev Share	2	37	.986	.082	2	25	1.000	.000
	3	15	.967	.129		3	32	1.000	.000	3	18	.972	.118
Overall		42	.952	.185	Overall		52	.997	.023	Overall	46	.973	.151
3 Low Risk	1	10	.808	.319	3 Low Risk	1	25	.967	.118	1	18	.917	.257
Baseline	2	9	1.000	.000	Baseline	2	19	1.000	.000	2	11	1.000	.000
	3	9	.922	.172		3	20	.950	.154	3	12	1.000	.000
Overall		28	.907	.222	Overall		33	.967	.110	Overall	27	.969	.114
4 Low Risk	1	11	.909	.302	4 Low Risk	1	26	1.000	.000	1	16	.938	.250
Rev Share	2	12	.972	.096	Rev Share	2	29	1.000	.000	2	17	.971	.121
	3	11	1.000	.000		3	28	1.000	.000	3	17	1.000	.000
Overall		34	.961	.179	Overall		34	1.000	.000	Overall	30	.975	.101
5 High Risk	1	12	.833	.326	5 High Risk	1	32	.953	.195	1	22	.955	.213
2 + Renege	2	11	.970	.101	2 + Renege	2	28	.982	.094	2	17	1.000	.000
	3	10	.850	.337		3	24	.938	.224	3	14	1.000	.000
Overall		33	.884	.275	Overall		49	.966	.111	Overall	37	.973	.164
IV. HHH Groups					**H with HH**								
1 High Risk	1	8	1.000	.000	1 High Risk	1	21	1.000	.000				
Baseline	2	8	1.000	.000	Baseline	2	18	1.000	.000				
	3	7	1.000	.000		3	15	1.000	.000				
Overall		23	1.000	.000	Overall		36	1.000	.000				
2 High Risk	1	7	1.000	.000	2 High Risk	1	18	1.000	.000				
Rev Share	2	10	1.000	.000	Rev Share	2	18	1.000	.000				
	3	10	.917	.180		3	24	.917	.170				
Overall		27	.969	.114	Overall		40	.954	.131				
3 Low Risk	1	9	1.000	.000	3 Low Risk	1	27	1.000	.000				
Baseline	2	11	.955	.151	Baseline	2	30	.967	.127				
	3	6	.833	.408		3	18	.889	.323				
Overall		26	.942	.216	Overall		35	.955	.158				
4 Low Risk	1	10	.950	.158	4 Low Risk	1	18	.917	.192				
Rev Share	2	9	.944	.167	Rev Share	2	21	.929	.179				
	3	11	.864	.323		3	27	.944	.212				
Overall		30	.917	.231	Overall		35	.919	.202				
5 High Risk	1	9	1.000	.000	5 High Risk	1	15	1.000	.000				
2 + Reneg	2	5	1.000	.000	2 + Renege	2	9	1.000	.000				
	3	6	1.000	.000		3	15	1.000	.000				
Overall		20	1.000	.000	Overall		33	1.000	.000				

and low risk borrowing groups drive differences in overall repayment rates for groups of all (non LLL) compositions – 78.9% overall for high risk borrowers, and 89.0% for low risk borrowers.

Tests of whether these differences are statistically significant are provided in Table 9, Question 1. At group outcome level, two tailed Mann Whitney and regression-based tests find low risk HLL repayment rates to be significantly higher than high risk HLL repayment rates in Set 2, 3, and overall. Similarly, at individual vote level, these tests find H repayment votes to be significantly higher for low risk borrowers in Sets 2, 3, and overall. Our evidence that 'risk hurts' weakens only slightly when we pool all group compositions together, with group repayment rates being significantly higher for low risk borrowers in Set 2, and overall according to tests comparing treatment coefficients in pooled cross section regression. (See Appendix I for the regressions upon which such tests are based.) Thus, we have been able to capture in our lab experiment Banerjee and Duflo (2011)'s field observation that group liability microcredit does not work as well for higher risk borrowers, which supports our Hypothesis 1.

We turn next to Hypothesis 2: whether the option to revenue share (without renege) increases loan repayment for high risk borrowers (Treatment 2). Again, despite the high repayment rate of HLL groups in the high risk baseline, we find evidence that the option of revenue sharing raises them further. The mean repayment rate for high risk HLL groups with revenue sharing climbs to 82.1%, 100.0% and 94.3% in Sets 1, 2, and 3, respectively, or 92.3% overall. The analogous H repayment votes in HLL groups rise to 86.7%, 100% and 94.4% in Sets 1, 2, and 3, or 96.2% overall. At group outcome level, Mann Whitney and regression based tests find these rates to be significantly higher for Sets 2, 3 and overall (see Table 9 Question 2.) Our evidence that 'revenue sharing helps' weakens only slightly when we pool all group compositions together, with group repayment and H repayment voting significantly higher in Treatment 2 in Set 2 and overall. Thus, as predicted by theory, the option to lock into revenue sharing *ex ante* raises loan repayment rates for high risk borrowers whose groups turn out to contain only one high earner, and for high risk borrowers overall, which supports our Hypothesis 2.

Although our theory does not predict that the revenue sharing option will benefit low risk borrower groups (who should already repay with even one high earner), we still examine the effect of revenue sharing there as well (Hypothesis 3). Surprisingly, there is suggestive evidence that the revenue sharing option may raise loan repayment rates for low risk borrowers as well. The evidence is marginal, though the room for improvement for low risk borrowers is somewhat limited with an overall baseline loan repayment rate of 89.0%. From Table 8, the mean repayment rates for low risk borrowers of all group compositions climbs by set from 83.2, 93.1 and 90.8%, respectively without

Table 9 P Values for Loan Repayment Treatment Effects (All Two Tailed) (Excludes LLL Outcomes)

1. Are Loan Repayment Rates Lower for High Risk than Low Risk Borrowers? (Treatment 1 vs. 3)

	Group Level Outcomes		*Individual Level Votes*			
	Mann Whitney	**OLS[2]**	**Mann Whitney**	**OLS[2]**	**Mann Whitney**	**OLS[2]**
All Groups			H with Anyone		L with Anyone	
Set 1	.158		.993		.302	
Set 2	**.044**		**.078**		.264	
Set 3	.591		.599		.213	
Combine	.469[1]	**.034**	.377[1]	**.035**	.390[1]	.896
HLL/LHL/LLH Groups			H with LL		L with HL	
Set 1	.746		.403		.614	
Set 2	**.056**		**.042**		.253	
Set 3	**.057**		.147		.216	
Combine	**.048**[1]	**.025**	**.019**[1]	**.009**	.546[1]	.965
HHL/HLH/LHH Groups			H with HL		L with HH	
Set 1	**.012**		.101		.122	
Set 2	.189		.230		.	
Set 3	**.082**		**.085**		.	
Combine	**.064**[1]	.747	.437[1]	.988	.110[1]	.618
HHH Groups			H with HH			
Set 1	.		.			
Set 2	.394		.268			
Set 3	.280		.190			
Combine	.179[1]	.196	**.075**[1]	**.???**		

2. Does Revenue Sharing Raise Repayment Rates for High Risk Borrowers? (Treatment 1 vs. 2)

All Groups			H with Anyone		L with Anyone	
Set 1	.783		.262		.345	
Set 2	**.001**		**.004**		.	
Set 3	.385		.917		.878	
Combine	**.009**[1]	**.001**	**.027**[1]	**.027**	.374[1]	.638
HLL/LHL/LLH Groups			H with LL		L with HL	
Set 1	.487		.265		.525	
Set 2	**.003**		**.004**		.	
Set 3	**.017**		**.045**		.440	
Combine	**.001**[1]	**.000**	**.001**[1]	**.000**	.743[1]	.466
HHL/HLH/LHH Groups			H with HL		L with HH	
Set 1	.299		.		.306	
Set 2	.357		.363		.	
Set 3	.352		.		.331	
Combine	.765[1]	.662	.474[1]	.232	.221[1]	.533
HHH Groups			H with HH			
Set 1	.		.			
Set 2	.		.			
Set 3	.223		**.062**			
Combine	.187[1]	.168	**.029**[1]	**.028**		

Table 9 P Values for Loan Repayment Treatment Effects (Cont'd)

3. Does Revenue Sharing Raise Repayment Rates for Low Risk Borrowers? (Treatment 3 vs. 4)

	Group Level Outcomes		*Individual Level Votes*			
	Mann Whitney	**OLS[2]**	**Mann Whitney**	**OLS[2]**	**Mann Whitney**	**OLS[2]**
All Groups			H with Anyone		L with Anyone	
Set 1	**.026**		.645		.218	
Set 2	.515		.990		.960	
Set 3	.313		**.098**		.	
Combine	**.018**[1]	.139	.376[1]	.382	.371[1]	.193
HLL/LHL/LLH Groups			H with LL		L with HL	
Set 1	**.022**		.104		.142	
Set 2	.215		.358		.363	
Set 3	.146		.136		.	
Combine	**.004**[1]	**.001**	**.020**[1]	**.050**	**.069**[1]	.105
HHL/HLH/LHH Groups			H with HL		L with HH	
Set 1	.144		.145		.649	
Set 2	.387		.		.421	
Set 3	.109		**.091**		.	
Combine	**.083**[1]	.143	**.074**[1]	**.037**	.900[1]	.977
HHH Groups			H with HH			
Set 1	.343		**.030**			
Set 2	.884		.373			
Set 3	1.000		.639			
Combine	.520[1]	.648	.213	.406		

4. Does Renege Option Lower Repayment Rates? (Treatment 2 vs. 5)

All Groups			H with Anyone		L with Anyone	
Set 1	.102		**.072**		.836	
Set 2	**.016**		**.012**		.	
Set 3	.556		.828		.194	
Combine	**.009**[1]	**.004**	**.053**[1]	**.000**	.579[1]	.713
HLL/LHL/LLH Groups			H with LL		L with HL	
Set 1	.223		.360		.839	
Set 2	**.012**		**.027**		.	
Set 3	.416		.281		.344	
Combine	**.009**[1]	**.001**	**.014**[1]	**.001**	.758[1]	.853
HHL/HLH/LHH Groups			H with HL		L with HH	
Set 1	.287		.148		.946	
Set 2	.907		.842		.	
Set 3	.302		**.099**		.378	
Combine	.153[1]	.188	**.075**[1]	**.024**	.702[1]	.741
HHH Groups			H with HH			
Set 1	.		.			
Set 2	.		.			
Set 3	.258		**.062**			
Combine	.219[1]	.135	**.037**[1]	**.012**		

Table 9: P Values for Loan Repayment Treatment Effects (Cont'd)

5. Does Revenue Sharing with Renege Raise Repayment from Baseline? (Treatment 1 vs. 5)

	Group Level Outcomes		*Individual Level Votes*			
	Mann Whitney	**OLS[2]**	**Mann Whitney**	**OLS[2]**	**Mann Whitney**	**OLS[2]**
All Groups			H with Anyone		L with Anyone	
Set 1	.143		.454		.437	
Set 2	.321		.737		.	
Set 3	.777		.771		.172	
Combine	.900[1]	.853	.841[1]	.563	.725	.638
HLL/LHL/LLH Groups						
Set 1	.563		.833		.644	
Set 2	.362		.399		.	
Set 3	.176		.418		.142	
Combine	.373[1]	.354	.282[1]	.407	.993[1]	.466
HHL/HLH/LHH Groups						
Set 1	**.052**		.148		.329	
Set 2	.474		.507		.	
Set 3	**.099**		.117		.	
Combine	.106[1]	.399	.316[1]	.421	.338	.533
HHH Groups						
Set 1	.		.			
Set 2	.		.			
Set 3	.		.			
Combine	.	.853	.	.495		

[1] Combining sets is not strictly valid for group or individual level Mann Whitney tests, as outcomes are not independent between sets.

[2] From Wald tests comparing coefficients on treatment dummies in pooled cross section regression using group outcomes or individual votes at set level, using set dummies and demographics. See Appendices 1 and 2 for the underlying regressions.

revenue sharing, to 94.2%, 96.3%, and 89.6% with. Mann Whitney tests in Table 9 Question 3 find these repayment rates to differ significantly for Set 1 and Overall for group outcomes, but regression based tests do not, nor in most cases do either type of test for individual voting rates. Thus Hypothesis 3 of no effect finds only ambiguous support – revenue sharing may actually improve loan repayment rates among low risk borrowers.

Our final repayment question is whether revenue sharing continues to raise repayment rates among high risk borrowers when they can renege on commitments after learning their business outcomes (Hypothesis 4). Disappointingly, but in line with game theory, our results indicate that the renege option hollows out the gains of revenue sharing in raising repayment rates among high risk

borrowers. Again focussing on high risk HLL groups in Table 8, the mean group repayment rates fall from 82.1%, 100.0% and 94.3% by set without a renege option, to 62.8%, 73.3% and 83.9% with the option. In short, the binding revenue sharing option raised the overall repayment rate of HLL groups from 67.3% to 92.3%, but then allowing a renege option reduced it back most of the way, to 73.6%. H voting patterns in HLL groups tell a similar story; pooling over all three sets, repayment votes rise from 72.8% in the baseline, to 96.2% with the revenue share option, back down to 80.0% with revenue sharing plus the renege option. The results for HLL groups carry over to groups of all compositions – pooling across sets, group repayment rates rise from 78.9% in the high risk baseline, to 93.0% with the revenue sharing option, back down entirely to 76.2% when renege is possible.[7] Formal statistical tests in Table 9 Questions 4 and 5 confirm that the renege option significantly lowers HLL group repayment outcomes and associated H votes compared to when renege is not possible, rendering them undifferentiable from repayment outcomes and votes when revenue sharing was not available. This result then carries over to groups of all earnings composition types. The gains of revenue sharing are undone when those who must share the most (H members of HLL groups) can renege on their commitment, confirming both Hypotheses 4 and 5.

V.2 Revenue Sharing Rates

So far, we have seen that the *option* to share revenue raises loan repayment rates for high risk borrowers so long as such commitments are binding once made. But do high risk subjects actually take up revenue sharing to secure these gains as predicted, and are low risk subjects indifferent? Are high risk subjects who can renege on revenue sharing commitments also indifferent to committing to revenue share or not in the first place?

To measure revenue sharing decisions, we again construct revenue sharing rates over the potential rounds for each set, analogous to our loan repayment rate described before. For group share outcomes, we divide the number of rounds a given group in a given set unanimously voted to share revenue, by the number of rounds in which they were eligible to do so. Here, we can count rounds in which a group turns out to have (LLL) earnings, since this is not known at the time sharing is decided upon. To illustrate, a group who unanimously voted to revenue share in Rounds 3 and 4 of a set, but then either earned (LLL) or voted not to repay the loan in Round 4 so as to rule out a Round 5, would have a rate of 2/2 = 1. For individual voting, we similarly divide the number of rounds a person voted to revenue share over the number of rounds he or she was eligible to vote. Figure 2 and Table 10 provides these group and individual revenue sharing rates by set and

[7] There is isolated evidence in a few non HLL groups of individuals punishing those who reneged on revenue sharing by then voting not to repay the loan, despite it being in their pecuniary interest to do so.

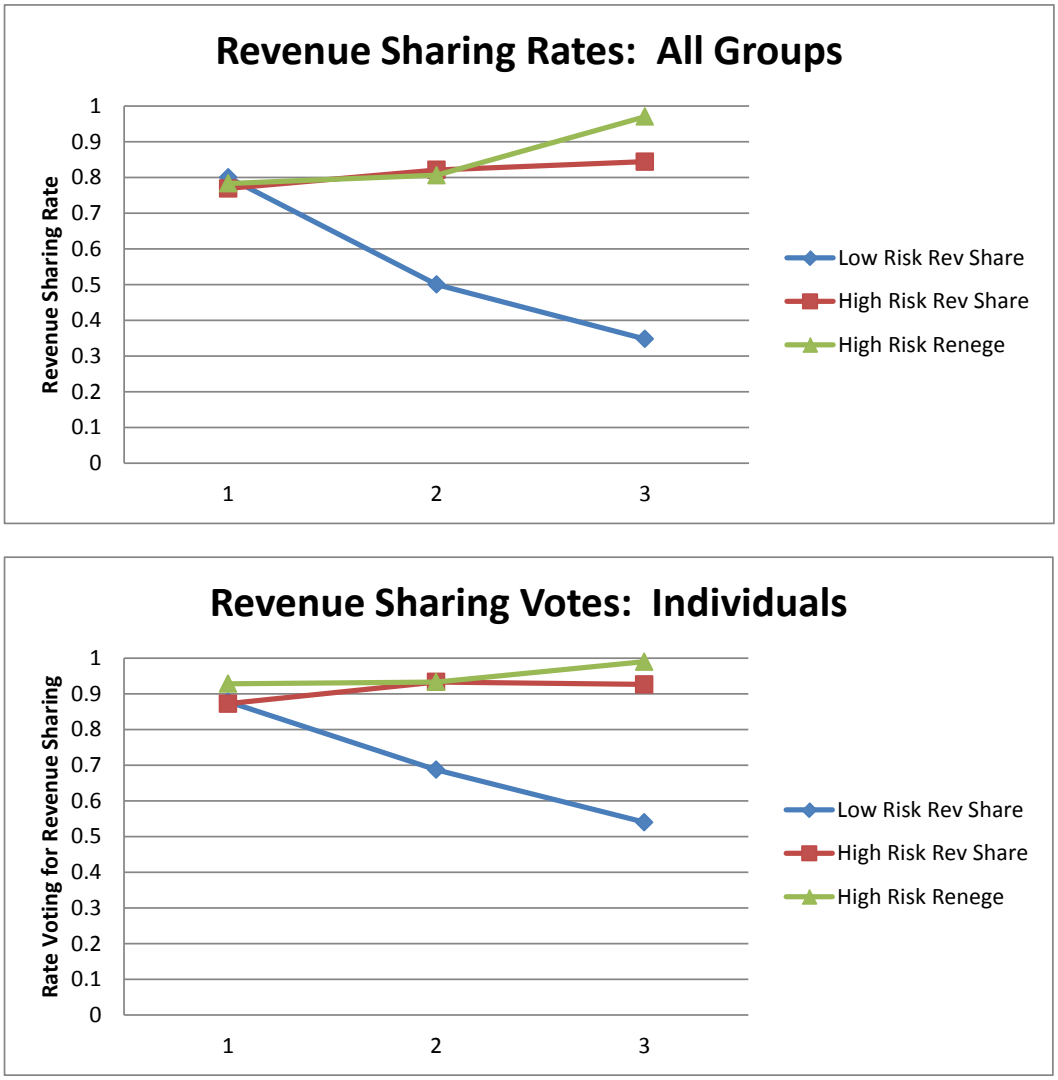


Figure 2: Revenue Sharing Rates by Set for All Groups, and Votes by Individuals

treatment. In keeping with our game theoretic predictions that revenue sharing would bring gains for high risk borrowers, but not for low risk borrowers, we find high risk borrowers were more likely to adopt it. For group outcomes by set, revenue sharing rates were 76.9%, 82.1% and 84.4% for high risk subjects (without a renege option), vs. 80.0%, 50.0% and 34.8% for low risk subjects. Corresponding individual votes by set for revenue sharing were 87.2%, 93.3%, and 92.6% for high risk subjects, and 87.8%, 69.2% and 51.0% for low risk subjects. Mann Whitney and regression tests in Table 10 Question 1 find these differences to be significant in Sets 2 and 3 or over all sets pooled for both group outcomes and individual votes. Less in keeping with predictions, high risk borrowers did not become indifferent as to revenue sharing once the renege option was introduced. Across sets, high risk groups still adopted revenue sharing 78.3%, 80.6% and 97.0% of the time once renege

Table 10: Revenue Sharing Rates By Set and Treatment, and Test P Values (All Two Tailed)

Group Level Outcomes

Treatment	Set	N	Mean Rev Share Rate	Std. Dev.
2 High Risk Rev Share	1	13	.769	.439
	2	14	.821	.296
	3	15	.844	.353
	Overall	42	.813	.357
4 Low Risk Rev Share	1	10	.800	.233
	2	11	.500	.453
	3	11	.348	.369
	Overall	32	.542	.402
5 High Risk RS + Renege	1	10	.783	.334
	2	12	.806	.388
	3	11	.970	.101
	Overall	33	.854	.305

Individual Level Voting

Treatment	Set	N	Mean Rev Share Rate	Std. Dev.
2 High Risk Rev Share	1	39	.872	.319
	2	42	.933	.191
	3	45	.926	.206
	Overall	52	.901	.191
4 Low Risk Rev Share	1	30	.878	.205
	2	33	.692	.387
	3	33	.510	.363
	Overall	35	.690	.261
5 High Risk RS + Renege	1	30	.928	.213
	2	36	.935	.237
	3	33	.990	.058
	Overall	49	.955	.125

1. Is Revenue Sharing Adopted More By High Risk Borrowers? (Treatment 2 vs. 4)

	Group Level Outcomes		*Individual Level Votes*	
	Mann Whitney	**OLS[2]**	**Mann Whitney**	**OLS[2]**
All Groups				
Set 1	.464		.294	
Set 2	**.065**		**.001**	
Set 3	**.001**		**.000**	
Combine	**.001**[1]	**.046**	**.000**[1]	**.000**

2. Is Revenue Sharing Adopted More Often When it Can Be Reneged On? (Treatment 2 vs. 5)

	Group Level Outcomes		*Individual Level Votes*	
	Mann Whitney	**OLS[2]**	**Mann Whitney**	**OLS[2]**
All Groups				
Set 1	.619		.707	
Set 2	.705		.459	
Set 3	.408		.107	
Combine	.769[1]	.793	**.049**[1]	.272

[1] Combining sets is not strictly valid for group or individual level Mann Whitney tests, as outcomes are not independent between sets.

[2] From Wald tests comparing coefficients on treatment dummies in pooled cross section regression using group outcomes or individual votes at set level, using set dummies and demographics. See Appendices 1 and 2 for the underlying regressions.

was an option, and individuals voted to revenue share 92.8%, 93.3% and 99.0% of the time. Mann Whitney and regression tests in Table 10 Question 2 do not find a significant difference in the proportion of high risk groups revenue sharing once renege was an option, although the overall difference among individuals is statistically significant.

V.3 Reneging on Revenue Sharing

We have seen that loan repayment rates were higher when high risk borrowing groups could commit to revenue share, and that indeed more of them chose to revenue share than did low risk borrowing groups. However, we have also seen that most of the increase in loan repayment rates was lost when high risk borrowers could renege on revenue sharing commitments once earnings were revealed. Given that revenue sharing rates did not decline when reneging became an option, we can infer that this is because at least some borrowers reneged on their commitment, rather than because borrowers could foresee this outcome, and declined to revenue share in the first place. It remains to summarize what renege rates were, however, and how they varied by the earnings compositions that groups turned out to have. Recall our theoretical prediction that high risk groups will be indifferent to revenue sharing or not, but if revenue sharing occurs, renege will occur in groups containing even one L earner.

We construct a renege rate in a way analogous to our repayment and revenue sharing rates. For group outcomes, we take the number of rounds a given group in a given set did not revenue share after having voted unanimously to do so, divided by the number of rounds in which they were eligible to have this occur. Here, groups who voted unanimously to revenue share but then experienced (LLL) earnings are excluded, since they did not face a confirmation decision. We calculate a renege rate for groups of all non-LLL compositions combined, as well as conditioned by earnings composition. Note that as fewer groups meet the criteria for inclusion in the renege rate, the number of observation can become severely limited, particularly for high risk businesses achieving (HHH) earnings. For individual renege votes, we similarly take the number of rounds an individual voted to renege on a unanimous agreement to revenue share, divided by the number of rounds he or she was eligible to do so. Renege rates are provided by set in Figure 3 and in Table 11.

As Figure 3 and Table 11 indicate, group renege rates appear slightly higher in groups containing two or one low earners than in (rarer) groups with all high earners. Combined across the three sets, renege rates for these group compositions were 39.1%, 33.%, and 25.0%, respectively, though none of these rates differ significantly in pair-wise Mann Whitney tests. At the individual level, high earners appear more likely to vote to renege on revenue sharing agreements as the

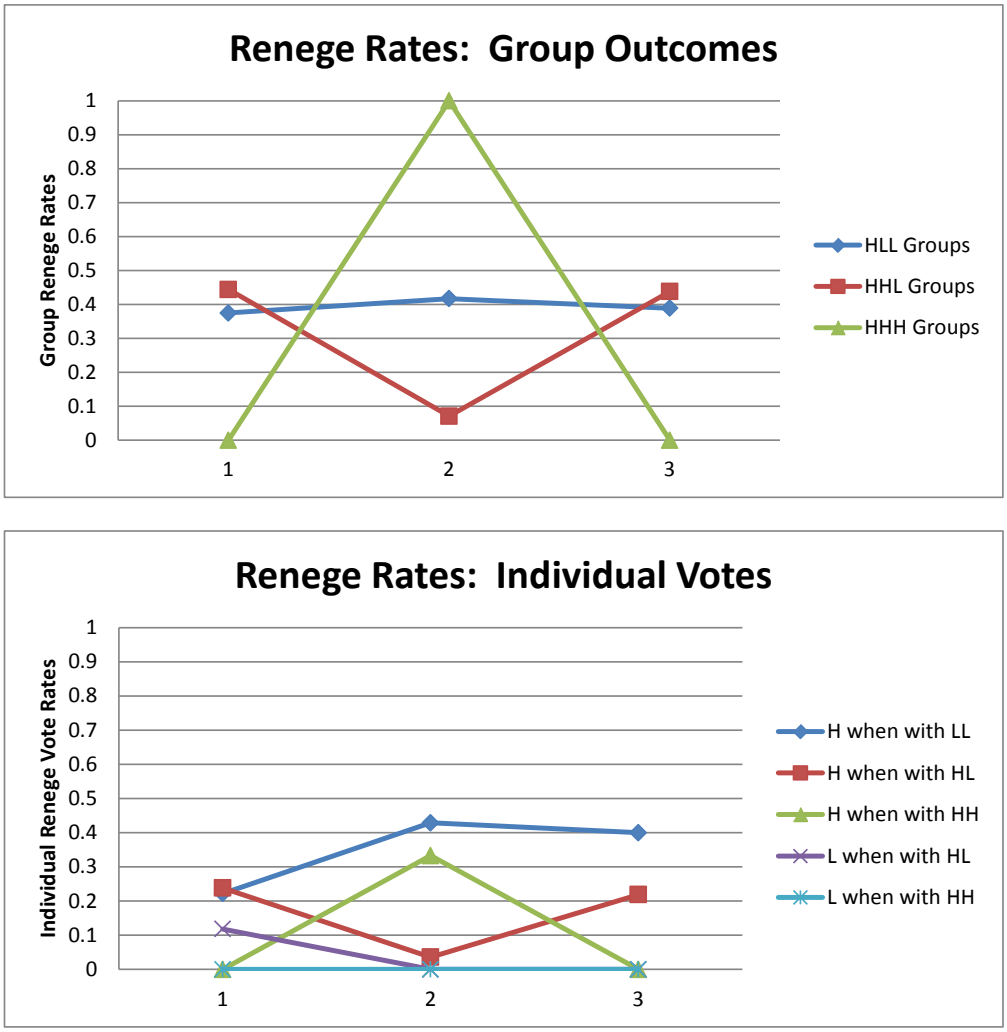


Figure 3: Renege Rates by Set for Group Outcomes and Individual Votes in Treatment V

number of in-group low earners increases, from 8.3% of the time with no low earners, to 21.7% of the time with one low earner, to 31.0% with two low earners, when all sets are pooled. However these differences are not significant (from (HHH) to (HLL) groups Mann Whitney p value .12). High earners also appear more likely to renege than low earners (18.7% vs. 3.8% overall, 31.0% vs. 5.6% in HLL groups, and 20.6% vs. 0.0% in HHL groups). These differences are for the most part statistically significant, and in the direction predicted by theory.[8] Nevertheless, the absolute levels of reneging are much lower than would be predicted by theory. For example, in individual voting, pooled over all three sets, fully 69% of high earners do not vote to renege on unanimously adopted revenue sharing agreements upon learning they are in HLL groups, and 78.3% similarly refrain upon learning

[8] In particular, high earners are significantly more likely to renege than low earners for all three sets when unconditioned on the composition of the other two group members, and in Sets 2 and 3 of HLL groups, and in Set I of HHL groups.

Table 11: Renege Rates by Set and Composition [1]

Group Level Outcomes				**Individual Level Voting**							
I. All Groups (excl LLL)				**H with Anyone**				**L with Anyone**			
Set	**N**	**Renege Rate**	**Std. Dev.**	**Set**	**N**	**Renege Rate**	**Std. Dev.**	**Set**	**N**	**Renege Rate**	**Std. Dev.**
1	9	.352	.377	1	23	.188	.323	1	20	.075	.245
2	8	.250	.282	2	17	.157	.285	2	15	.000	.000
3	11	.348	.425	3	22	.220	.396	3	21	.000	.000
Overall	28	.321	.363	Overall	38	.184	.292	Overall	40	.038	.177
II. HLL Groups				**H with LL**				**L with HL**			
1	8	.375	.518	1	9	.222	.441	1	17	.118	.332
2	6	.417	.492	2	7	.429	.535	2	13	.000	.000
3	9	.389	.486	3	10	.400	.516	3	19	.000	.000
Overall	23	.391	.476	Overall	21	.310	.460	Overall	36	.056	.232
III. HHL Groups				**H with LH**				**L with HH**			
1	9	.444	.464	1	21	.262	.436	1	12	.000	.000
2	7	.071	.189	2	14	.036	.134	2	7	.000	.000
3	8	.438	.496	3	16	.219	.407	3	8	.000	.000
Overall	24	.333	.434	Overall	34	.217	.373	Overall	23	.000	.000
IV. HHH Groups				**H with HH**							
1	1	.000	.	1	3	.000	.000				
2	1	1.000	.	2	3	.333	.577				
3	2	.000	.000	3	6	.000	.000				
Overall	4	.250	.500	Overall	12	.083	.289				

[1] Only an option in Treatment 5. Renege Rate is conditioned on group composition, and excludes those who experienced (LLL), those who had not unanimously agreed to revenue share for a round, or those no longer receiving loans by round 3 of a set.

they are in HHL groups. These are far below the 0% rates predicted by standard theory. At the same time, as seen earlier, the reneging that does occur is enough to reduce loan repayment rates to the (surprisingly high) levels they were in the high risk borrower baseline treatment, where revenue sharing was not even an option.

VI. Conclusion

Microcredit with group liability has been found to work well for advancing credit to low risk borrowers, but has had limited uptake from higher risk borrowers. We argue this is caused in part by the fact that, compared to analogous low risk borrowers, successful high risk borrowers have to pay more to "bail out" less successful group members, and that these "bail outs" are more likely to exceed the expected benefits of repaying the loan than they are in the case of low risk borrowers. In this paper, we have proposed a revenue sharing mechanism that higher risk borrowers could use under group-liability microcredit. High risk borrowers could commit *ex ante* to share a fraction of their subsequent revenues with other borrowing group members, prior to learning whether those revenues will be high or low. If binding once agreed to, this revenue sharing option can make it in high risk borrowers' interests to repay the group loan under more earnings states than for high risk borrowers without this option. With repayment predicted under more states with revenue sharing, the reward to borrowers from ensuring a current loan is repaid so as to qualify for future loans is increased. This in turn can increase the incentives high risk borrowers have to ensure initial group loans are repaid, even if revenue sharing is not initially required or offered when borrowing groups first join together. A limitation of this mechanism is that its gains could unravel if high risk borrowers who end up doing well could renege on revenue sharing commitments once earnings outcomes are realized.

We conduct a lab experiment to test this mechanism. Under a full information design where high or low earnings are randomly assigned to three person borrowing groups and all repayment or revenue sharing require unanimity, we find greater baseline cooperation among high risk borrowers to ensure loan repayment than would be predicted by theory. Beyond that, the predictions of our theory are consistent with the treatment effects we observe. First, we are able to replicate Banerjee and Duflo's (2011) finding that loan repayment rates (and underlying votes for repayment) are lower for high risk borrowing groups than for low risk borrowing groups. Second, we find that including a 40% revenue sharing option raises loan repayment rates among a pivotal type of high risk borrowing group: those containing a majority of low earners. As predicted, this is because the minority high earners in such groups are more likely to vote for repayment. Unfortunately, we find that much of this gain from revenue sharing in raising loan repayment rates among high risk borrowers is indeed lost if they can renege on revenue sharing commitments.

We find auxiliary results that are partly consistent with theoretical predictions: high risk borrowers are more likely to adopt revenue sharing than low risk borrowers, since it should raise the expected earnings of the former, and make no difference to the latter. On the other hand, revenue

sharing should make no difference to expected earnings if renege is possible, yet high risk borrowers who can renege commit to revenue share just as often as those who cannot renege. Overall, 33% to 39% of groups who unanimously committed to revenue share had at least one member renege when the group contained at least one low earner. The unravelling of revenue sharing's benefits to loan repayment rates occurred because of these reneges, rather than because groups stopped voting to revenue share in the first place when renege became an option.

While revenue sharing does appear to have the potential to make microcredit more attractive to high risk borrowers, and thus to microfinance organisations who required low default rates, the vulnerability of this mechanism to reneging is also evident. Unfortunately, microfinance has the greatest potential for good precisely in those settings where third parties such as courts may not be relied upon to enforce commitments or contracts to revenue share *ex post*. Profitable future research could look for acceptable ways that high risk borrowing groups could enforce such commitments once made.

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Appendix 1: OLS Regressions Underlying Tests for Treatment Effects, at Group Outcome Level

	Pooled Group Loan Repay Rate	HLL Group Loan Repay Rate	HHL Group Loan Repay Rate	HHH Group Loan Repay Rate	Rev Share Adoption Rate
Constant	.982***	.905***	1.042***	.946***	.061
	(.161)	(.257)	(.164)	(.079)	(.353)
Treatment 2 (HRRS)	.192***	.341***	0.021	-.048	Omitted
	(.059)[1]	(.079)	(.058)	(.036)	Baseline
Treatment 3 (LR)	.120**	.197**	-.023	-.071	
	(.056)	(.087)	(.062)	(.055)	
Treatment 4 (LRRS)	.192***	.422***	.048	-.098**	-.213**
	(.062)	(.078)	(.062)	(.045)	(.098)
Treatment 5 (HRRSR)	-0.001	.079	-.057	-.003	.023
	(.070)	(.088)	(.064)	(.030)	(.091)
Set 2	.013	.065	.045	-.010	-.061
	(.044)	(.063)	(.045)	(.023)	(.083)
Set 3	.025	.108*	.042	-.063	-.030
	(.042)	(.057)	(.040)	(.039)	(.082)
Male/Male/Fem	-.001	-.001	-.033	.060	.072
	(.054)	(.068)	(.042)	(.055)	(.130)
Male/Fem/Fem	-.093	-.091	-.063	.027	.196
	(.065)	(.081)	(.051)	(.060)	(.125)
Fem/Fem/Fem	-.091	-.166*	-.038	.045	.074
	(.072)	(.094)	(.057)	(.071)	(.153)
Taken Econ (ave)	.073	.106	-.007	.018	-.186
	(.078)	(.104)	(.064)	(.056)	(.154)
Taken Stats (ave)	-.040	-.083	-.014	.092	.122
	(.078)	(.110)	(.071)	(.080)	(.155)
English 1st Lang (ave)	.117	.232**	.130	-.053	.459***
	(.078)	(.109)	(.085)	(.062)	(.170)
Trust Others (ave)	-.030**	-.028*	-.029**	.018*	-.006
	(.013)	(.016)	(.013)	(.011)	(.026)
Age (ave)	-.006	-.014	-.001	-.003	.018**
	(.006)	(.011)	(.006)	(.004)	(.009)
No. Others Recognized (ave)	.013*	.002	.011**	-.007	-.013
	(.007)	(.011)	(.005)	(.010)	(.024)
N[2]	216	183	175	126	107
R Square	.150	.227	.092	.154	.286

[1] Robust standard errors in parentheses.

[2] N is less than 234 in loan repayment regressions because some groups experienced LLL earnings in round 1 of a set, or did not experience a given earnings configuration during a set, or demographics are missing.

Appendix 2: OLS Regressions Underlying Tests for Treatment Effects, at Individual Voting Level

	H with Anyone Repay	H with LL Repay	H with HL Repay	H with HH Repay	L with Anyone Repay	L with HL Repay	L with HH Repay	Voting to Share Revenue
Constant	.904***	.763***	.942***	.912***	.902***	.901***	.910***	.869***
	(.061)	(.155)	(.038)	(.072)	(.044)	(.055)	(.055)	(.077)
Treat 2 (HRRS)	.083***	.244***	.026	-.062**	.010	.019	-.011	Omitted
	(.026)[1]	(.064)	(.021)	(.028)	(.021)	(.026)	(.018)	Baseline
Treat 3 (LR)	..058**	.200***	-.000	-.045*	-.003	-.001	-.012	
	(.027)	(.086)	(.023)	(.027)	(.027)	(.034)	(.023)	
Treat 4 (LRRS)	.075***	.294***	.031	-.073***	.026	.044**	-.013	-.198***
	(.028)	(.062)	(.021)	(.024)	(.020)	(.022)	(.024)	(.043)
Treat 5 (HRRSR)	-.020	.063	-.022	.011	.016	.015	-.003	.035
	(.034)	(.076)	(.027)	(.016)	(.018)	(.023)	(.016)	(.032)
Set 2	-.019	.044	-.008	.003	.045***	.053**	.043*	-.032
	(.019)	(.054)	(.013)	(.018)	(.016)	(.021)	(.023)	(.038)
Set 3	-.008	.076	-.007	-.025	.038**	.042**	.039*	-.063*
	(.017)	(.049)	(.013)	(.023)	(.017)	(.021)	(.021)	(.037)
Male	.023	.060	.008	-.015	.034**	.041**	.020	-.054*
	(.019)	(.048)	(.015)	(.019)	(.015)	(.020)	(.017)	(.032)
English 1st Lang	.046**	.063**	.033*	-.022	.022	.019	.008	.071
	(.022)	(.049)	(.020)	(.014)	(.017)	(.019)	(.019)	(.045)
Grade "B" range	.033*	.046	.016	-.010	-.011	-.011	.000	.017
	(.018)	(.044)	(.012)	(.024)	(.013)	(.015)	(.017)	(.032)
Grade "C" range	.036	.143**	-.010	-.001	-.001	-.031	.031	.045
	(.029)	(.061)	(.033)	(.022)	(.028)	(.042)	(.021)	(.058)
Trust Others	.003	.004	.002	-.007	.001	-.001	.002	-.005
	(.004)	(.009)	(.002)	(.006)	(.003)	(.004)	(.003)	(.007)
Age	-.002	-.007	-.000	.004*	-.000	-.001	-.000	
	(.002)	(.005)	(.000)	(.002)	(.001)	(.001)	(.001)	
No. Others Recognized	.004**	.009**	.011**	-.004	.003***	.003**	.003**	-.006
	(.002)	(.004)	(.005)	(.004)	(.001)	(.001)	(.001)	(.006)
Others are Fair	.001	.010	.001	-.002	-.001	-.000	.001	
	(.004)	(.010)	(.002)	(.006)	(.003)	(.004)	(.002)	
Take Risks	-.001	-.001	.003	.003	.003	.001	.006	
	(.005)	(.001)	(.003)	(.006)	(.003)	(.004)	(.005)	
Taken Econ								-.052
								(.040)
Taken Stats								.059
								(.039)
N[2]	567	248	419	294	512	418	260	316
R Square	.064	.165	.053	.077	.051	.056	.052	.174

[1] Robust standard errors in parentheses.

[2] N is less than 702 in loan repayment regressions because some individuals experienced LLL earnings in round 1 of a set, or did not experience a given earnings configuration during a set, or demographics are missing.