Microfinance Games*

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Abstract

Microfinance has been heralded as an effective way to address imperfections in credit markets. From a theoretical perspective, however, the success of microfinance contracts has puzzling elements. In particular, the group-based mechanisms often employed are vulnerable to free-riding and collusion, although they can also reduce moral hazard and improve selection. We created an experimental economics laboratory in a large urban market in Lima, Peru and over seven months conducted eleven different games that allow us to unpack microfinance mechanisms in a systematic way. We find that risk-taking broadly conforms to predicted patterns, but that behavior is safer than optimal. The results help to explain why pioneering microfinance institutions have been moving away from group-based contracts. The work also provides an example of how to use framed field experiments as a methodological bridge between laboratory and field experiments.

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1 Introduction

Banking in low-income communities is a notoriously difficult business. Banks typically have limited information about their customers and often find it costly or impossible to enforce loan contracts. Customers, for their part, frequently lack adequate collateral or credit histories with commercial banks. Moral hazard and adverse selection, coupled with small transaction sizes, together limit the possibilities for banks to lend profitably.

Despite these obstacles, over the past three decades microfinance practitioners have defied predictions by finding workable mechanisms through which to make small, uncollateralized loans to poor customers. Repayment rates on their unsecured loans often exceed 95 percent, and by 2005 (officially-designated by the United Nations as the "International Year of Microcredit"), microfinance institutions had served about 100 million customers around the world.

This achievement has been exciting to many, and advocates describe microfinance as a revolutionary way to reduce poverty (Yunus 1999). From a theoretical perspective, though, the success has puzzling elements. Many of the new mechanisms rely on groups of borrowers to jointly monitor and enforce contracts themselves. However, group-based mechanisms tend to be vulnerable to free-riding and collusion. Inefficiencies are well known to emerge in similar contexts: examples are documented in the literatures on public goods, the tragedy of the commons, insurance, and environmental externalities (Gruber (2005), e.g., describes examples).

We created an experimental economics laboratory in a large, urban market in Lima, Peru, and conducted eleven different games which allow us to unpack microfinance mechanisms in a systematic way.[1] The experiments took place twice a week for seven months. All of the participants were small-scale entrepreneurs in the market. By design, the demographic and economic profiles of participants are similar to those of microfinance customers in urban Peru. The simulated microfinance transactions involved

[1] Harrison and List (2004) would classify the approach as a series of "framed field experiments." Examples of the approach in other settings include List (2004) and Barr and Kinsey (2002). The closest study to this paper is Cassar, Crowley and Wydick (2005) which conducts a series of repeated public goods games, framed as a decision to repay a loan, in South Africa and Armenia in order to relate contributions to likely behavior in a microfinance setting.

players choosing hypothetical risky investments, receiving loans, and managing the risk of default. In a typical day, we played two or three games, and over seven months of experimental sessions each of the eleven variants of the game was played on average 27 times. Participants were compensated based on their success as investors in the simulations. By working in Lima and designing the games to replicate actual microfinance scenarios, our aim has been to understand the logic of the mechanisms with individuals likely to participate in an actual microfinance program, but not to replicate exactly customers' experience with microfinance.

The simulated environment allowed us to test systematically many of the features embedded in lending contracts; such a strategy would be impractical for bankers. By playing a sequence of games with the same individuals, we are able to isolate the impact of contract from innate propensities to take risks. Second, the experiment allows us to control the nature of risky choices thus allowing us to gauge explicitly impacts on risk-taking.

We show that the tendency toward free-riding also emerges in experimental settings that simulate microfinance transactions: moral hazard is exacerbated by simple group-based microfinance contracts that make customers jointly liable for all group members' repayments. However, we show that moral hazard is allayed by allowing customers to form their own groups voluntarily. Moreover, the mutual insurance induced by joint liability can allow borrowers to invest in profitable risky projects without reducing overall repayment rates. Given endogenous group formation, microfinance contracts do function effectively to reduce moral hazard and facilitate profitable risk-taking. We find that in the most "true-to-life" game, participants tend, in fact, to take *too little* risk relative to the optimum. The finding is consistent with a strong role for social factors in group settings.

We find in particular that participants who have a propensity to take risks tend to reduce their risk-taking when their partners act more safely. The result is consistent with altruism or fairness, rather than profit maximization.[2]

In Section 2, we discuss the microfinance mechanisms that motivate the experiments. In Section 3, we outline the competing roles of *ex ante* moral hazard and mutual insurance that are at the heart of the study. Section 4 describes the lab setting and participant pool. Section 5 presents theoretical predictions and initial data that relate contract structure to individual choices. Section 6 presents our main empirical results, and Section 7 concludes.

2 Microfinance mechanisms

Microfinance loan contracts typically include multiple and overlapping mechanisms aimed at reducing the risk of default. A large theoretical literature details how these components work in isolation to mitigate problems arising from information asymmetries, but empirical progress in sorting out the pieces has proved slower.

To see the complexity, consider the following microfinance mechanism, often called a "group lending" or "joint liability" contract; it is based on models first employed in South Asia and Latin America in the late 1970s. The mechanism begins with a lender deciding to enter a new location. In preparation for entry, the lender announces to residents of the community that in order to access credit, potential customers must first form small groups. In Bangladesh, groups have typically been restricted to five people, but sizes vary across programs and regions. Borrowers obtain loans and invest the funds independently, selecting investments based on the technologies available and their own perceptions of risk and return. Access to loans continues without interruption as long as all loans are repaid. But all group members are denied future credit if any member fails to repay. In this sense, the group members are jointly liable for the loan repayments of their peers.

Joint liability is used to harness customers' information about each other and their mutual relationships to the lender's advantage. First, group self-formation provides a

[2] For instance, see Rabin (1993) and Fehr and Schmidt (1999) for recent work that incorporates fairness into decision-making models.

screening mechanism that can help to reduce adverse selection (e.g., Ghatak 1999). In addition, moral hazard can be reduced either by fostering cooperation among group members (e.g., Stiglitz 1990) or through repeated interactions (Armendariz de Aghion and Morduch 2000). The group element provides an inducement for members to monitor each other (Banerjee, Besley and Guinnane 1994) and to punish each other in the face of moral hazard, possibly through social sanctions (Wydick 1999; Karlan 2005a). In sum, group liability can potentially reduce risk-taking and improve the lender's repayment rate.

It could also increase risk-taking, though, by fostering a mutual insurance arrangement within the group. This could be helpful for the bank and customers (Sadoulet 2000) or could lead to free-riding or collusion against the bank (Besley and Coate 1995). By just observing the mechanism as implemented, it is difficult to determine the relative importance of group formation, the dynamic incentives created by repeated interactions, peer monitoring, peer enforcement, mutual insurance, free-riding, or collusion.

Ideally, researchers would like to analyze the behavior of customers who are (randomly) offered a wide range of different credit contracts, each designed to reveal the logic behind a particular component. As a practical matter, though, this kind of randomized variation is difficult to implement. Identifying the role of each component, though, is critical for understanding how microfinance markets function – and for determining where the largest payoff to innovation might lie in expanding financial access. We use the methods of laboratory experimental economics to understand the logic of existing microfinance mechanisms and illuminate various theoretical explanations of their performance. The experimental setting also allows us to accommodate psychological and social forces that may systematically operate alongside standard economic motivations.

3 Design of the experiment

The games were designed to capture the logic of the best-known microfinance contract features, focusing on moral hazard and the ways that contracts reduce default rates by enabling partners to insure one another and by creating social costs to individual default. To disentangle the relative importance of specific mechanisms behind joint liability contracts, we place participants in an experimental setting inspired by Stiglitz's (1990) model of *ex ante* moral hazard in microfinance. We then extend the model to consider the impact of introducing opportunities for monitoring, coordination, and enforcement.

Note that *ex-ante* moral hazard broadly construed includes many types of behavior. The typical description involves entrepreneurs changing from a safe project to a risky project due to incentives from the loan contract. For a microentrepeneur who manages a small shop, such a change could be subtle, e.g., buying more inventory than they would normally, or buying a new product for which the revenue is uncertain. Ex-ante moral hazard might also be manifested in diversion of the loan from business to household needs, hence lowering expected revenue. Although microfinance lenders typically target micro-entrepreneurs, it is widely accepted that many borrowers use the proceeds for consumption smoothing (Menon 2003; Armendariz de Aghion and Morduch 2005).

It is worth emphasizing that moral hazard does not necessarily entail any social inefficiency: diverting loan funds toward consumption smoothing by poor families may well be welfare-enhancing, and risky projects that are undesirable from the bank's perspective may be socially optimal if they have high expected returns. However, to the extent that the bank cannot observe loan use and vary the interest rate accordingly, a moral hazard problem exists when a bank would like to offer borrowers loans to invest in safe, profitable business ventures, but the bank cannot prevent clients from diverting the funds toward riskier or less (economically) productive activities.

3.1 A model of investment in risky projects

Following Stiglitz, we model the decision facing borrowers as a choice between a relatively risky and a relatively safe project. A weakly risk averse agent receives a loan of size L and must invest it in one of two projects. Thus, the borrower chooses an action from the set $\{R, S\}$, where R denotes the risky project, which yields profits Y_R with probability π_R and zero otherwise, and S denotes the safe investment, which suceeds and pays out $Y_S < Y_R$ with probability $\pi_S > \pi_R$. Because borrowers are poor, an agent can only repay her loan when her project is successful. Hence, the safe project is desirable from the bank's point of view. We do not assume that one project has a higher expected value than the other. However, project choice is not observable to the lender, so the bank cannot charge individuals a lower interest rate when they take the safe option. Hence, the bank would like to design a loan contract that induces safe behavior among borrowers (or, through a joint liability clause, forces them to insure each other). That desire is complicated by the fact of limited liability: some borrowers who would have chosen the safe investment instead choose the risky investment once downside risk is limited.

In a one-shot setting, an individual borrower would choose the safe project if $\pi_S[u(Y_S - L)] \geq \pi_R[u(Y_R - L)]$, assuming that $u(0) = 0$. No microfinance lenders, though, offer their clients a single, one-shot loan. Instead, they offer the prospect of a series of loans, often of increasing size, spread out over future periods. Hence, the bank can attempt to encourage safe project choice by denying future credit to agents who default in any period. Then, given infinite possible repetitions and an individual discount factor β, an agent would choose the safe investment option whenever

$$\frac{\pi_S[u(Y_S - L)]}{1 - \beta\pi_S} \geq \frac{\pi_R[u(Y_R - L)]}{1 - \beta\pi_R}.$$

Clearly, borrowers who were at the margin in the one-shot setting will be induced to invest in the safe project in the face of such dynamic repayment incentives. However, this strategy may not maximize profits (or whatever else the microfinance lender seeks to maximize) over the long-term because a faction $1 - \pi_S$ of unlucky borrowers investing in the safe project are excluded every period.

Banks can also offer group loans in lieu of individual credit. Adding a joint liability clause to the borrowing contract, though, may increase the rate of risky project choice. This occurs because joint liability forces agents to insure their partners, taxing successful projects.

PROPOSITION: Define the *marginal individual liability borrower* as an agent with preferences such that $\pi_S[u(Y_S - L)] = \pi_R[u(Y_R - L)]$. Under joint liability, a marginal individual liability borrower prefers the risky project to the safe one.

PROOF: See Mathematical Appendix.

The relationship shows that, though all agents prefer to have a safe partner, the only agents who prefer to *be* a safe partner are individuals who are risk averse enough that they would have chosen the safe project under individual liability.

However, for many parameter values, agents with levels of risk aversion near (both above and, more importantly, below) that of the marginal individual liability borrower face a prisoner's dilemma: though each individual prefers to invest in the risky project, coordination on the safe option is a Pareto improvement over the all-risky Nash equilibrium. In this case, joint liability might facilitate safe project choice in several ways. First, if, as in the Stiglitz model, investment decisions are visible *ex ante* or are, in effect, made jointly, agents can simply commit to the safe project. Alternatively, borrowing partners may have access to social sanctions unavailable to the bank, and these may be coupled with better information about actions that the lender cannot observe. If, upon learning *ex post* that one's partner chose the risky investment, an agent can impose a social cost, $c > 0$, on the other borrower, the incentive compatibility constraint facing the borrower becomes

$$\pi_S\{[\pi_S q + \pi_R(1-q)][u(Y_S - L)] + [(1-\pi_S)q + (1-\pi_R)(1-q)][u(Y_S - 2L)]\}$$
$$\geq \pi_R\{[\pi_S q + \pi_R(1-q)]u[(Y_R - L)] + [(1-\pi_S)q + (1-\pi_R)(1-q)][u(Y_R - 2L)]\} - \lambda c$$

where λ is the probability that one's partner will punish risky behavior[3] and q is the probability that one's partner invests in the safe project. The possibility of social sanctions makes the risky option less attractive and should increase the rate of safe project choice. Moreover, if borrowing groups are given a series of loans over time, coordination on safe behavior is always possible when discount rates are low enough.

Which, if any, of these mechanisms drives the observed tendency toward safe behavior among microfinance borrowers depends, in part, on the nature of asymmetric information *between* borrowing partners. Much theoretical work on microfinance (e.g. Besley and Coate 1995, Ghatak and Guinnane 1999) explores the role of monitoring, assuming that agents differ from the lender both because they can observe the actions of their borrowing partners *ex post* and because they have recourse to social sanctions unavailable to the bank. In Stiglitz' original model, on the other hand, agents cannot sanction each other, but they have more than perfect information: they can credibly commit to strategies that are not Nash equilibria. However, in the real world, even in a small village, each agent may not know the full specification of another villager's preferences (see for example Laffont and N'Guessan (2000) and Armendariz de Aghion and Gollier (2000) for theoretical models that assume imperfect information among borrowers). Alternatively, they may have access to perfect information, but it may be costly to obtain.

In the simplest case, individuals may not have better information than the bank; they may only differ from the lender because they have recourse to non-pecuniary punishments for bad borrowing behavior. In such a setting, an agent would be forced to make inferences about the probability that an observed outcome resulted from excessively risky behavior on the part of one's partner. Given any prior belief, q, about the likelihood of safe project choice by her partner, an agent will revise her belief down whenever she receives a negative signal and is forced to repay a loan for her partner, and she will revise her belief up whenever she receives a positive signal. However, whether

[3] There is no reason to punish safe behavior, since, at all parameter values, every agent (at least weakly) prefers a safe partner.

any particular signal translates into punishment depends on the parameters of the model and the perceived costs and benefits of punishing bad behavior, lettings bad behavior go unpunished, and inadvertently punishing the bad luck of safe types.

If monitoring is costless and automatic within a village, then the structure of the game is much simpler: those who wish to punish excessively risky actions will always do so, and there is only uncertainty about whether one's partner is a safe type who will punish risky actions. Thus, adding costless monitoring to a model of joint liability should increase rates of safe project choice. Moreover, if agents are given the opportunity to communicate and state their strategies *ex ante*, coordination problems should disappear, though this may or may not increase rates of conservative behavior depending on the parameters of the model.

3.2 The microfinance game

Our benchmark game extends Stiglitz's model of moral hazard to a dynamic framework where agents make repeated project choice decisions. Each participant was first given a game sheet marked with spaces for ten rounds, but participants were told that the game might end after any given round and we varied the ending round across games. In the analysis below, we focus on the first six rounds only to minimize potential survivor biases (participants with a propensity to choose the safe project will be disproportionately represented among active participants as the game proceeds); the qualitative results are robust to restricting analyses to even earlier rounds.

In each round, participants were given a "loan" of 100 points and instructed to invest it in one of two projects: a safe project ("project square") which yielded a return of 200 points with certainty or a riskier project ("project triangle") that pays out 600 points with probability ½ and zero otherwise. At no time during the games did we refer to the choices as "safe" and "risky."

An individual whose project succeeded had to repay her loan, while an individual whose project failed did not; wealth from prior rounds could not be used to repay the current round's loan. Thus limited liability – and hence the possibility of moral hazard –

is introduced. In each round, the safe project had an expected (and certain) net return of 100 points after repaying the principal, whereas the risky project had an expected return of 250 points (50 percent chance of 500 points and 50 percent chance of zero).

In Stiglitz's model, as in much of the theoretical work on microfinance, safer projects are assumed to have higher expected returns than riskier projects, and, consequently, the bank's optimum is equivalent to the social optimum. In that context, an optimal contract induces a safe project choice. We relax this assumption here for several reasons. First, the assumption that risky projects have higher expected returns than safe projects is more realistic than the alternative assumption that the expected returns to safe projects are higher (de Meza and Webb 1990). One objective in expanding financial access is to enable borrowers to make risky investments in pursuit of higher incomes – and the structure highlights this possibility. Moreover, our pilot games suggested that participants were risk averse even over small stakes. When gross project returns were equal in expectation, risk aversion appeared to eliminate moral hazard, and most participants chose the project that was optimal from the bank's perspective. In light of this finding, we calibrated the project returns so that approximately equal numbers of participants would choose the safe and the risky project in the benchmark games. In our most "true-to-life" game, the calibration yields an average loan repayment rate (94 percent) that approximates repayment rates achieved by leading microfinance institutions.

We compare individual liability games to outcomes under a "joint liability" (JL) contract structure that captures elements of the "group lending" approach described in the previous section. In the joint liability treatments, each participant was matched with a single partner and investment payouts depend on both one's own decisions and one's partner's choices.[4] Table 1 shows the expected net returns. If both partners choose safe investments, their outcomes are identical to those in the benchmark individual game: each participant is guaranteed a safe return of 100 points. But if a safe investor is partnered with someone who chooses the risky investment, the safe investor can expect to bail out its partner half the time. The only case in which the group may not be able to

[4] We test different matching processes, including random and anonymous, random and public, as well as peer-selected.

repay the bank occurs when both partners choose risky investments and fail, a situation that occurs with a probability of one quarter given that outcomes are independent.

From the risk-taker's point of view, choosing the risky investment when the partner chooses the safe investment is a particularly winning arrangement – though it imposes burdens on the partner. From the lender's perspective, risk-taking may result in lower repayment rates. In this sense, risk taking has an element of moral hazard. However, note that the payoff structure is such that some degree of risk-taking is desirable from the borrower and the lender's perspective as long as at least *one* person chooses the safe project, since the lender should prefer higher profits for its clients as long as repayment is not jeopardized. Thus, in the analysis, we will examine the determinants not only of risky choice, but of the coordination of the players as well.

Table 1 shows the advantages to information and coordination in this setting. If a participant has no information on the investments of their partner, they are left guessing about how exposed they are. Depending on preferences over risk, this could push toward safer or riskier behavior. But with information and the possibility of coordinating, a strategy of alternating safe and risky investments can emerge that over time will trump outcomes in which both group members choose the safe option. Here, for instance, one participant could choose the risky choice while the partner chooses the safe option; next round they switch investment choices; and so forth. Table 1 shows that this (safe-risky, risky-safe, safe-risky, etc.) strategy removes default risk completely while ensuring higher expected returns than the case in which both partners always opt for the safe choice. The downside is that it is unclear how long the game will last, nor whether it is possible to sustain coordination. Risky-risky choices carry greater risk, but they also promise higher expected net returns. For the bank, the risky-risky situation is unambiguously the worst outcome since it alone carries the possibility of default.

4 The lab setting in Peru and the nature of the sample

To capture the logic of microfinance as accurately as possible, we implemented our game design as a "lab experiment in the field" or a "framed field experiment" which we played with owners and employees of micro-enterprises in Lima, Peru. We set up our experimental lab in an isolated room in a large consumer market, Polvos Azules, located in the center of the city. The market has approximately 1,800 stalls where vendors sell clothes, shoes, personal items, jewelry, and consumer electronics. We used two methods to recruit participants. First, we hired delegates from the local association of micro-entrepreneurs to round up players for specific game sessions. We then invited participants to return for subsequent sessions and to invite their friends and neighbors from the same market. On certain days, only previous participants (hosts) were allowed to play if they invited someone that had never played (a guest).

We played eleven different games an average of 27 times each over the course of seven months (from July 2004, to February 2005). Our sample includes data from 324 games played over the course of 81 days. We had 491 participants who played an average of eleven games each. Table 2 describes the allocation of players across games. 238 participants attended only one game session, while 23 participants attended more than ten sessions.

We informed participants that we would convert the points they won in each round into Peruvian currency (Nuevos Soles) at a constant rate. Payouts were made at the end of each game session, after all the games were completed. Each individual was awarded 10 Soles for showing up on time, an amount which is equal to approximately two hours worth of profits for the micro-business owners in our sample (10 Soles = $2.98 in July 2004). Earnings in a given session ranged from ten to twenty soles (including the show-up fee). The rules for each game were explained to all the participants simultaneously, and no written instructions were provided except for large poster boards explaining the rules that were posted on the wall as reminders throughout the game. Appendix A provides further details of the game administration.

Each session consisted of two or three game variants played in random order followed by a social networks survey. To conduct the networks survey, we asked participants to stand up one at a time. While participant *J* was standing, we asked the other participants to indicate if they knew participant *J*'s name, if they knew where her store was located, if they had ever watched her store for her, if they met her on social occasions, and if they were relatives. We then used these data to construct a social network map for each game session.

We also conducted a census of micro-entrepreneurs working in Polvos Azules. The market census serves four purposes. First, it allows us to control for demographic and socioeconomic characteristics in our experimental analysis. Second, we can examine hypotheses about heterogeneous behavior – e.g., do men play differently than women, or do the risk averse play differently than the less risk averse? Third, we use the census data to learn about the matching process for the game in which individuals choose their own partners. Fourth, the census allows us to examine sample frame selection biases to determine the characteristics of individuals that are likely to participate in our experiments. Specifically, we are able to test whether the nature of the games specifically attracts risk-seeking individuals.[5]

Demographic summary statistics of our subject pool are provided in Table 3. The data suggest that most of our participants are not the poorest according to local poverty measures: most completed secondary school and own both a refrigerator and a television. However, eleven percent indicated that they cook with kerosene, a characteristic that Peruvians use to identify poor households. Approximately half of our subjects own a microenterprise in Polvos Azules; the rest are microenterprise employees. Only six percent have experience with group lending, but 65 percent have participated in an informal rotating and saving and credit association (ROSCA).

Relative to the broader population of Polvos Azules, participants tend to be older (34 years old on average versus 30); have more work experience (eleven years versus eight); and are more likely to be married (49 percent versus 39), to attend church (28 percent versus 22), to own a microenterprise (51 percent versus 34), to work in an enterprise with a government business license (38 percent versus 27), to have taken a loan in the past year (39 percent versus 29), and, specifically, to have taken a joint

[5] The bias caused by nonrandom participation in experiments is rarely mentioned in the experimental literature and almost never studied directly. Two recent exceptions are Lazear, Malmendier and Weber (2005) and Harrison, Lau and Rutström (2005).

liability loan (six percent versus three). Participants also score somewhat higher on questions designed to elicit a sense of trust, fairness, and altruism.[6] The correlates of poverty (assets, cooking with kerosene) show the participants to be similar to the broader population but slightly poorer on average.

From a broader methodological perspective, the survey shows that participants in lab experiments in the field cannot be assumed to represent the general population. While the economic and social variables show participants are roughly similar to the general population of the community, they are more similar to those of the typical microfinance borrowers.

Since our experiment randomizes contract structure within the games, non-random selection will not affect the internal validity of our results. However, the selection of risk-seeking types into our experimental laboratory may alter the external validity of this exercise. To check this, we ran between-effects regressions of individual risky project choice on the set of socioeconomic characteristics and found that, with the exception of the propensity to hold a savings account, the variables do not systematically predict risky play.[7] To further address selection on nonrandom characteristics, we also run all main specifications with individual-level fixed effects, sweeping out the roles of fixed demographic variables, and find that results are robust. Although of course if individuals who participate respond differently to contract variations than individuals who do not participate, the generalizability of these results is limited. This of course is

[6] The General Social Survey (GSS) contains three questions on "trust," "fairness" and "helping" which purport to measure social capital. The exact wording is as follows: the trust question, "Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?", the fairness question, "Do you think most people would try to take advantage of you if they got a chance, or would they try to be fair?", and the helpful question, "Would you say that most of the time people try to be helpful, or that they are mostly just looking out for themselves?" In cross-country regressions, several studies find that these GSS questions correlate with outcomes of interest. Knack and Keefer (1997) finds correlations with growth; Kennedy et al. (1998) and Lederman et al. (2002) with crime; Brehm and Rahn (1997) with civic involvement; Fisman and Khanna (1999) with communication infrastructure; and Guiso et al. (2005) with stock market participation. In experimental economics, Karlan (2005b) finds that positive answers to the GSS questions predict the repayment of loans one year after the survey, and that positive answers to the GSS questions predict trustworthy behavior in a Trust game (conducted shortly after the GSS questions).

[7] Individuals with savings accounts are more likely to choose the risky project in the dynamic games, but, as noted in the text, fixed effects specifications should control for this effect.

merely a statement about laboratory experimental economics, and is not a concern that is particular to this project or selection process. The census data also allow us to interact joint liability contract structure with demographic characteristics, and again we find little evidence that sample selection within pool of individuals working at Polvos Azules alters our results. Regression results relating to demographic characteristics are included as Appendix Tables 1 and 2.

5 Treatments and theoretical predictions

The games isolate the roles of information and communication across different contract structures and allow us to gauge impacts on risk-taking and coordination. The eleven different manipulations involve adding one or more treatments to the benchmark individual liability game (described in Section 3) in order to isolate key features of contracts. Figure 1 describes these permutations. Table 4 gives the percent of players choosing the risky investment option and the average loan repayment rate for each permutation. The regression analyses (Table 5) described in sections 5.7 and 5.8 show similar patterns to those in Table 4 after controlling for a range of variables and individual-level and round-level fixed effects.

There are two main categories of treatment manipulations: "repeated one-shot" (ROS) games and "dynamic" games. In repeated one-shot games, the bank does not penalize default, and participants are allowed to continue playing even if they have defaulted in previous rounds. In the dynamic games, individuals who default in any round are forced to sit out the rest of the game. Defaulters are allowed to participate in subsequent games on the same day.

5.1 The benchmark individual game

The individual repeated one-shot game serves as a benchmark against which to measure the impact of contract structure on outcomes of interest. There is no consequence to defaulting and no joint liability mechanism. As a result, participant choices depend entirely on individual risk aversion. Participants who are risk neutral will select the risky project in all rounds. Those who are sufficiently risk averse will opt for the safe project.[8] Table 4 indicates that many participants displayed considerable risk aversion: despite the relatively attractive expected returns, the risky project is chosen just 61 percent of time in this benchmark game, with an average repayment rate of 68 percent.[9]

5.2 Adding a dynamic incentive to the individual game

Introducing a dynamic incentive raises the cost of default by excluding defaulters from future rounds. In the individual dynamic game, this cost of default looms large, particularly in the early rounds. Hence, rates of risky project choice and, consequently, default should be lower in the individual dynamic treatment than in the benchmark individual repeated one-shot games. Table 4 shows this to be the case: the average rate of risky choices falls to 34 percent (from 61), with a corresponding rise in the average repayment rate to 82 percent (from 68). Thus, the simple dynamic incentive has considerable power, and its inclusion in the loan contract dramatically increases the amount of money recouped by the bank.

5.3 Adding joint liability to the repeated one-shot game

In the benchmark repeated one-shot joint liability treatment, each player is matched with an anonymous partner for the duration of the game. Players are informed that they will not learn the identities of their partners during or after the experiment. The joint liability treatment differs from the individual liability setup because players are liable for the loans of their defaulting partners. Net payouts are identical to those described in Table 1. The choice to invest in the safe project no longer eliminates risk since participants may

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[8] It is impossible to use behavior in the individual repeated one-shot game to calibrate a parameter of relative risk aversion for several reasons: points were not converted into Soles until after the games, we have no reasonable estimates of individual lifetime wealth, and we cannot be certain that players were framing their decisions at the round rather than the game level. However, taking the extreme assumptions of zero wealth and framing at the round level, we can calculate that an individual's parameter of constant relative risk aversion would need to be *at least* 0.57 in order for her to prefer the safe project in the individual repeated one-shot game.

[9] The repayment rate depends on the fraction choosing the safe project (39 percent on average) since they always repay. To the 39 percent are added those who opt for the risky project and who have favorable outcomes (roughly half of 61 percent). With sufficient replications, the repayment rate should converge in this case to just under 70 percent (39 + 0.5 x 61), and the rate we find is close (68 percent).

now be forced to repay the loan of a defaulting partner. When a player investing in the safe project is forced to repay both loans, her profits are reduced to zero. The risky option also becomes less appealing since there is now a 50 percent chance that a risk-taker with a positive investment outcome will have to bail out their risk-taking partner's loss. Joint liability thus imposes a potential tax on participants. In the one-shot games, the customers receive no compensating benefit from the implicit insurance — though the bank gains as repayments increase.

Table 4 shows that in this set-up risk-taking rises only slightly – to 63 percent from 61 percent – while repayment rates rise sharply – to 88 percent from 68 percent. The result shows that the insurance element of joint liability helps the bank, even if average risk-taking behavior changes little.

5.4 Adding joint liability to the dynamic game

When we add joint liability to the dynamic game, risk-taking should fall relative to the one-shot game with joint liability, and it should increase relative to the dynamic game without joint liability. Both predictions are borne out in the data.

Adding joint liability to the dynamic set-up creates strong incentives for safe behavior that are absent in the joint-liability repeated one-shot game. As Table 1 shows, risk-taking could lead to project failure that triggers exclusion from future rounds. If agents held the same priors in the dynamic joint liability treatment that they had in the analogous repeated one-shot game, we would expect rates of risky project choice to fall. This is because the cost of default decreases expected returns over the course of the game. However, as this is common knowledge, subjects believe that their partners are more likely to choose the safe investment in the dynamic game. A strategic tension exists because agents do not have perfect information about their partners' risk preferences: safe projects are more attractive *holding fixed the partner's decision*, but risky projects are more attractive (to some) if one's partner is more likely to choose the safe investment.

Relative to the individual dynamic game, predictions are unambiguous: joint liability leads to an increase in risky choice. First, as in the repeated one-shot case, safe players are forced to cover the defaults of their partners, taxing success and making the risky project relatively more desirable. Moreover, the cost of default decreases relative to the individual liability case, since players are able to insure each other. In the individual liability case, project failure leads to exclusion with certainty. Here, project failure never leads to exclusion if your partner plays safe, and the chance of exclusion is just 50 percent if your partner invests in the risky project. Joint liability will thus push toward more risk-taking than in the individual dynamic games.

Table 4 shows that risk-taking does indeed fall relative to the repeated one-shot games – to 49 percent from 63 – while, as predicted, risk-taking rises relative to the individual dynamic game – to 49 percent from 34. As seen in section 5.3, the implicit insurance element of the joint liability contract means that the increase in risk-taking does not necessarily translate to a drop in repayment rates. Instead, the average repayment rate rises relative to the individual dynamic case, from 82 percent to 94 percent.

5.5 Monitoring and communication

The next variant maintains anonymity while increasing information flows. In "monitoring" games, each participant receives complete information about her partner's project choice and outcome at the end of each round. Hence, *ex post* monitoring is costless and automatic. As in the other joint liability treatments described above, partner identities are never revealed during or after the game. The information allows participants to sharpen their beliefs about their partners' propensities to take risks – specifically, risky actions are apparent even when they do not impose costs on the cosigning partner – and this can encourage additional risk-taking. At the same time, risk-takers now have to worry about strategic responses by partners. This force will push some risk-takers to take less risk than in the games without information. Table 4 shows that, on average, the latter force predominates and, in both repeated one-shot games and dynamic games, risk-taking falls slightly relative to the variants with no information on partner decisions.

In "communication" games, we eliminate partner anonymity, though participants still have no choice in group formation because groups are randomly assigned. In this communication treatment, partners sit together and are allowed to talk during the course of play. Thus, each participant knows both the identity of her partner and the action that her partner takes in every round. With the ability to coordinate, we expect that a greater number of groups will move from safe-safe choices to safe-risky or risky-safe choices, exploiting the insurance possibilities while increasing expected net benefits. We may also see increases in risky-risky choices as groups decide to collude against the bank. Not surprisingly, average risk-taking rises strikingly in response: from 47 percent to 58 percent in the joint liability dynamic games with monitoring but no communication. In evidence consistent with coordination on mixed safe-risky choices, the sharp increase in risk-taking is not met with a sharp fall in the average repayment rate. In fact, it hardly falls: to 93 percent from 95 percent.

5.6 Allowing partner choice

"Partner choice" games are a variant of communication games in which participants choose their partners before the start of play. As in the communication games, participants sit together and they are allowed to talk throughout the game.

The literature on joint liability makes competing predictions about the endogenous group formation process. While some (e.g., Ghatak 1999) argue that individuals will sort themselves into groups that are relatively homogenous in their levels of risk aversion and creditworthiness, Sadoulet (2000) suggests that borrowers may intentionally form groups that are heterogeneous so as to take maximal advantage of the possibilities for mutual insurance. In our model, participants do not have perfect information about the propensities of others to take risk, so it is not obvious that participants will choose to match along the lines defined by past play in the game.

While we expect that coordination will be facilitated, the effect of this treatment on risky project choice and default is ambiguous. In the repeated one-shot games, partner choice makes little difference to average risk-taking – it raises the rate from 68 percent to 69 percent – but it sharply improves repayment rates – taking from 58 percent to 89 percent. This result is consistent with improved coordination. However, we find that risk-taking falls sharply from 87 percent to 53 percent in the dynamic games, though repayment rates change little. We show in section 6 that the move reflects a shift by both players toward safe investments—a shift that is consistent with an important role for social forces working alongside the economic forces described above.

5.7 Regression analysis

In Table 5 we examine the basic predictions outlined above in a regression framework. The dependent variable is individual risky project choice in a round of play. All regressions are estimated using a linear probability model, and all include individual-level and round-level fixed effects. The fixed effects control for learning and for time invariant characteristics of participants. The sample includes just the first six rounds of play to limit possible survivor bias, and the qualitative results are robust to restricting estimation to shorter panels.

Column (1) shows that the independent impact of adding a dynamic incentive to any loan mechanism reduces the rates of risky project choice by 21 percent. The variables interacted with "Dynamic" pertain to the dynamic permutations of the game, while the others pertain to the repeated one-shot benchmarks. As predicted, adding joint liability increases rates of risk-taking, and the impact is larger in the dynamic games – moving from the individual dynamic treatment to the analogous joint liability treatment increases the rate of risky project choice by more than seven percentage points. The effect of monitoring is only marginally significant, but allowing for communication increases the rate of risk-taking significantly. Finally, allowing players to choose their partners decreases the rate of risky project choice in the dynamic treatments, but not as much as the other treatments led to more risky choices.

Overall, the findings are broadly consistent with the theoretical predictions presented above and the summary statistics of Table 4. In sum, in the dynamic games, introducing joint liability contracts increases risk-taking, and risk-taking increases further when information and communication channels improve. But risk-taking falls in the most true-to-life scenario, in which participants are allowed to form groups on their own, a result to which we return below.

5.8 Heterogeneity by age, gender, education, trust, and savings

Much is written on how credit contracts may or should differ for different demographic groups. Microfinance has tended to focus on females (Armendariz de Aghion and Morduch 2005). Women are viewed as more reliable customers, and they do, in fact, tend to repay their loans more frequently than men do. By the same token, they tend to be less prone to moral hazard (Karlan and Zinman 2005). We examine our primary set of results for different demographic groups in order to identify systematic differences in the responses to different mechanisms.

Table 6 breaks down the analysis of Table 5 by demographic categories. Despite some variation in significance across the specifications, we find that the sign patterns are broadly consistent across the demographic subsets we consider. Strikingly, we find no gender differences, and only minor differences between the old and the young. The patterns are also similar among better educated individuals, more trusting individuals (as measured by the social survey, i.e., GSS, questions), and individuals who have a savings account in a commercial bank.[10] These results are reinforced by findings below that individual play within the game is not driven predominantly by personal characteristics.

6 Joint play

In line with most of the theoretical literature on microfinance mechanisms, the focus thus far has been largely on levels of risk-taking by individuals, but the bank is less concerned with individual risk-taking than with overall repayment. Joint liability games offer the possibility of implicit insurance such that risk-taking can rise while repayment rates remain steady. But joint liability does not eliminate the risk of collusion against the bank. In this section we consider determinants of joint play and coordination.

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[10] One surprising result in the games with "trusting" participants (GSS≥2) is their strong increase in risk-taking in the dynamic joint liability games once monitoring is introduced. The regressions, though, pertain just to 24 individuals, and might not be robust to expanding the data set.

6.1 Asymmetric predictions

We begin with a set of asymmetric predictions. To see these, consider the payouts in Table 1. Under joint liability, a player whose partner always plays safe faces a decision problem identical to the individual liability case, since a safe partner never defaults. However, the safe project becomes less attractive as the probability that the partner invests in the risky project increases; indeed, any player prefers the risky project to the safe one if she is certain that her partner is also choosing the risky investment. Thus, the effects of the joint liability treatment on risky choice may not be uniform across the population: relatively safe players matched with relatively risky partners should unambiguously move toward the risky project in the joint liability repeated one-shot treatment.

It is also possible that some players might become *safer* in the joint liability treatment: for individuals with levels of risk aversion just low enough to prefer the risky project to the safe one in the benchmark game, the cooperative “all safe” outcome is preferable to the “all risky” equivalent. Hence, these players are playing a game equivalent to a repeated prisoners’ dilemma, and might therefore invest in the safe project, particularly in the early rounds, in an attempt to coordinate. Alternatively, individuals motivated by altruism or reciprocity may increase their rates of safe project choice if they do not wish to penalize relatively safer partners by forcing them to cover defaults.

Adding monitoring sharpens the asymmetric predictions described above. Monitoring should not affect the behavior of individuals in homogeneous pairings: players who prefer the safe project in the individual game have no incentive to change strategy when matched with a similar type in the joint liability treatments, and individuals who choose the risky project in a joint liability game without monitoring will still prefer this strategy when they are matched with an equally risky partner. However, as described above, relatively safe individuals matched with riskier partners in repeated one-shot games should switch to the risky investment. In the monitoring treatment, such players receive better information on their partners’ propensities for risk-taking, and should respond with greater alacrity as a result. Similarly, in monitoring games, intrinsically risk neutral players motivated by feelings of reciprocity receive better information on safe play by their partners, and should consequently respond more readily.

The asymmetric predictions might be even more striking in the communication game, since each participant knows *in advance* what strategy her partner will choose in each round. On the other hand, coordination is easier, and players may be able to coordinate on an "all safe" or alternating strategy. In addition, players may be able to convince each other to adopt a new strategy: a player who prefers the risky project might convince her partner of the value of high expected returns; alternatively, an extremely risk averse player might discourage a partner from choosing the risky investment by blaming him when she has to repay his loan.

In Table 7, we examine our asymmetric predictions about the impact of joint liability contract structure on different types of players. We again take advantage of seeing the same individuals making choices under different contracts. In columns (1) and (2), we focus on heterogeneous pairings. The variables "Safer Player w/ Riskier Partner" and "Riskier Player w/ Safer Partner" are defined as follows: we termed a player "safer" ("riskier") if she chose the risky project with less (greater) than the median frequency in the individual liability games; the variable "Safer Player w/ Riskier Partner" ("Riskier Player w/ Safer Partner") is a dummy equal to one if a player is safer (riskier) and her partner is riskier (safer) by this definition. As predicted, column (1) shows that safe types do increase their rates of risky project choice when they are matched with risky partners, though at only three percent the effect is relatively small. Column (2) indicates that risky players are somewhat less likely to invest in the risky project when they are matched with a safe individual, providing evidence of coordination, altruism, or both.

6.2 Coordination

The effects of the behavioral changes described above on joint outcomes and default rates are indeterminate since they depend on the nature of pairings, and that depends on the initial distribution of risk preferences, beliefs about this distribution, and the outcome of the random group formation process. For example, joint liability might decrease default rates in a uniformly risk neutral population, since partners would be forced to insure one another. Alternatively, all of the contractual mechanisms we consider might have no effect on a uniformly risk averse population – one in which it was known that everyone preferred the safe investment to the risky option in the individual game – since, in that population, everyone would play safe. Or joint liability contract structures might lead to increased default if players move toward risky behavior when they expect to repay the loans of their partners with positive probability.

Table 8 considers joint outcomes using a multinomial logit specification with three possible values for the dependent variable: both played risky, played opposite, and both played safe (the omitted category). Allowing communication in the repeated one-shot games greatly increases the rate of both playing risky, a result that is profit maximizing given the lack of penalty for default. In the dynamic games with communication, we see a substantial increase in both playing opposite (i.e., risky-safe) and both playing risky. Playing opposite is consistent with the strategy of profit maximization while protecting the ability to continue playing.

Strikingly, in the dynamic games, allowing for endogenous partner choice sharply decreases the rate of joint risky play and the rate of mixed play. The result is a strong increase in jointly safe choices. This is a result to which we return below in Section 6.4 (Partner Choice).

Table 9 considers the outcome of interest to the bank – repayment. The table examines the effect of loan contract structure on repayment among those actively taking out loans in any given round (i.e. excluding those who are no longer playing because they have defaulted in an earlier round of a dynamic game). Not surprisingly, dynamic incentives, joint liability, monitoring and endogenous partner choice all increase repayment in this framework. Communication, on the other hand, leads to higher default rates due to the increase in jointly risky play shown in Table 8.

6.3 Punishment

Can allowing explicit punishment improve contract performance? We introduced an opportunity for *ex post* punishment in the dynamic monitoring games. To focus on the independent role of punishment, communication was not allowed and anonymity was maintained throughout. In "punishment games," participants learned at the beginning of the game that they would be allowed to punish their partners at the end of the game. After the completion of each punishment game, each participant was given an opportunity to pay 50 points and deduct 500 points from the final point total of her partner.

Several models suggest that joint liability increases repayment because villagers can punish default with social sanctions (e.g. Besley and Coate 1995). Though social sanctions are not feasible in a laboratory environment, previous studies have found that participants in experiments are often willing to pay to punish uncooperative behavior in the lab, despite the fact that such punishment is not part of any subgame perfect equilibrium (Fehr and Gächter 2000).

In total, 380 players participated in punishment games, and 61 of these players punished a partner. Since theory suggests that punishment can only occur out of equilibrium, the observed frequency is unexpectedly high: the mere threat of punishment should drive behavioral changes, and we should not actually observe punishment. On the other hand, if we expect all safe players to punish risky choices by their partners, the punishment rate is low.

Table 4 shows that adding punishment leads to a slight increase in risk-taking – to 53 percent from 47 percent in the joint liability dynamic games with monitoring – and roughly no change in the average repayment rate (to 93 percent from 95). In principle, punishment should help steer coordination, but the summary statistics in Table 4 are too aggregated to reveal the specific dynamics. Table 10 explores specific hypotheses around coordination. Analyses of punishment treatments are completed using OLS and a multinomial logit. In the multinomial logit, we use the dependent variables "both played risky," "both played safe," and "played opposite" that were defined above. Table 10 shows that adding the possibility of punishment significantly increases rates of joint risky play and has little effect on opposite play (relative to joint safe play).

6.4 Partner choice

As Tables 5 and 7 demonstrate, allowing participants to choose their own partners has a strong, *negative* effect on risk-taking. Table 11 begins to address the issue by examining the determinants of matching among players by running social network regressions. For each communication game (where partners are either elected or assigned), we create all possible dyads or pairs among players: if a game has twenty players, there are 190 possible pairs or combinations of two players. However, only ten of those pairs are matches, either randomly assigned by the computer or elected by the players themselves.[11] The goal is to determine the relevant variables used by players in choosing their partners. We use the information on where players were sitting during the games, whether they had ever been guests or hosts, the social network survey, and the census survey.

Columns (2), (3) and (4) report the results for all elected partner games, broken down into one-shot and dynamic treatments. For comparison purposes, column (1) reports the results of the network regression using the randomly assigned matches from the other communication treatment (without endogenous partner choice) as dependent variable. By comparing the R-squared of the elected partner games to that of the assigned partner manipulations, it is clear individuals match on information that is observable to the econometrician – there is a much better fit when players can choose their partner.

The coefficient on "sitting next to your partner" is only significant (taking a negative sign) when the partner is assigned. This reflects the fact that the random assignment process avoided pairing individuals who were sitting next to each other (so that they could not share information and infer they were matched). In contrast, having

[11] Dyadic observations are typically not independent due to the presence of individual-specific factors common to all observations involving the individual. Thus, OLS or probit methods will yield inconsistent standard errors. We use game and player fixed effects to correct for this problem. Another method used in the literature, especially among sociologists, is the Quadratic Assignment Procedure (QAP). This method, similar to bootstrap, computes the p-value directly. We compared both fixed effects estimates and QAP estimates and found them very similar. Thus, we only report fixed effects estimates.

been a host or a guest of someone else is an important predictor of partner choice.[12] Despite its correlation with some social network questions, these questions have predictive power on their own, even when census variables are introduced. While participants tend to sort along most social network variables in one-shot games, fewer variables predict pairing in the dynamic games: being relatives and having watched the partner's store are the only significant predictors from the social networks data in the dynamic treatments.

The most notable finding is a non-result: there is no evidence that risk averse partners particularly choose each other in the dynamic games. *Not* being risk averse has some explanatory power, but the coefficient (0.048) is considerably smaller than other variables like being a relative or having watched a partner's store.[13] These data thus offer little support for Ghatak's (1999) hypothesis that joint liability will lead to assortative matching by risk attributes.

The findings reinforce the puzzle: if pairing is done mainly on the basis of social attributes, the ability to coordinate on mixed risky-safe project choices (and thus to increase earnings) should be enhanced. It should be easier to coordinate among people who know each other well, and, with anonymity dropped, enforcement mechanisms that operate outside of the game setting may come into play. But instead we see a tendency toward safe-safe choices.

It cannot simply be that partners who know each other enjoy playing the game together and thus opt for longevity in the game over maximizing point totals: the mixed safe-risky option also guarantees longevity. One possibility is that participants judge their success relative to their close friends and relatives; in this case, they may prefer to coordinate at a low, safe level in which equal point totals are guaranteed, rather than risking the chance of imbalanced totals when trying to coordinate on risky-safe choices.

[12] Using the same methods we regressed "Had ever been a host or guest" against social network variables as well as census variables and found (not shown) that host and guest pairs tended to be between individuals that sold the same product, were relatives or close friends, that is, people that trusted each other and knew each other well.

[13] In general matched players do not have the same marital status, but given that being relatives is so important, it could be that parents and children play together, explaining the difference in marital status (and possibly the same religion).

Another possibility is that participants that would otherwise choose the risky project, play safe instead in an attempt to be fair to their friends (Rabin 1993; Fehr and Schmidt 1999). Stiglitz (1990) assumes that partner selection allows coordination to the efficient outcome. In contrast, we find that communication introduces a social element that results in a sub-optimal level of risk-taking, albeit only in the dynamic treatment. The explanation, with its stress on the desire for equality of outcomes, points to a downside of joint liability: that it can induce a set of choices that is more conservative than optimal.

7 Conclusion

Microfinance is transforming thinking about banking in low-income communities. The techniques that are employed to ensure loan repayment contain numerous overlapping mechanisms, and we have taken them apart in order to examine how important components function in isolation and how they interact with one another.

The results draw from a series of experimental "microfinance games" run over seven months in Peru. The experimental laboratory approach allows us to pose clear but narrow questions and generate precise hypotheses about several loan features all at once. Furthermore, by locating the games in Peru, we were also able to attract participants who are similar to typical microfinance customers, including some who were in fact customers of local microfinance institutions.

Our focus has been on group-based mechanisms. We describe a balancing act. Joint liability reduces default since group members bail each other out when luck is bad.[14] Thus, *ceteris paribus*, group-based mechanisms help the lender's bottom line. But the mechanisms can also generate riskier behavior on the part of borrowers, undermining some of the lender's gains. Our findings here confirm the existence of a puzzle that is often overlooked in theoretical models of group-based lending: the group-based mechanisms that are frequently employed can induce moral hazard (or more risk-taking behavior) instead of reducing it. Moreover, improving the information flows between

[14] Although, as Rai and Sjöström (2004) show, insurance could also be achieved through side contracts in an individual liability setting.

members can make matters even worse. However, we show that allowing participants to form groups can mitigate these tendencies – through assortative matching, the positive features of group banking can be established. This, though, introduces its own puzzle: risk-taking falls to levels that are surprisingly low.

This finding is revealed by the experimental method. The participants in these games behaved strategically as economic theory would predict, making investment choices according to predictions drawn from neo-classical theories of choice under risk. But participants were also sensitive to social factors of the simulated credit contracts. Ultimately, these microfinance games show how strategic behavior and social concerns interact to yield effective contracts that can work both for customers and lenders. We find evidence that the social factors undermine profit maximization by customers and may blunt the effectiveness of group-based approaches in reducing poverty and stimulating investment.

We also find that dynamic incentives are powerful tools for reducing moral hazard even when lenders use individual liability contracts. These results are consistent with recent shifts by microlenders from group-based mechanisms toward individual loans. The Grameen Bank of Bangladesh and Bolivia's BancoSol, for example, are the two best-known group lending pioneers, but they have both shifted toward individual lending as their customers have matured and sought larger loans (Armendariz de Aghion and Morduch 2005). Grameen has dropped joint liability entirely, and just one percent of BancoSol's loan portfolio was under group contracts in 2005.[15] The individual-lending approach allows customers and lenders more flexibility without the worry about the moral hazard induced by the use of groups. Giné and Karlan (2006) conduct a natural field experiment in the Philippines in which pre-formed group liability centers were assigned randomly to be converted to individual-liability centers (treatment group) or to remain as-is (control group) in order to test the importance of group liability for mitigating moral hazard. They find no change in default rate under individual liability

[15] The Grameen Bank's founder argues that his bank never formally instituted joint liability contracts, but allows that they may have been employed in practice by loan officers. Most replicators of the Grameen Bank have instituted explicit joint liability contracts.

relative to group liability and an increase in ability to attract new clients. Hence, the group liability contract does not appear to be a necessary component of the microfinance model in order to maintain high repayment rates.

From a methodological vantage, the "framed" field experiments developed here (using the taxonomy put forth by Harrison and List, 2004) act as a bridge from laboratory experiments to field experiments. Similar "bridge" work has been done with respect to auctions and charitable fundraising, but as Levitt and List (2006) discuss, much remains to be known about how the laboratory itself alters the behavior of individuals and thus the interpretation of results. By working with the same type of individuals that are of interest to those who study credit markets for the poor, we show how laboratory experimental tools can be used to begin crisper discussions of the relative merits of different lending mechanisms. With further links from these "framed" field experiments to "natural" field experiments (e.g., Gine and Karlan, 2006), such approaches can be integrated in a research and development process that is helpful both to applied theorists interested in testing mechanisms and to practitioners interested in observing actual behavior under different incentive schemes.

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Figure 1: Treatment Manipulations of the Basic Game

	Repeated One-Shot Games	*Dynamic Games*	
Individual Games	Individual Game	Dynamic * Individual Game	
Joint Liability Games	Joint Liability (JL) Game	Dynamic * Joint Liability (JL) Game	
+ Monitoring	JL + Monitoring Game	Dynamic * (JL + Monitoring) Game	Punishment Game
+ Communication	JL + Monitoring + Communication Game	Dynamic * (JL + Monitoring + Communication) Game	
+ Partner Choice	JL + Monitoring + Communication + Partner Choice Game	Dynamic * (JL + Monitoring + Communication + Partner Choice) Game	

Table 1: Net Payouts each Round in Joint Liability Games

Decision-Maker's Choice	Partner's Choice	Decision-Maker's Outcome	Partner's Outcome	Probability	Net Payout	Default?
■: Safe Project	Safe	+	+	100%	100	No
	Risky	+	+ -	50 50	100 0	No No
▲: Risky Project	Safe	+ -	+	50 50	500 0	No No
	Risky	+ -	+ - + -	25 25 25 25	500 400 0 0	No No No Yes

Table 2: Treatment Manipulations

	Total Number of Games Played		Average Number of Players / Game	
	Repeated One-Shot Games	Dynamic Games	Repeated One-Shot Games	Dynamic Games
Individual Games	34	37	19.3	20.2
Joint Liability	31	33	21.6	19.7
Joint Liability + Monitoring	32	28	18.6	19.3
Joint Liability + Monitoring + Communication	22	25	20.2	20.7
Joint Liability + Monitoring + Communication + Partner Choice	25	23	20.5	18.3
Joint Liability + Monitoring + Punishment	N.A.	32	N.A.	13.1

Table 3: Summary Statistics on Player and Market Demographic Characteristics

	Entire Census Sample		Participants in Games	
	Mean	**Standard error**	**Mean**	**Standard error**
Female	0.58	(0.49)	0.57	(0.50)
Age	29.9	(10.5)	34.4	(11.9)
Married	0.39	(0.49)	0.49	(0.50)
Years of education	5.6	(1.1)	5.6	(1.15)
Spanish is second language	0.08	(0.27)	0.11	(0.31)
Attends church at least once a week	0.22	(0.41)	0.28	(0.45)
Does not attend church	0.10	(0.30)	0.05	(0.21)
Born in Lima	0.53	(0.50)	0.51	(0.50)
Household size	4.7	(2.3)	4.9	(2.1)
Number of assets / appliances	3.1	(1.7)	2.9	(1.6)
Cooks with kerosene	0.08	(0.26)	0.11	(0.32)
Played lotto in past month	0.19	(0.39)	0.18	(0.38)
Visited casino in past month	0.07	(0.26)	0.06	(0.24)
Number of positive GSS answers	0.33	(0.59)	0.40	(0.67)
Years experience	8.2	(7.9)	11.4	(9.2)
Owns microenterprise	0.34	(0.48)	0.51	(0.50)
Hours worked per week	65.8	(15.6)	63.3	(19.8)
Number of workers in business	1.9	(0.9)	2.3	(1.0)
Has government business license	0.73	(0.44)	0.62	(0.49)
Saves in a commercial bank	0.09	(0.28)	0.07	(0.26)
Has been involved in a ROSCA	0.61	(0.49)	0.65	(0.48)
Has had a joint liability loan	0.03	(0.17)	0.06	(0.24)
Received a loan in past year	0.28	(0.45)	0.39	(0.49)
Observations	1427		323	

Table 4: Summary Statistics: Average Rates of Risky Choices and Repayment

	Percent of Participants Choosing Risky Investment		Repayment Rate (Percent)	
	Repeated One-Shot games	**Dynamic Games**	**Repeated One-Shot Games**	**Dynamic Games**
Individual Games	61	34	68	82
Joint Liability	63	49	88	94
Joint Liability + Monitoring	61	47	90	95
Joint Liability + Monitoring + Communication	68	58	87	91
Joint Liability + Monitoring + Communication + Partner Choice	69	53	89	94
Joint Liability + Monitoring + Punishment	N.A.	53	N.A.	94

Table 5: Determinants of Risky Choice by Individuals: Implications of Contract Structure
Dependent Variable = 1 if participant chooses risky project, 0 otherwise
OLS

Sample:	All Games (1)	Repeated One-Shot Games (2)	Dynamic Games (3)
Dynamic Game	-0.213***		
	(0.013)		
Joint Liability (JL) Game	0.015	0.022*	
	(0.012)	(0.012)	
JL + Monitoring	-0.023*	-0.023*	
	(0.012)	(0.012)	
JL + Monitoring + Communication	0.061***	0.060***	
	(0.013)	(0.014)	
JL + Monitoring + Communication + Partner Choice	0.007	0.007	
	(0.013)	(0.014)	
Dynamic * JL	0.065***		0.072***
	(0.018)		(0.014)
Dynamic * (JL + Monitoring)	0.056***		0.022*
	(0.017)		(0.012)
Dynamic * (JL + Monitoring + Communication)	-0.028		0.044***
	(0.018)		(0.013)
Dynamic * (JL + Monitoring + Communication + Partner Choice)	-0.037*		-0.035**
	(0.020)		(0.015)
Previous days played			
Constant	0.666***	0.651***	0.484***
	(0.012)	(0.012)	(0.015)
Observations	26716	13541	13175
Number of Unique individual ID (constant across games)	493	474	449
R-squared	0.04	0.01	0.03

Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Individual and round fixed effects included in all specifications.

Table 6: Demographic Determinants of Risky Choice: Interactions with Contract Structure
Dependent variable = 1 if participant chooses risky project, 0 otherwise
OLS

Sample:	All Players (1)	Females (2)	Younger (3)	Older (4)	Secondary Education (5)	Positive GSS ≥ 2 (6)	Savings Account (7)
Dynamic Game	-0.213***	-0.217***	-0.327***	-0.177***	-0.232***	-0.246***	-0.254***
	(0.013)	(0.017)	(0.032)	(0.021)	(0.016)	(0.054)	(0.076)
Joint Liability (JL) Game	0.015	0.008	0.051*	-0.004	0.006	0.069	-0.041
	(0.012)	(0.016)	(0.030)	(0.019)	(0.014)	(0.047)	(0.062)
JL + Monitoring	-0.023*	-0.016	-0.030	-0.054***	-0.016	-0.103**	-0.060
	(0.012)	(0.017)	(0.030)	(0.019)	(0.015)	(0.044)	(0.060)
JL + Monitoring + Communication	0.061***	0.064***	0.029	0.097***	0.047***	0.064	0.044
	(0.013)	(0.018)	(0.030)	(0.020)	(0.015)	(0.049)	(0.065)
JL + Monitoring + Communication + Partner Choice	0.007	-0.005	0.037	0.023	0.023	-0.018	-0.109
	(0.013)	(0.018)	(0.031)	(0.021)	(0.015)	(0.047)	(0.070)
Dynamic * JL	0.065***	0.086***	0.085*	0.079***	0.073***	0.048	0.089
	(0.018)	(0.024)	(0.044)	(0.028)	(0.022)	(0.071)	(0.099)
Dynamic * (JL + Monitoring)	0.056***	0.028	0.070*	0.069***	0.072***	0.174***	0.062
	(0.017)	(0.023)	(0.041)	(0.026)	(0.020)	(0.063)	(0.087)
Dynamic * (JL + Monitoring + Communication)	-0.028	-0.022	-0.005	-0.057**	-0.024	-0.091	0.074
	(0.018)	(0.025)	(0.042)	(0.028)	(0.021)	(0.064)	(0.093)
Dynamic * (JL + Monitoring + Communication + Partner Choice)	-0.037*	-0.017	-0.081*	-0.046	-0.073***	0.032	-0.091
	(0.020)	(0.026)	(0.045)	(0.030)	(0.023)	(0.068)	(0.118)
Constant	0.666***	0.655***	0.772***	0.651***	0.711***	0.673***	0.808***
	(0.012)	(0.014)	(0.029)	(0.017)	(0.015)	(0.051)	(0.058)
Observations	26716	15340	4241	11064	18886	1930	904
Number of Unique individual ID (constant across games)	493	253	61	131	271	24	24
R-squared	0.04	0.04	0.09	0.03	0.05	0.05	0.05

Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. The dependent variable in all specifications is individual risky choice. "Younger" ("older") is defined as being below (above) the 25th (75th) percentile of the age distribution. "Secondary education" includes all individuals who have completed at least secondary school. "Positive GSS ≥ 2" includes individuals who gave "trusting" answers to at least two of the three GSS questions.

Table 7: Determinants of Individual Play:
Asymmetric Predictions in Joint Liability (JL) Games

Dependent variable = 1 if participant chooses risky project, 0 otherwise

OLS

Sample (Game Types Included):	**All Joint Liability Games**	
Sample (Players included):	**All**	**All**
	(1)	**(2)**
JL + Monitoring	-0.023*	-0.025**
	(0.013)	(0.013)
JL + Monitoring + Communication	0.059***	0.061***
	(0.014)	(0.014)
JL + Monitoring + Communication + Partner Choice	0.008	0.006
	(0.014)	(0.014)
Dynamic * JL	-0.146***	-0.146***
	(0.012)	(0.012)
Dynamic * (JL + Monitoring)	0.054***	0.056***
	(0.017)	(0.017)
Dynamic * (JL + Monitoring + Communication)	-0.025	-0.029
	(0.019)	(0.019)
Dynamic * (JL + Monitoring + Communication + Partner Choice)	-0.040**	-0.039*
	(0.020)	(0.020)
Safer Player w/ Riskier Partner	0.029***	
	(0.009)	
Riskier Player w/ Safer Partner		-0.020**
		(0.008)
Constant	0.681***	0.703***
	(0.013)	(0.013)
Observations	21420	21420
Number of Unique individual ID (constant across games)	491	491
R-squared	0.03	0.03

Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. All specifications include individual and round fixed effects. The variable "Safer Player w/ Riskier Partner" in column (1) equals one if (a) player *i*'s rate of risky project choice in either the individual repeated one-shot game or the individual dynamic game was below the median and (b) player *i*'s partner's rate of risky project choice was above the median in one of those two game. The variable "Riskier Player w/ Safer Partner" in column (2) is defined analogously. Column (3) is restricted to individuals whose rate of safe project choice in the individual *dynamic* game was below the median, while column (4) uses players whose rate of safe project choice in the individual dynamic game is above the median. Columns (5) and (6) are dynamic game analogues of columns (3) and (4).

Table 8: Determinants of Joint Outcomes
Multinomial Logit

Treatments Included:	**Repeated One-Shot Games Only**	**Dynamic Games Only**
Specification:	**Multinomial Logit**	**Multinomial Logit**
Omitted Outcome:	**Both Played Safe**	**Both Played Safe**
	(1)	**(2)**
Outcome #1:	Both Played Risky	Both Played Risky
Monitoring	-0.097	0.085
	(0.098)	(0.093)
Monitoring + Communication	0.385***	0.598***
	(0.110)	(0.103)
Monitoring + Communication + Partner Choice	0.038	-0.433***
	(0.112)	(0.121)
Constant	0.250	28.978***
	(1.423)	(1.654)
Outcome #2:	Played Opposite	Played Opposite
Monitoring	0.035	0.076
	(0.093)	(0.073)
Monitoring + Communication	0.053	0.482***
	(0.108)	(0.085)
Monitoring + Communication + Partner Choice	0.054	-0.207**
	(0.112)	(0.100)
Constant	1.289	28.464***
	(1.126)	(1.428)
Observations	10554	10166
Fixed Effects of Individuals	Yes	Yes
R-squared	0.15	0.16

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

Table 9: Repayment Rate
Dependent variable = 1 if loan is repaid to the bank, 0 otherwise
OLS

	Repayment Rate (Active Players) (1)
Dynamic Game	0.124***
	(0.009)
Joint Liability (JL) Game	0.202***
	(0.008)
JL + Monitoring	0.023***
	(0.009)
JL + Monitoring + Communication	-0.029***
	(0.009)
JL + Monitoring + Communication + Partner Choice	0.020**
	(0.010)
Dynamic * JL	-0.067***
	(0.013)
Dynamic * (JL + Monitoring)	-0.023**
	(0.012)
Dynamic * (JL + Monitoring + Communication)	0.017
	(0.013)
Dynamic * (JL + Monitoring + Communication + Partner Choice)	-0.004
	(0.014)
Constant	0.661***
	(0.009)
Observations	26716
Number of Unique individual ID (constant across games)	493
R-squared	0.06

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

Table 10: Effect of Punishment Opportunity on Outcomes
OLS, Multinomial Logit

Dependent variable:	**Default**	**Both Played Risky**	**Played Opposite**
Specification:	**OLS**	**Multinomial Logit**	
	(1)	**(2)**	**(3)**
Punishment Game	0.010	0.626***	0.294***
	(0.008)	(0.104)	(0.090)
Constant	0.056***	28.012	28.012***
	(0.003)	(1.633)	(1.414)
Observations	6968	6968	
Fixed Effects of Individuals	Yes	Yes	
R-squared	0.00	0.15	

Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. In all specifications, the sample is restricted to dynamic joint liability games with monitoring. Columns 2 and 3 report the results from one multinomial logit specification, where "Both played safe" is the omitted outcome.

Table 11: Determinants of Partner Choice
Dependent variable = 1 if dyad is partnered
OLS

	Assigned Partners	Elected Partners		
		All games	Repeated One-Shot Games	Dynamic games
	(1)	(2)	(3)	(4)
Sitting next to each other	-0.0722***	0.0097	0.0184	-0.0013
	(0.0145)	(0.0138)	(0.0176)	(0.0227)
Has ever been host or guest of partner	-0.0545	0.4720***	0.6255***	0.2389***
	(0.0349)	(0.0322)	(0.0395)	(0.0555)
From Social Networks Survey				
Bought or sold from partner's store	-0.0065	0.0134	0.0166	0.0129
	(0.0123)	(0.0124)	(0.0157)	(0.0210)
Is relative of partner	-0.0038	0.1971***	0.2019***	0.2029***
	(0.0361)	(0.0340)	(0.0480)	(0.0507)
Coincides in social gathering with partner	-0.0194	0.0254*	0.0384**	0.0004
	(0.0126)	(0.0131)	(0.0168)	(0.0217)
Knows store location of partner	0.0321***	0.0256**	0.0271*	0.0222
	(0.0116)	(0.0126)	(0.0153)	(0.0221)
Has watched over store for partner	0.0347***	0.0906***	0.0857***	0.1039***
	(0.0129)	(0.0127)	(0.0163)	(0.0208)
Both are popular	-0.0021	-0.0271**	-0.0171	-0.0392
	(0.0123)	(0.0123)	(0.0157)	(0.0242)
Both are trusted	0.0068	-0.0155	-0.0164	-0.0045
	(0.0112)	(0.0111)	(0.0139)	(0.0211)
From Census Survey				
Both are highly risk averse	-0.0077	-0.0085	-0.0224	0.0011
	(0.0195)	(0.0189)	(0.0239)	(0.0313)
Both are moderately risk averse	0.0314	-0.0234	-0.0067	-0.0505
	(0.0215)	(0.0215)	(0.0262)	(0.0384)
Both are not risk averse	-0.0161	0.0375**	0.0290	0.0478*
	(0.0175)	(0.0167)	(0.0207)	(0.0284)
Both have same marital status	-0.0004	-0.0163**	-0.0082	-0.0277**
	(0.0089)	(0.0081)	(0.0102)	(0.0136)
Both share same religion	-0.0012	0.0380***	0.0423***	0.0375*
	(0.0121)	(0.0118)	(0.0148)	(0.0200)
Wealth difference	0.0160***	-0.0107*	-0.0138*	-0.0077
	(0.0062)	(0.0062)	(0.0079)	(0.0103)
Polvos Azules founder	0.0134	0.0357**	0.0419**	0.0329
	(0.0157)	(0.0153)	(0.0192)	(0.0257)
Both own the store	-0.0180	0.0008	0.0357*	-0.0578*
	(0.0179)	(0.0173)	(0.0216)	(0.0296)
Constant	-0.3474	-0.1530	-0.1423	-0.0021
	(0.4096)	(0.5271)	(0.5038)	(0.3232)
Observations	3,610	3,426	1,985	1,441
R-squared	0.0501	0.1887	0.2520	0.1722

Standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%. The dependent variable is a binary variable with value one if the dyad is a match. "Sitting adjacent to each other" takes value one if both players in the dyad are sitting next to each other. "Has ever been host or guest of partner" equals one if player was ever been a guest or host of the partner in days where participation was restricted to individuals that had previously played as long as they invited an individual that had never played. All the variables from the social networks survey except for "both are popular" and "both are trusted" take value one if either player in the dyad answers positively to the statement when asked about partner. A player is popular if the number of participants that know the name or store location of the player is higher than that of the median player. Likewise, a player is trusted if the number of participants that report having watched the store or being related to the players is higher than that of the median player. "Both are popular" ("both are trusted") takes the value one if both players are popular (trusted), and takes the value zero otherwise. Risk aversion questions come from the experimental questions in the survey. The regressions include game and individual fixed effects.

Appendix Table 1: Determinants of Participation in Games
OLS

Dependent Variable:	Played Games at Least Once			Days Played
Sample:	Entire Census	Owners	Non-Owners	Entire Census
	(1)	(2)	(3)	(4)
Female	0.014	0.029	0.016	0.454
	(0.023)	(0.047)	(0.024)	(0.493)
Age	0.005***	0.003	0.006***	0.116***
	(0.002)	(0.003)	(0.002)	(0.036)
Married	-0.019	-0.018	-0.029	-0.238
	(0.025)	(0.048)	(0.026)	(0.532)
Years of education	0.003	0.003	0.000	0.015
	(0.005)	(0.009)	(0.007)	(0.105)
Spanish is second language	-0.028	-0.014	-0.028	-0.929
	(0.040)	(0.065)	(0.055)	(0.900)
Attends church at least once a week	0.019	-0.005	0.025	0.465
	(0.027)	(0.054)	(0.030)	(0.557)
Does not attend church	-0.074**	-0.153*	-0.039	-1.750*
	(0.035)	(0.083)	(0.036)	(0.956)
Born in Lima	0.043*	0.051	0.040	0.844
	(0.024)	(0.052)	(0.025)	(0.532)
Household size	-0.003	-0.019*	0.001	-0.067
	(0.005)	(0.012)	(0.005)	(0.111)
Number of assets / appliances	-0.017**	-0.034**	-0.009	-0.285*
	(0.007)	(0.014)	(0.008)	(0.159)
Cooks with kerosene	0.086*	0.060	0.080	1.194
	(0.049)	(0.096)	(0.054)	(0.846)
Played lotto in past month	-0.003	-0.037	0.022	-0.273
	(0.032)	(0.063)	(0.038)	(0.704)
Visited casino in past month	-0.017	-0.137	0.003	-0.057
	(0.044)	(0.092)	(0.043)	(0.957)
Number of positive GSS answers	0.043**	0.036	0.047***	0.982***
	(0.017)	(0.039)	(0.018)	(0.375)
Years experience	0.002	0.002	0.006**	0.059
	(0.002)	(0.003)	(0.003)	(0.043)
Owns microenterprise	0.073**			1.115*
	(0.029)			(0.591)
Hours worked per week	-0.001	0.000	-0.001*	-0.020
	(0.001)	(0.001)	(0.001)	(0.014)
Number of workers in business	0.091***	0.083***	0.080***	2.002***
	(0.012)	(0.030)	(0.012)	(0.259)
Has government business license	-0.058**	-0.132***	-0.006	-1.186**
	(0.026)	(0.048)	(0.029)	(0.523)
Saves in a commercial bank	-0.033	-0.152**	0.037	-1.449
	(0.038)	(0.070)	(0.048)	(0.900)
Has been involved in a ROSCA	0.020	0.064	0.002	0.134
	(0.023)	(0.047)	(0.025)	(0.511)
Has had a joint liability loan	0.097	0.198*	0.033	1.949
	(0.076)	(0.103)	(0.130)	(1.221)
Received a loan in past year	0.086***	0.098**	0.063*	1.938***
	(0.027)	(0.046)	(0.032)	(0.519)
Constant				-11.765***
				(2.279)
Pseudo R^2	0.14	0.11	0.16	0.07
Observations	1418	488	930	1418

Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Columns (1) through (3) are probit regressions in which the dependent variable is equal to one if an individual ever participated in the microfinance games (marginal effects reported). Column (4) is a tobit regression in which the dependent variable is the number of times an individual participated in the games. The independent variable "number of assets / appliances" aggregates seven survey questions which asked whether individuals owned a land line telephone, a cell phone, a computer, a car, a washing machine, a television with a remote control, or a refrigerator.

Appendix Table 2: Demographic Determinants of Risky Choice

Dependent variable = 1 if participant chooses risky project, 0 otherwise

OLS

	Individual Games Only		All Games
	Repeated One Shot	Dynamic	All Games
	(1)	(2)	(3)
Female	-0.011	0.004	-0.007
	(0.047)	(0.039)	(0.028)
Age	-0.007**	-0.003	-0.004**
	(0.003)	(0.003)	(0.002)
Married	0.041	-0.050	0.009
	(0.050)	(0.041)	(0.029)
Years of education	0.007	0.016**	0.012**
	(0.009)	(0.008)	(0.005)
Spanish is second language	-0.029	-0.024	0.002
	(0.079)	(0.068)	(0.049)
Attends church at least once a week	0.062	0.045	0.019
	(0.050)	(0.042)	(0.030)
Does not attend church	-0.011	0.074	0.014
	(0.110)	(0.090)	(0.066)
Born in Lima	-0.006	-0.008	-0.006
	(0.052)	(0.042)	(0.030)
Household size	-0.000	-0.005	-0.005
	(0.012)	(0.010)	(0.007)
Number of assets / appliances	-0.016	-0.007	0.007
	(0.016)	(0.013)	(0.009)
Cooks with kerosene	-0.034	-0.035	0.026
	(0.069)	(0.061)	(0.044)
Played lotto in past month	-0.034	-0.026	-0.015
	(0.064)	(0.054)	(0.038)
Visited casino in past month	-0.101	-0.048	-0.003
	(0.087)	(0.080)	(0.059)
Number of positive GSS answers	-0.055	-0.052*	-0.030
	(0.036)	(0.027)	(0.020)
Years experience	0.000	0.002	0.001
	(0.004)	(0.003)	(0.002)
Owns microenterprise	-0.020	-0.018	0.001
	(0.051)	(0.045)	(0.032)
Hours worked per week	-0.000	0.001	0.000
	(0.001)	(0.001)	(0.001)
Number of workers in business	0.018	0.016	0.021
	(0.022)	(0.019)	(0.013)
Has government business license	0.000	0.001	0.007
	(0.047)	(0.040)	(0.029)
Saves in a commercial bank	0.098	0.144**	0.101**
	(0.087)	(0.070)	(0.051)
Has been involved in a ROSCA	0.012	0.024	0.011
	(0.047)	(0.040)	(0.029)
Has had a joint liability loan	0.044	0.065	0.029
	(0.088)	(0.081)	(0.059)
Received a loan in past year	0.026	0.036	0.023
	(0.047)	(0.039)	(0.028)
Constant	0.752***	0.406**	0.452***
	(0.216)	(0.176)	(0.126)
Observations	2265	3972	22586
Number of Unique Players	212	291	303
R-squared	0.11	0.10	0.13

Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. All specifications include round fixed effects. The dependent variable in all regressions is individual risky project choice in a round of play – between effects are reported from an individual fixed effect specification. All columns also include round fixed effects.

Appendix A: Mathematical Appendix

PROPOSITION: Define the *marginal individual liability borrower* as an agent with preferences such that $\pi_S\left[u\left(Y_S - L\right)\right] = \pi_R u\left[\left(Y_R - L\right)\right]$. Under joint liability, a marginal individual liability borrower prefers the risky project to the safe one.

PROOF:

LEMMA: Let π_S and π_R be probabilities such that $\pi_S > \pi_R$, let $Y_R > Y_S > 0$ be real numbers, and let $u(\cdot)$ be a strictly increasing, weakly concave utility function. Then, $\frac{\partial}{\partial Z}\left\{\pi_S\left[u\left(Y_S - Z\right)\right] - \pi_R u\left[\left(Y_R - Z\right)\right]\right\} < 0$.

PROOF:

$$\frac{\partial}{\partial Z}\left\{\pi_S\left[u\left(Y_S - Z\right)\right] - \pi_R\left[u\left(Y_R - Z\right)\right]\right\} = -\pi_S\left[u'\left(Y_S - Z\right)\right] + \pi_R\left[u'\left(Y_R - Z\right)\right]$$

By concavity,

$$u'\left(Y_S - L\right) \geq u'\left(Y_R - L\right)$$

since $Y_R > Y_S$. Thus, because $\pi_S > \pi_R$,

$$-\pi_S\left[u'\left(Y_S - Z\right)\right] + \pi_R\left[u'\left(Y_R - Z\right)\right] < 0.$$

Q.E.D.

Let q be the probability that an agent's partner invests in the safe project. When $q = 1$, we have the following. By the lemma,

$$\pi_S\left[u\left(Y_S - 2L\right)\right] < \pi_R\left[u\left(Y_R - 2L\right)\right].$$

Thus, since $\pi_S\left[u\left(Y_S - L\right)\right] = \pi_R\left[u\left(Y_R - L\right)\right]$, we have

$$\left(\pi_S\right)^2\left[u\left(Y_S - L\right)\right] + \pi_S\left(1 - \pi_S\right)\left[u\left(Y_S - 2L\right)\right] < \pi_R\pi_S\left[u\left(Y_R - L\right)\right] + \pi_R\left(1 - \pi_S\right)\left[u\left(Y_R - 2L\right)\right].$$

Similarly, when $q = 0$,

$$\pi_S\pi_R\left[u\left(Y_S - L\right)\right] + \pi_S\left(1 - \pi_R\right)\left[u\left(Y_S - 2L\right)\right] < \left(\pi_R\right)^2\left[u\left(Y_R - L\right)\right] + \pi_R\left(1 - \pi_R\right)\left[u\left(Y_R - 2L\right)\right].$$

Finally, by the above,

$$\begin{aligned}&\pi_S\left\{\left[\pi_S q + \pi_R(1-q)\right]\left[u\left(Y_S - L\right)\right] + \left[\left(1-\pi_S\right)q + \left(1-\pi_R\right)(1-q)\right]\left[u\left(Y_S - 2L\right)\right]\right\}\\ &\quad\leq \pi_R\left\{\left[\pi_S q + \pi_R(1-q)\right]u\left[\left(Y_R - L\right)\right] + \left[\left(1-\pi_S\right)q + \left(1-\pi_R\right)(1-q)\right]\left[u\left(Y_R - 2L\right)\right]\right\}\end{aligned}$$

for any $0 < q < 1$.

Q.E.D.

Appendix B: Game Administration

All games were administered by a team of three to five researchers. Players were randomly assigned to numbered seats at the beginning of each game session, and were identified using their seat numbers throughout the day. In each game, each player received a packet of ten game worksheets. Sample worksheets are included in Appendix B. In each round, participants would circle their desired projects before returning their game packets to the researchers. Choices were then entered into a computer which randomized outcomes for players investing in the risky project and then reported individual earnings for that round (after automatically deducting the loan repayment). A member of the research team then highlighted final outcomes on participant game sheets before returning them to players. After players examined their results for the round, the game either continued into the next round or ended.

Instructions Read to Participants

Read at the beginning of all games:

Good morning everyone. We are a group of college students carrying out research about how microentrepreneurs from Polvos Azules make business decisions. We would like you to participate in our study. If you choose to participate, we will ask you to play several types of games with us. Just for showing up and staying for two hours, you will receive ten soles. You may earn up to ten soles. How much you earn will depend on how many points you accumulate during the course of the games. The more points you accumulate during the games, the more money you will receive at the end of the session.

Packets of game worksheets are passed out at this point.

You are not allowed to talk to each other during the course of the games. In addition, you are not allowed to look at the worksheets of people sitting near you.

Each game consists of multiple rounds. At the beginning of each round, you will receive a bank loan for 100 points. You must invest this loan in one of two projects: "Project Square" or "Project Triangle." Project Square pays 200 points with certainty. If you choose Project Triangle, your project may be successful or it may fail. Each time you choose Project Triangle, it is like the computer flips an imaginary coin. If the coin lands on heads, you will receive 600 points. However, if the coin lands on tails, you won't receive anything.

Note that project outcomes are independent, so if two players chose Project Triangle in the same round, one can be successful while the other fails because the computer tosses a different imaginary coin for each player.

Before receiving the points from your project, you have to repay the loan from the bank. This is done automatically by the computer, so no one has the right to decide whether or not to repay the loan. You can only use the points you earned in each round to repay the bank. In any round, if you choose Project Triangle and your project is not successful, you cannot repay the bank.

To begin the game everybody is assigned 500 points.

The only thing you have to do is circle one of the two projects for each round. After that you will hand us the game sheets and we will fill in the rest of the information after entering your choice into the computer. Do not forget to write your ID number in the upper right corner of each sheet.

We will be playing many rounds, but we are not sure how many. It will be as if we were rolling an imaginary dice, and with some probability the game stops and we will start another game.

There are going to be several types of games that we will explain as we play them. In some of them you will play alone, in others you will have a partner.

Read before specific game specifications:

Individual Repeated One-Shot Games: In this game you will be playing alone, meaning you will be solely responsible for your loan from the bank. You will receive the loan from the bank and you will have to circle the project (Square or Triangle) that you want to invest in. In this game, you will always receive a new loan at the beginning of each round even when you were not able to repay your loan in the previous round. In this case, the bank will allow you to borrow again even if your project does not succeed and you do not repay the loan.

Individual Dynamic Games: In this game you will be playing alone, meaning you will be solely responsible for your loan from the bank. You will receive the loan from the bank and you will have to circle the project (Square or Triangle) that you want to invest in. In this game, the bank will *not* loan to you again if your project does not succeed and thus are unable to repay the loan. This will happen if you choose Project Triangle and your project fails. In that case you will have to remain in your seat and wait for the other participants to finish playing.

Joint Liability Repeated One-Shot Games: In this game you will be borrowing jointly from the bank with a partner in the room. You will not know who the partner is, nor will you be shown what project the partner chooses. As before, you will choose a project by circling either Square or Triangle. You and your partner are responsible for each other's loans. If your project succeeds and your partner's does not, you will have to repay your partner's loan. On the other hand, if your partner's project succeeds and yours does not, your partner will repay your loan. In this game, you will always receive a new loan at the beginning of each round even when neither of you are able to repay the loan in the previous round.

Joint Liability Dynamic Games: In this game you will be borrowing jointly from the bank with a partner in the room. You will not know who the partner is, nor will you be shown what project the partner chooses. As before, you will choose a project by circling either Square or Triangle. You and your partner are responsible for each other's loans. If your project succeeds and your partner's does not, you will have to repay your partner's loan. On the other hand, if your partner's project succeeds and yours does not, your partner will repay your loan. In this game, the bank will *not* loan to you or your partner again if your projects do not succeed and you are unable to repay your loans. This will happen if both partners choose Triangle and both projects fail.

Monitoring Repeated One-Shot Games: In this game you will be borrowing jointly from the bank with a partner in the room. You will not know who the partner is. However, at the start of each round, we will show you what your partner chose (square or triangle) in the prior round. As before, you will choose a project by circling either Square or Triangle. You and your partner are responsible for each other's loans. If your project succeeds and your partner's does not, you will have to repay your partner's loan. On the other hand, if your partner's project succeeds and yours does not, your partner will repay your loan. In this game, you will always receive a new loan at the beginning of each round even when neither of you are able to repay the loan in the previous round.

Monitoring Dynamic Games: In this game you will be borrowing jointly from the bank with a partner in the room. You will not know who the partner is. However, at the start of each round, we will show you what your partner chose (square or triangle) in the prior round. As before, you will choose a project by circling either Square or Triangle. You and your partner are responsible for each other's loans. If your project succeeds and your partner's does not, you will have to repay your partner's loan. On the other hand, if your partner's project succeeds and yours does not, your partner will repay your loan. In this game, the bank will *not* loan to you or your partner again if your projects do not succeed and you are unable to repay your loans. This will happen if both partners choose Triangle and both projects fail.

Repeated One-Shot Games with Communication: In this game you will be borrowing jointly from the bank with a partner in the room. Before the game begins, the computer will assign each of you a partner and we will ask you to move to a seat next to your partner. You and your partner will sit next to each other, and you will be allowed to talk to your partner throughout the game. In addition, in each round we will show you what your partner chose (square or triangle) in the prior round. As before, you will choose a project by circling either Square or Triangle. You and your partner are responsible for each other's loans. If your project succeeds and your partner's does not, you will have to repay your partner's loan. On the other hand, if your partner's project succeeds and yours does not, your partner will repay your loan. In this game, you will always receive a new loan at the beginning of each round even when neither of you are able to repay the loan in the previous round.

Dynamic Games with Communication: In this game you will be borrowing jointly from the bank with a partner in the room. Before the game begins, the computer will assign each of you a partner and we will ask you to move to a seat next to your partner. You and your partner will sit next to each other, and you will be allowed to talk to your partner throughout the game. In addition, in each round we will show you what your partner chose (square or triangle) in the prior round. As before, you will choose a project by circling either Square or Triangle. You and your partner are responsible for each other's loans. If your project succeeds and your partner's does not, you will have to repay your partner's loan. On the other hand, if your partner's project succeeds and yours does not, your partner will repay your loan. In this game, the bank will *not* loan to you or your partner again if your projects do not succeed and you are unable to repay your loans. This will happen if both partners choose Triangle and both projects fail.

Repeated One-Shot Games with Partner Choice: In this game you will be borrowing jointly from the bank with a partner in the room. Before the game begins, we will ask you to stand up and find a partner that you would like to play with. You and your partner will sit next to each other, and you will be allowed to talk to your partner throughout the game. In addition, in each round we will show you what your partner chose (square or triangle) in the prior round. As before, you will choose a project by circling either Square or Triangle. You and your partner are responsible for each other's loans. If your project succeeds and your partner's does not, you will have to repay your partner's loan. On the other hand, if your partner's project succeeds and yours does not, your partner will repay your loan. In this game, you will always receive a new loan at the beginning of each round even when neither of you are able to repay the loan in the previous round.

Dynamic Games with Partner Choice: In this game you will be borrowing jointly from the bank with a partner in the room. Before the game begins, we will ask you to stand up and find a partner that you would like to play with. You and your partner will sit next to each other, and you will be allowed to talk to your partner throughout the game. In addition, in each round we will show you what your partner chose (square or triangle) in the prior round. As before, you will choose a project by circling either Square or Triangle. You and your partner are responsible for each other's loans. If your project succeeds and your partner's does not, you will have to repay your partner's loan. On the other hand, if your partner's project succeeds and yours does not, your partner will repay your loan. In this game, the bank will *not* loan to you or your partner again if your projects do not succeed and you are unable to repay your loans. This will happen if both partners choose Triangle and both projects fail.

Dynamic Games with Opportunities for Punishment:

In this game you will be borrowing jointly from the bank with a partner in the room. You will not know who the partner is. However, at the start of each round, we will show you what your partner chose (square or triangle) in the prior round. As before, you will choose a project by circling either Square or Triangle. You and your partner are responsible for each other's loans. If your project succeeds and your partner's does not, you will have to repay your partner's loan. On the other hand, if your partner's project succeeds and yours does not, your partner will repay your loan. In this game, the bank will *not* loan to you or your partner again if your projects do not succeed and you are unable to repay your loans. This will happen if both partners choose Triangle and both projects fail.

At the end of the game, you will be given the opportunity to punish your partner. If for any reason you feel the person that has been your partner did something you do not approve or that you want to send them a message about your satisfaction in relation to their choices, you can punish them. If you choose to punish your partner, we will deduct 500 points from their total earnings in this game. Punishing is costly: we will also deduct 50 points from your earnings. Keep in mind that as well as you can punish your partner, your partner can punish you if he/she feels they ought to. Also remember that your winnings are determined by how many points you accumulate, and are not affected by how many points everyone else accumulates.

In order to be able to punish you are receiving an additional sheet. At the end of the game, you will able to choose between option 1 (No punishment – 0 Cost of punishment) or option 2 (500 points of punishment – 50 points as cost of punishment). After you hand in your sheets with your punishment choice we will return them to you and you will be able to see if someone punished you. You will never know the identity of your partner, even if they punish you.

Appendix C: Sample Game Worksheets

Worksheet for Individual Repeated One-Shot Game:

Your number: _______________

PRACTICE ROUND

Initial Points: 500

Choose your product here!

Information on the possible outcomes. Don't write here!

Determined by the computer. Don't write here!

PRODUCT	Is your product successful?	Points from your product	Minus your loan (If you have points to repay it)	Points for the round
■	Yes	200	- 100	= 100
▲	Yes	600	- 100	= 500
▲	No	0	- 0	= 0

YOUR OUTCOME

Total Points: ___________

Worksheet for Monitoring Dynamic Game:

Your number: _________

Initial points: 500

PRACTICE ROUND

Choose your product here!

Information on the possible outcomes. Don't write here!

Determined by the computer. Don't write here!

PRODUCT	Is your product successful?	Points from your product	Your partner's product	Is your partner's product successful?	Minus the points you have to repay from the 2 loans	Your points for the round	Can your group keep playing?
■	Yes	200	■	Yes	- 100	= 100	Yes
■	Yes	200	▲	Yes	- 100	= 100	Yes
■	Yes	200	▲	No	- 200	= 0	Yes
▲	Yes	600	■	Yes	- 100	= 500	Yes
▲	Yes	600	▲	Yes	- 100	= 500	Yes
▲	Yes	600	▲	No	- 200	= 400	Yes
▲	No	0	■	Yes	- 0	= 0	Yes
▲	No	0	▲	Yes	- 0	= 0	Yes
▲	No	0	▲	No	- 0	= 0	No

YOUR OUTCOME

Total Points: ______

Keep playing?

Yes No