Psychological and Social Motivations in Microfinance Contracts: Theory and Evidence*

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Abstract

We study, theoretically and empirically, the effort choices of microfinance borrowers under individual liability (*IL*) and joint liability (*JL*) contracts when loan repayments are made either privately or publicly. Our theoretical model identifies guilt aversion in a *JL* contract and shame aversion under public repayment of loans as the main psychological drivers of effort choice. Evidence from our lab-in-the-field experiment in Pakistan reveals large treatment effects and confirms the central roles of guilt and shame. Under private repayment, a *JL* contract increases effort by almost 100% relative to an *IL* contract. Under public repayment, effort levels are comparable under *IL* and *JL* contracts, indicating that shame aversion plays a more important role than guilt aversion. Under *IL*, public repayment relative to private repayment increases effort by 60%, confirming our shame-aversion hypothesis. Under *JL*, the private versus public repayment contrast shows that shame trumps guilt in explaining borrowers' effort choices.

Keywords: Joint/individual liability; public/private repayment; belief-dependent motivations; guilt; shame; lab-in-the-field experiment

JEL Classification: C91, C92, D82, D91, G21

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1 Introduction

Microfinance institutions (MFIs) offer small, short-term loans to borrowers who lack collateral to borrow from the conventional banking sector. Borrowers typically engage in risky projects, but the risk can be mitigated by greater effort that improves the probability of success of the projects. Despite impressive advances in the literature, we know relatively little about the determinants of borrowers' effort and repayment decisions (Banerjee, 2013). The traditional arguments rely on *peer pressure* and *social capital* induced by alternative microfinance contracts to explain effort and repayment rates (Stiglitz, 1990; Banerjee et al., 1994; Besley and Coate, 1995). However, precise and empirically testable definitions of peer pressure and social capital remain elusive. This paper studies, theoretically and experimentally, the psychological factors that underpin these concepts and explains effort choices and repayment rates under different microfinance contracts.

Two types of contracts, *individual liability* (*IL*) and *joint liability* (*JL*) contracts, have played a central role in the literature and are pervasive in the field.[1] Under *IL* contracts, an individual borrower can get a future loan if, and only if, the current loan is repaid. Under *JL* contracts, a 'group' of borrowers borrows jointly; any borrower in the group receives a future loan if, and only if, all group members repay the current loan. Group members typically pursue their individual, possibly independent, projects (production independence, but contractual dependence).[2]

The Grameen bank resolved the microfinance problem by initially offering *JL* contracts. This contractual package, known as *Grameen-I*, also required *repayments of loans in public meetings* in front of other borrowers, small weekly repayments of loans, and regular savings deposits. It achieved exceptional repayment rates (99.6% in 2016). In recent years, the Grameen Bank has successfully replaced *JL* contracts by *IL* contracts (*Grameen-II*), but retained repayment in public meetings from Grameen-I (Rai and Sjöström, 2013). The success of Grameen-I using *JL* contracts (when *IL* contracts were available), and the success of Grameen-II using *IL* contracts (when *JL* contracts were available), is puzzling.

Theoretically, potential justifications for *JL* contracts arise from information and enforcement concerns. For instance, assortative matching of risk types under adverse selection (Ghatak, 1999, 2000; Van Tassel, 1999); moral hazard arising from non-observability of borrower effort and peer pressure, backed by private monitoring and enforcement in *JL* contracts (Stiglitz, 1990; Banerjee et al., 1994; Besley and Coate, 1995).[3] These mechanisms do not explain the transition from Grameen-I to Grameen-II, nor specify the precise nature of peer pressure. The empirical evidence on the relative effectiveness of *JL* and *IL* contracts is mixed. Selection and

[1]Data from 346 MFIs and 18 million active borrowers shows that 2/3 of the microfinance banks use *IL*, and 3/4 of the non-governmental organizations use some form of *JL* contracts (Cull et al., 2009).

[2]Group members in a *JL* contract may help a partner pay off an installment, providing mutual insurance. However, there is no presumption that over the entire duration of a loan, group members pay a net balance towards the contributions of others, Armendáriz and Morduch (2010). Armendáriz and Morduch (2010, p. 100) note: "The original idea was not that group members would be forced to repay for others, rather it was that they would lose the privilege of borrowing."

[3]An even better outcome arises if, in the absence of collusion among players, players in *JL* contracts cross-report the actions of each other to the bank (Rai and Sjöström, 2004). However, there is no evidence for the existence of such formal contracts(Banerjee, 2013).

endogeneity issues make it difficult to draw unambiguous conclusions from field data.[4]

In contrast to joint liability, *public repayment* has not received much attention in the literature.[5] Under *public repayment*, in order to economize on transaction costs, loan officers visit specified areas at discrete intervals of time. The borrowers in the area are assembled in one place and their repayment decisions are revealed in front of other borrowers. By contrast, under *private repayment*, a third party does not observe repayment/default decisions. Thus, potential non-repayment of loans under public repayment is likely to invite *public shame* and *loss of social capital* among one's peers. While this implication of public repayment has been recognized in the literature, social capital is either not formally defined, or introduced in a reduced form manner without specifying the exact empirical counterparts/proxies (Besley and Coate, 1995; de Quidt et al., 2016). This gives rise to difficulties in comparing results across different studies.[6]

The public repayment of loans allows borrowers to acquire information about the outcomes of other borrowers' projects and, in addition to inviting shame for defaulters, may encourage informal side contracts amongst borrowers (Rai and Sjöström, 2013). However, these informal contracts may also suffer from information and enforcement problems that could potentially be mitigated by social norms, sanctions, and repeated play (Fafchamps, 2011; Ligon et al., 2002; Kocherlakota, 1996). We abstract from such contracts to avoid any confounding effects of informal side contracts on borrowers' effort and repayment decisions. Instead, we focus on isolating the effects of shame arising from loan defaults in public repayment meetings that may explain the recent shift away from *JL* contracts in Grameen-II.

Our Approach: Emotions play a central role in sustaining cooperation; *guilt* mediates social interaction, while *shame* aids norm conformity (Bowles and Gintis, 2003; Fessler, 2004; Henrich, 2016). Kandel and Lazear (1992) differentiate between guilt from letting down a partner and shame from violating a social norm, but they do not provide a formal beliefs-based account of these emotions. We propose a beliefs-based foundation for peer pressure and social capital that relies, respectively, on guilt and shame.

Example 1. *(Guilt aversion in JL contracts): An MFI enters into a two-person JL contract with Gill and a partner. Gill and her partner form expectations about each other's effort levels (first-order positive beliefs). Gill also receives a 'private' signal, θ_i, from her partner about the effort level the partner expects from Gill, capturing diverse real-world mechanisms that partners use to exert peer pressure on each other. Gill uses the signal θ_i to form her beliefs*

[4] Giné and Karlan (2014) find no significant difference in default rates when half of the *JL* contracts are switched to *IL* contracts, but repayments were made in public. Thus, it is not clear if their results are driven by assortative matching in the switched borrowers or the anticipation of losing social capital from defaulting in the public repayment meeting. Carpena et al. (2013) report data on missed payments (but not defaults) when a switch is made from *IL* to *JL* loans under private repayment of loans. They find a significant reduction in missed payments in *JL* loans. However, this switch also changed interest rates, loan amounts, and the installment amounts. Attanasio et al. (2015) find no differences in default rates in *JL* loans relative to *IL* loans. However, *IL* loans were larger in magnitude; most *IL* loans (92%) were collateralized; and *JL* loans had shorter maturity.

[5] Notable exception are Feigenberg et al. (2013), Rai and Sjöström (2013), and de Quidt et al. (2016).

[6] Different proxies are used for social capital: the extent to which members partake in joint social activities (Wydick, 1999); whether subjects register for the experiment singly or in groups (Abbink et al., 2006); the frequency of meetings outside the contractual setting, such as social meetings (Feigenberg et al., 2013). The first study finds no effect, the second finds a moderate effect, and the third finds a large effect.

about the partner's expectations (Gill's second-order positive beliefs). If Gill is guilt averse, then she experiences disutility by exerting effort below what she believes is expected of her by her partner. This gives rise to the guilt-aversion motive (Battigalli and Dufwenberg, 2007). If Gill believes that her partner expects a high effort level from her, then guilt aversion may induce Gill to increase her effort in a JL contract. By contrast, an IL contract, by shutting down guilt-aversion with respect to other borrowers, may induce lower effort.

Shame arises when an individual's behavior violates an established norm in a social group that can observe and sanction the violator (Fessler, 2004). The aversion to shame fosters adherence to social norms (Bicchieri, 2006; Elster, 2011).

Example 2. *(Shame aversion in public repayment): Norma enters into an IL contract with an MFI that also requires her to make 'public repayments' that are observed by her social group (SG). The SG forms expectations about the effort that its group members 'ought' to exert (SG's first-order normative beliefs). The SG observes and sanctions actions (e.g., non-repayments and defaults on loans) of the group members that can erode the sanctioned member's social capital. Norma receives a 'public' signal, s, of the SG's first-order normative expectations that allows her to make better inferences about the SG's expectations (Norma's second-order normative beliefs about the SG's first-order normative beliefs).*[7] *If Norma is shame averse, then she experiences disutility from falling below the SG's normative expectations. So she increases her effort, and the chances of loan repayment. By contrast, the shame-aversion motive is missing under private repayment, reducing effort and the chances of loan repayment.*

We consider a 2×2 design. Along one dimension, we vary the *liability structure*, *IL* or *JL*, and along the other, we vary the *method of repayment*, private on an individual basis (I) or public in a group (P). This gives rise to four different contracts shown in Table 1: *ILI* (individual liability, private repayment), *ILP* (individual liability, public repayment), *JLI* (joint liability, private repayment), *JLP* (joint liability, public repayment).

We examine the levels of effort and the repayment rates in a two-period microfinance game with moral hazard. Risk neutral borrowers undertake independent, identical, and risky projects that are more likely to succeed if they exert a higher level of costly effort. The borrowers' effort is unobserved by the lender. In choosing their first-period effort, borrowers take account of the consequences for second-period loans. In *IL* contracts (*ILI*, *ILP*), second-period loans are given only if the borrower repays the first-period loan. In *JL* contracts (*JLI*, *JLP*), first-period effort decisions have two kinds of consequences. (i) Intertemporal consequences arise because all group members must repay their first-period loans for each of them to qualify for a second-period loan. (ii) Interpersonal consequences arise because borrowers may experience peer pressure from their partners that activates the guilt-aversion motive, regardless of the repayment method. There are

[7] Norma also observes the actual effort levels of others in her social group (empirical expectations). The alignment of normative expectations and empirical expectations is essential for establishing social norms (Bicchieri, 2006; Biccheiri and Xiao, 2009). For example, in corrupt societies, one observes that most other people are corrupt (empirical expectations), yet the normative expectation is that people 'ought' not to be corrupt. In such cases, human behavior appears motivated by empirical rather than normative expectations. The problem does not arise, as in our case, if the two expectations are aligned.

Table 1: Emotions and Signals in Four Contracts in a Two-period Microfinance Game.

First-Period Contracts		
Repayment **Liability**	**Private (*I*)** Unobservable to a third party	**Public (*P*)** Observable to a third party
Individual Liability (*IL*) Borrower gets 2^{nd} period loan only if the 1^{st} period loan is repaid.	***ILI*** Emotions absent No Private Signal No Public Signal	***ILP*** Shame No Private Signal Public Signal s
Joint Liability (*JL*) Borrower gets 2^{nd} period loan only if all group members repay their 1^{st} period loans.	***JLI*** Guilt Private Signal θ_i No Public Signal	***JLP*** Guilt & Shame Private Signal θ_i Public Signal s
Second-Period Contracts		
Individual Liability (*IL*) Only *IL* loans in the 2^{nd} period.	***ILI*** Emotions absent No Private Signal No Public Signal	***ILP*** Shame No Private Signal Public Signal s

no future and interpersonal consequences of actions in the second period of a two-period model. Hence, the second period of a *JL* loan is effectively an *IL* loan, and peer pressure/guilt-aversion is absent in the second period. However, in public repayment contracts (*ILP*, *JLP*), a low effort relative to the normative expectations of one's social group may invite social disapproval in any of the two periods, as in Example 2. Thus, the shame-aversion motive/social capital plays a potentially important role in both periods.

Table 1 summarizes the four contracts. In the baseline contract *ILI*, there is neither joint liability nor public repayment, so emotions play no role. The *ILP* contract activates the emotion of shame through the public repayment aspect (as in Norma's case in Example 2). The *JLI* contract activates the emotion of guilt in the first period due to the joint liability feature of the contract (as in Gill's case in Example 1). The *JLP* contract, the most psychologically rich of the four contracts, activates the emotions of guilt from the joint liability aspect and shame from the public repayment aspect.

The pairwise contrasts between contracts isolate the effects of peer pressure and social capital. (i) Keeping fixed the liability structure but varying the mode of repayment, the contrasts *ILI vs ILP* and *JLI vs JLP* determine the effects of social capital alone. (ii) Keeping fixed the mode of repayment but varying the liability structure, the contrasts *ILI vs JLI* and *ILP vs JLP* determine the effects of peer pressure alone. (iii) Simultaneously changing the liability structure and the mode of repayment from the baseline contract *ILI*, the contrast *JLI vs ILP* is mediated by the effects of both peer pressure and social capital.

Our beliefs-based approach uses the framework of *psychological game theory* (Geanakoplos et al., 1989; Battigalli and Dufwenberg, 2009) allowing for a formal analysis of guilt and shame. Our theoretical model requires that borrowers play a psychological best response to their beliefs.[8]

[8]The main solution method in psychological game theory relies on players playing the best response to their

However, the evidence suggests that humans may exhibit bounded rationality, so they resort to using simple *heuristics*, that are fast and frugal, to solve economic problems.[9] In Section 7, we briefly consider *heuristics-based effort choices*.

We have noted above the limitations of field studies that make it difficult to introduce exogenous variation in the type of microfinance contracts. This leads to selection and endogeneity issues that can be addressed by lab-in-the-field experiments. These experiments allow exogenous variation in contracts holding fixed, loan sizes, interest rates; and random allocation of actual microfinance borrowers to different contract treatments. In addition, they permit the necessary belief manipulation required to test for guilt aversion and shame aversion; this is infeasible in a natural field experiment. Thus, to test the theoretical predictions of our model, we conducted a lab-in-the-field experiment in Pakistan. We tried to maximize external validity by (i) recruiting 400 actual microfinance borrowers as subjects, (ii) using interest rate and contractual specifications that were similar to what our subjects faced in their real-world contracts, and (iii) offering payoffs at least equal to the daily minimum wage. Lab-in-the-field experiments have been used to study risk characteristics of microfinance contracts (Giné et al., 2010; Fischer, 2013) but, unlike our paper, not the effort levels in *IL*/*JL* contracts, the determinants of effort, and the implications of public/private repayment of loans.

Our experimental results confirm the significance of guilt-aversion and shame-aversion mechanisms in the effort decisions of our subjects. We summarize our results as follows.

First-period comparisons: Restricting attention to private repayment (*ILI vs JLI*), the average effort under *JLI* is almost double relative to *ILI*, and the repayment rate increases by 33%. We find a strong causal effect of the private signals of the partner's first-order beliefs, θ_i, on effort in *JLI*; this confirms the role of guilt aversion in a *JL* contract. The average effort decisions in both public repayment treatments (*ILP vs JLP*) exactly matched the public signal, s, confirming our shame-aversion hypothesis; the liability structure is unimportant in this case. Thus, public repayment, even without joint liability, is effective in ensuring high effort and loan repayment. This may explain why Grameen-II retained public repayment and dropped joint liability. If effort provision and repayment rates are similar under the *JLP* and *ILP* contracts, then borrowers can be freed from the restrictive borrowing requirements of joint liability.

The contrast between private and public repayment under *IL* contracts (*ILI vs ILP*) shows that public repayment alone increases the first-period average effort by 60% and the repayment rate by 23%, consistent with our shame-aversion hypothesis. The same comparison between *JL* contracts (*JLI vs JLP*) shows that while the average effort matches the public signal s in *JLP*, the effect of the private signal θ_i, which had a strong causal effect on the first-period effort in *JLI*, is close to zero. This suggests that *shame aversion trumps guilt aversion*. Finally, our

beliefs and the mutual consistency of beliefs and actions. While players may play a best response to their beliefs, the evidence shows that consistency between beliefs and equilibrium actions required in variations of sequential Nash equilibrium does not hold in the early rounds of most games and often even when the game is repeated a large number of times. For this reason, we do not require the mutual consistency of beliefs in our model below. For useful surveys of the evidence, see Crawford (2018), Mauersberger and Nagel (2018), and Dhami (2019, Vol. 4). In particular, Bellemare et al.,(2011) show that there is a lack of consistency between actions, first-order beliefs, and second-order beliefs. See also Section 9 in Battigalli and Dufwenberg (2020) for a critical discussion of the solution concepts in psychological games.

[9]The seminal paper is Tversky and Kahneman (1974). For a survey, see Dhami (2020, Vol. V).

comparison between the contracts *JLI* and *ILP* shows no significant difference in repayment rates. This implies that either feature of Grameen-I, joint liability or public repayment, can be effective on its own to ensure high effort and repayment rates.

Our results have two implications for contractual choices by banks. (1) Under public repayment, given the more restrictive borrowing conditions in the *JLP* contract, the bank may prefer the *ILP* contract; shame aversion suffices in this case. (2) Under private repayments, the bank may prefer the *JLI* contract to the *ILI* contract due to the higher repayment rate in the first period and the higher take-up of loans in the second period in the *JLI* contract; peer pressure/guilt aversion is efficacious in this case.

Second-period comparisons: In the second period, we do not find the predicted end-game effects in the literature. This puzzling result is inconsistent with the standard optimization approach and suggests a form of anchoring. Contrary to our theoretical prediction, the average second-period effort levels are not lower than the average first-period effort levels in the *JLI*, *ILP* and *JLP* contracts, and are respectively aligned with the private and public signals. We explore the possibility that these findings reflect the underlying heuristics that borrowers might be using.

Related literature: Our paper contributes foremost to the literature on social incentives of joint liability and the public repayment features of microfinance contracts (Giné and Karlan, 2014; Feigenberg et al., 2013; Carpena et al., 2013; Wydick, 1999). As far as we are aware, our paper is the first to formalize the underlying belief-based mechanisms of peer pressure and social capital, and provide clear experimental evidence on the incentive effects of these mechanisms for the effort decisions of borrowers and contractual choices by banks.

More broadly, the paper also contributes to the literature on individual behavior under team/group incentives and social pressure.[10] However, this literature does not formalize or analyze the role of underlying beliefs. We contribute to the earlier literature on social capital by analyzing the role of shame aversion that builds on the theory of social norms (Bicchieri, 2006; Elster, 2011; Fehr and Schurtenberger, 2018).

Plan of the Paper: Section 2 describes the theoretical model. Section 3 analyses the optimization problem faced by the agent. Section 4 gives the comparative static results of our model. Proofs are contained in the Appendix. Section 5 presents the experimental design. Experimental results are discussed in Section 6. Section 7 briefly discusses the heuristics approach that also organizes the evidence well. Section 8 concludes.

[10]On team/group incentives, notable contributions are Hamilton et al. (2003) who report that, on average, group piece-rate production increased worker productivity by 14% relative to individual piece rates; Falk and Ichino (2006) show that peer effects raise the average productivity and reduce the standard deviation of output; Bandiera et al. (2005, 2010) show the significance of social incentives with farm workers; Babcock et al. (2015) report that team incentives work through guilt and social pressure and increase productivity by 9% - 17% relative to individual incentives. On social pressure, Charness et al. (2007) and Andreoni and Bernheim (2009) find strong effects from being observed by one's peers. Bènabou and Tirole (2006) and Ellingsen and Johannesson (2008) provide theoretical models of the effect of social reputation/esteem on incentives.

2 Model

Consider a two-period model with a principal (bank) and two agents (potential borrowers). The two agents are indexed by $i = 1, 2$ and time by $t = 1, 2$. The bank and the two agents are risk-neutral, expected utility maximizers, and there is no time discounting.[11] The endowments of both agents and their outside options, in each period, are assumed to be zero.

2.1 Production Technology

In each time period t, each agent i has access to an identical, risky, one-period, project. The production technology of a project is described as follows.

1. *Project inputs*: The fixed capital cost of undertaking the project in any period is $L > 0$. With zero endowments, agents need a bank loan to finance the cost, L. If the loan L is taken and if the project is successful, then the agent must repay an amount $L(1 + r)$ at the end of the period, where $r > 0$ is the exogenous, time-invariant, interest rate. Agent i may also exert costly effort $e_{it} \in [0, 1]$ towards the project in period t. The cost of effort function $c : [0, 1] \to \mathbb{R}$, is strictly increasing and strictly convex, so

$$c(0) = 0,\ c'(e_{it}) > 0,\ c''(e_{it}) > 0 \text{ for } e_{it} \in [0, 1]. \tag{2.1}$$

2. *Project outputs*: The outcome of the project is risky. It succeeds with probability $p(e_{it})$, and yields revenue Y, where $Y > L(1 + r)$. The borrower can repay the loan in this case. The project fails with probability $1 - p(e_{it})$ and revenues equal 0. We assume limited liability on the borrower's part, so the loan cannot be repaid in the case of failure. The returns across time $t = 1, 2$ and across agents $i = 1, 2$ are uncorrelated.
   The probability of success of the project, $p : [0, 1] \to [0.5, 1]$, is determined by two factors. (1) There is an exogenous probability, 0.5, that the project succeeds on account of the capital investment embodied in the loan, L. (2) The effort exerted by the agent increases the probability of success, $p(e_{it})$. We assume a linear form for p in our experiments

$$p(e_{it}) = \frac{1 + e_{it}}{2} \in [0.5, 1],\ p'(e_{it}) = \frac{1}{2} > 0,\ e_{it} \in [0, 1]. \tag{2.2}$$

2.2 Banking Technology

The bank does not observe the effort level of the borrower. But it does observe the outcome of the project which is also verifiable to a third party, such as a court. Thus, if the project is successful, the agent cannot engage in *strategic default*. If the project fails, the bank gets no repayment because of the limited liability of the agent. If the bank decides not to give a loan to an agent, then the agent gets zero monetary payoffs.[12] The bank can offer one of four contracts described below.

[11] Relaxing these assumptions does not change the qualitative results of the paper.

[12] We are agnostic as to whether the lender is a private competitive bank that earns zero profits, a profit-maximizing bank, or a state bank that provides subsidized loans to microfinance borrowers.

1. **Individual liability with private repayment (*ILI*)**. In the first period, the bank offers the agent a loan $L > 0$. If at the end of the first period the agent repays the loan with interest, $L(1+r)$, then the bank offers a second-period loan, also $L > 0$. Otherwise, the bank does not offer a second-period loan. Whether the agent repays the bank or not is private information to the bank and the agent.

2. **Individual liability with public repayment (*ILP*)**. The liability structure in *ILP* is the same as in *ILI*, but the repayment or default occurs in public and can be observed by other members of one's social network.

3. **Joint liability with private repayment (*JLI*)**. In the first period, the bank offers a loan, L, to each of the two agents in the *JL* contract. If *both* agents repay the loan with interest, $L(1+r)$, only then do both receive a second-period loan from the bank. If one or both of the agents fail to repay, then the bank does not offer a second-period loan to either. As in *ILI*, the repayment status is private knowledge to the bank and the agents.

4. **Joint liability with public repayment (*JLP*)**. The liability structure in the *JLP* contract is the same as *JLI*, but the repayment or default occurs in public as in *ILP*.

From (2.2), the probability that an agent gets a second-period loan is given by

$$p(e_{i1}, e_{j1}) = \begin{cases} \dfrac{1+e_{i1}}{2} & \text{for contracts } ILI,\ ILP \\ \dfrac{1+e_{i1}}{2} \times \dfrac{1+e_{j1}}{2},\ i \neq j & \text{for contracts } JLI,\ JLP. \end{cases} \tag{2.3}$$

We assume that in *JL* contracts (*JLI*, *JLP*), at the end of each period, (1) agents can observe the effort levels of their partners and this observability is common knowledge among them,[13] but (2) they cannot produce verifiable information about the effort levels to a third party.[14] Moral hazard arises because the effort levels are observed by the borrowers but not by the bank.

Remark 1. *In a two-period model, there is no future beyond period $t = 2$. For this reason, all second-period contracts are effectively IL contracts (see Table 1).*

2.3 Single Period Monetary Payoffs

If the bank decides to give a loan L to an agent i who chooses effort e_{it} in period t, then the expected monetary payoff of agent i at time t from the project is given by

$$EM(e_{it}) = p(e_{it})[Y - L(1+r)] - c(e_{it}), \tag{2.4}$$

where the expectation operator, E, is taken over the two states of the project (success and failure), and $p(e_{it})$ is given in (2.2). By substituting $e_{it} = 0$ in (2.4), it can easily be shown that the agent prefers to take a loan and invest in the project.

The bank's expected profit in period t from agent i is:

$$E\pi_t = rLp(e_{it}) - L[1 - p(e_{it})]. \tag{2.5}$$

[13] Perhaps the two agents work in close physical proximity where physical observations are possible, even if the two projects are independent. In addition, or alternatively, they might share information about mutual effort through a common social network. This is also the typical social environment faced by microfinance borrowers.

[14] Thus, contracts with cross-reporting of effort levels, as in Rai and Sjöström (2004), are ruled out.

2.4 Sequence of Moves

In period 1, the bank offers one of the four contracts, *ILI*, *ILP*, *JLI,* or *JLP* and lends an amount L to agent i. Agent i observes the contract and chooses the first-period effort level, e_{i1}, at a cost $c(e_{i1})$. Under *IL* contracts (*ILI* and *ILP*), there are two possible outcomes. (i) If the project succeeds in the first period (with probability $p(e_{i1})$), the agent repays the loan, gets a second-period loan for an identical project, and chooses second-period effort, e_{i2}, at a cost $c(e_{i2})$. If the second-period project succeeds (with probability $p(e_{i2})$), the loan is repaid, otherwise not. (ii) If the project fails in the first period (with probability $1 - p(e_{i1})$), limited liability protects the agent from non-repayment but the agent cannot get a second-period loan. The situation under *JL* contracts (*JLI* and *JLP*) is identical except that the projects of both agents must be successful in period 1 (an event with probability $p(e_{i1})p(e_{j1})$) for any of them to receive a second-period loan. In each period, repayments/defaults occur on a private basis in the contracts *ILI* and *JLI*, and in public in the contracts *ILP* and *JLP.*

It is pedagogically convenient to introduce dummy variables T_{ILI}, T_{ILP}, T_{JLI}, T_{JLP} that take the value of 1 to identify a contract that is under consideration and 0 otherwise. For example, under contract *ILI* we have $T_{ILI} = 1$ and $T_{ILP} = T_{JLI} = T_{JLP} = 0$. Therefore, the probability of success (2.3) under each contract can be written as:

$$p\left(e_{i1}, e_{j1}\right) = \frac{1+e_{i1}}{2}\left[T_{ILI} + T_{ILP} + \left(T_{JLI} + T_{JLP}\right)\frac{1+e_{j1}}{2}\right]. \tag{2.6}$$

For instance, under the contract *JLI*, $T_{JLI} = 1$ and $T_{ILI} = T_{ILP} = T_{JLP} = 0$, so $p\left(e_{i1}, e_{j1}\right) = \frac{1+e_{i1}}{2} \times \frac{1+e_{j1}}{2}$.

2.5 Beliefs

We now define the beliefs of an agent that are required to model the psychological and social motives in our model. Beliefs are private information, but agents may receive private and/or public signals that enable them to increase the precision of their beliefs.

Positive Beliefs: Positive beliefs are beliefs that agents have about each other's *actual effort levels*. *Hierarchies of positive beliefs* refer to positive beliefs and beliefs about such beliefs. In *JL* contracts (*JLI*, *JLP*), this enables the modelling of guilt aversion. In the first period of *JL* contracts, both agents *simultaneously* choose effort levels that determine the probability of each agent obtaining a second-period loan. Thus, agents form positive beliefs about the actual effort level and beliefs of their partners. In the second period, there is no economic interdependence between the decisions of the agents, so the guilt-aversion motive is absent. Hence, we need to define positive beliefs only for the first period. For this reason, we omit the time subscript on positive beliefs (but not on the effort levels).

Normative Beliefs: Normative beliefs are beliefs about what others *ought to do*, in a manner that is consistent with some underlying social norm, rather than what others will *actually do. Hierarchies of normative beliefs* are normative beliefs and beliefs about such beliefs; these enable the modelling of shame aversion in public repayment contracts (*ILP*, *JLP*). Defaults in public repayment contracts can occur in both periods. Public defaults due to low effort (relative to the normative expectation of the relevant social group) potentially evoke shame, and require the use of normative beliefs in both periods. Social norms and normative expectations are often inertial and slow to change, hence, we assume that they are identical in both periods. Thus, it is convenient to drop the time subscript for normative beliefs (but not for the effort levels).

We assume that (i) all distributions of beliefs are differentiable, so their densities exist, and (ii) all distributions are differentiable with respect to the relevant parameters. Beliefs up to order 2 are sufficient to formalize the relevant emotions.

2.5.1 First-Order Beliefs

1. Let b_i^1 be the *first-order positive belief* of agent i about the actual effort level, e_{j1}, of agent $j \neq i$ in period $t = 1$. The cumulative distribution of b_i^1 is $F_i^1 : [0,1] \to [0,1]$. Let θ_j be an appropriate parameter of F_i^1 (e.g., median, mean, mode, or any other statistic of F_i^1).

2. Let B_{SG}^1 be the *first-order normative beliefs* of the relevant social group about what effort levels *ought to be* exerted by agents at $t = 1, 2$. Agents may also receive a public signal s about B_{SG}^1. The public signal s is time independent and common to all agents.

3. In *JLI* contracts, $F_i^1(e_{j1}; \theta_j)$ depends parametrically on θ_j. In *JLP* contracts, $F_i^1(e_{j1}; \theta_j|s)$ depends on θ_j and the public signal s.[15] The associated densities are $f_i^1(e_{j1}; \theta_j) = \frac{\partial F_i^1(e_{j1};\theta_j)}{\partial e_{j1}}$ and $f_i^1(e_{j1}; \theta_j|s) = \frac{\partial F_i^1(e_{j1};\theta_j|s)}{\partial e_{j1}}$.

From (2.2), agent i expects the project of agent j to be successful with probability:

$$\begin{array}{lcll} Ep(e_{j1}; \theta_j) & = & \frac{1}{2} + \frac{1}{2}\int_{e_{j1}=0}^{1} e_{j1} dF_i^1(e_{j1}; \theta_j) & \text{for } JLI \text{ contract} \\ Ep(e_{j1}; \theta_j|s) & = & \frac{1}{2} + \frac{1}{2}\int_{e_{j1}=0}^{1} e_{j1} dF_i^1(e_{j1}; \theta_j|s) & \text{for } JLP \text{ contract} \end{array}. \tag{2.7}$$

First-order positive beliefs are assumed to satisfy the following properties B1, B2.

B1: $F_i^1(e_{j1}; \theta_j)$, $F_i^1(e_{j1} \mid \theta_j, s)$ have full support.

B2: Higher values of θ_j, s, induce strict first-order stochastic dominance in the distributions $F_i^1(e_{j1}; \theta_j)$, $F_i^1(e_{j1}; \theta_j|s)$.

Property B1 implies that from (2.7) we get

$$0 < Ep(e_{j1}; \theta_j) < 1,\ 0 < Ep(e_{j1}; \theta_j|s) < 1. \tag{2.8}$$

Property B2 implies that a higher value of the two parameters θ_j, s makes it more likely that one expects the opponent's effort level to be higher.

[15] The notation $F_i^1(e_{j1}; \theta_j|s)$ implies that in *JLP* contracts, agent $i's$ first-order belief distributions about the actual effort levels of agent j is conditioned on the signal s. In our experimental design, that implements our theoretical model, subjects in the *JLP* treatment receive a public signal s before a measure of their first-order positive beliefs was elicited.

2.5.2 Second-Order Beliefs

1. Let b_i^2 be the *second-order positive belief* of agent $i = 1, 2$ about the first-order belief of agent j, b_j^1. The cumulative distribution of b_i^2 is $F_i^2 : [0, 1] \to [0, 1]$ and the associated density is $f_i^2(e_{i1}) = \frac{dF_i^2(e_{i1})}{de_{i1}}$.

Prior to forming second-order positive beliefs, b_i^2, agent i observes a private signal θ_i of the partner's first-order positive beliefs, b_j^1. Thus, let $F_i^2(e_{i1} \mid \theta_i)$ be the *conditional cumulative distribution of the positive second-order beliefs* of agent i and let $f_i^2(e_{i1} \mid \theta_i) = \frac{\partial F_i^2(e_{i1}|\theta_i)}{\partial e_{i1}}$ be the associated conditional density. Given the hierarchical nature of beliefs, the signal θ_i is used to update second-order positive beliefs.

Second-order positive beliefs are assumed to satisfy the following properties, B3, B4.

B3: $F_i^2(e_{i1} \mid \theta_i)$ has full support.

B4: A higher private signal, θ_i, received by agent i, induces strict first-order stochastic dominance in the conditional distribution of second-order positive beliefs, $F_i^2(e_{i1} \mid \theta_i)$.

Property B4 implies that a higher private signal, θ_i, makes it more likely that the opponent's first-order positive beliefs about one's effort level are high.

2. Let B_i^2 be the *second-order normative beliefs* of agent $i = 1, 2$, in both periods $t = 1, 2$, about the *first-order normative beliefs* of the social group, B_{SG}^1. The cumulative distribution of B_i^2 is denoted by $G_i^2 : [0, 1] \to [0, 1]$ and the associated density is $g_i^2(e_{it}) = \frac{dG_i^2(e_{it})}{de_{it}}$.

Agents may also receive a time independent 'public' signal s about B_{SG}^1 that is common to all agents; contrast this with the individual-specific private signal θ_i that agent $i = 1, 2$ receives from his/her partner in a *JL* contract in forming positive beliefs. The second-order belief distributions can be heterogeneous across agents. Thus, agents may form independent *conditional second-order normative beliefs*, $G_i^2(e_{it} \mid s) \in [0, 1]$, $e_{it} \in [0, 1]$.

We assume the following properties for second-order normative beliefs:

B5: $G_i^2(e_{it} \mid s)$ has full support.

B6: A higher public signal, s, induces strict first-order stochastic dominance in the conditional distribution of second-order normative beliefs, $G_i^2(e_{it} \mid s)$.

Property B6 implies that a higher public signal, s, makes it more likely that the social group expects that the agents ought to put in a higher effort level.

2.6 Formalization of Psychological and Social Motives

To formalize the relevant emotions, we introduce two functions, $\phi_i(e_{i1}, \theta_i)$ and $\overline{\phi}_i(e_{it}, s)$; they respectively capture guilt aversion and shame aversion. Recall that guilt operates only in the first period of *JL* contracts, but shame applies in both periods in public repayment contracts. This explains the difference in time subscripts on effort in the two functions ϕ_i and $\overline{\phi}_i$.

2.6.1 Guilt Aversion

Under joint liability contracts (*JLI*, *JLP*), agent i may suffer a utility loss if i's effort falls short of what i believes agent j expects from him/her. Define the function:

$$\phi_i\left(e_{i1}, \theta_i\right) = -\mu_i \int_{e_{i1}^{\prime}=e_{i1}}^{1}\left(e_{i1}^{\prime}-e_{i1}\right) dF_i^2\left(e_{i1}^{\prime} \mid \theta_i\right), \; 0 \leq \mu_i < 1, \; \theta_i \in [0,1], \; i=1,2. \tag{2.9}$$

In (2.9), $e_{i1} \in [0,1]$ is the first-period effort level chosen by agent $i = 1,2$. Based on the second-order positive beliefs of agent i, $e_{i1}^{\prime}$ is the first-period effort level that agent i thinks that agent j believes that agent i will actually exert ($j = 1,2$; $j \neq i$). $F_i^2\left(e_{i1}^{\prime} \mid \theta_i\right)$ is the conditional cumulative probability of $e_{i1}^{\prime}$, where θ_i is the private signal that agent i receives about the first-order positive beliefs of agent j. In the interval $e_{i1}^{\prime} \in (e_{i1}, 1]$, $e_{i1} < e_{i1}^{\prime}$, thus, $\int_{e_{i1}^{\prime}=e_{i1}}^{1}\left(e_{i1}^{\prime}-e_{i1}\right) dF_i^2\left(e_{i1}^{\prime} \mid \theta_i\right)$ measures the *guilt-aversion* motive in the first period of *JL* contracts.[16] The coefficient μ_i gives the strength of the guilt-aversion motive.

2.6.2 Shame Aversion

Under public repayment contracts (*ILP*, *JLP*), agent i may suffer a utility loss if: (1) i's effort falls short of what i believes is the normative expectation of the social group that can sanction him/her, and (2) i's failure becomes common knowledge in the social group.[17] Define the function:

$$\overline{\phi}_i\left(e_{it}, s\right) = -\overline{\mu}_i \int_{e_{it}^{\prime}=e_{it}}^{1}\left(e_{it}^{\prime}-e_{it}\right) dG_i^2\left(e_{it}^{\prime} \mid s\right), \; 0 \leq \overline{\mu}_i < 1, \; s \in [0,1], \; i=1,2, \; t=1,2. \tag{2.10}$$

In (2.10), $e_{it} \in [0,1]$ is the effort level chosen by agent $i = 1,2$ in period $t = 1,2$. Based on the second-order normative beliefs of agent i, $e_{it}^{\prime}$ is the effort level that agent i believes is the normative expectation of her social group. $G_i^2\left(e_{it}^{\prime} \mid s\right)$ is the conditional cumulative probability of $e_{it}^{\prime}$, as perceived by agent i, and s is the public signal that agent i receives about the first-order normative beliefs of the social group, B_{SG}^1. In the interval $e_{it}^{\prime} \in (e_{it}, 1]$, $e_{it} < e_{it}^{\prime}$, thus, $\int_{e_{it}^{\prime}=e_{it}}^{1}\left(e_{it}^{\prime}-e_{it}\right) dG_i^2\left(e_{it}^{\prime} \mid s\right)$ measures the *shame-aversion* motive in public repayment contracts and the coefficient $\overline{\mu}_i$ its relative strength. The shame-aversion motive is activated only if one observes that a majority of the members of the social group comply with the social norm. As noted, this requires congruence of empirical and normative expectations (Bicchieri, 2006) which is ensured by our experimental design. Otherwise, $\overline{\mu}_i = 0$.[18]

[16] Our definition is motivated by the definition of simple guilt aversion in Charness and Dufwenberg (2006) and Battigalli and Dufwenberg (2007).

[17] For our purpose, it is sufficient to have three rounds of knowledge about the norm violation: (1) one knows that one has violated the norm, (2) others in the social group know that one has violated the norm, (3) one knows that others know that one has violated the norm. If *any* of these three rounds of knowledge is not satisfied, then shame does not arise (Fessler, 2004).

[18] We could also have added, to the guilt-aversion motive, the *surprise-seeking motive* that gives extra utility to the decision maker from exceeding the second-order positive expectations (Khalmetski et al., 2015; Dhami, et al., 2019). Similarly, to the shame-aversion motive, we could have added the *approval-seeking motive* that gives extra utility from exceeding the second-order normative expectations. However, this does not add any new insights to our comparative static results, nor changes our results. For, a full development of these ideas, and this claim, see Dhami, Arshad, and al-Nowaihi (2020).

2.7 Psychological Utility

We now augment expected monetary utility (2.4) with guilt aversion in (2.9) and shame aversion in (2.10) to define intertemporal psychological utility in (2.11) below.

Definition 1. *(Psychological utility): We define the intertemporal psychological utility of agent $i \in \{1,2\}$ under contract k, $k \in \{ILI, JLI, ILP, JLP\}$, by*

$$U^k(e_{i1}, e_{i2}) = \Psi^k(e_{i1}) + \psi^k(e_{i1}) V^k(e_{i2}), \tag{2.11}$$

where

$$\Psi^k(e_{i1}) = EM(e_{i1}) + (T_{JLI} + T_{JLP}) \phi_i(e_{i1}) + (T_{ILP} + T_{JLP}) \overline{\phi}_i(e_{i1}), \tag{2.12}$$

$$\psi^k(e_{i1}) = p(e_{i1}) [T_{ILI} + T_{ILP} + T_{JLI} Ep(e_{j1}; \theta_j) + T_{JLP} Ep(e_{j1}; \theta_j | s)], \tag{2.13}$$

$$V^k(e_{i2}) = EM(e_{i2}) + (T_{ILP} + T_{JLP}) \overline{\phi}_i(e_{i2}), \tag{2.14}$$

$p(e_{i1})$ is given by (2.2) and $Ep(e_{j1}; \theta_j)$, $Ep(e_{j1}; \theta_j | s)$ are given by (2.7).

In (2.11), $\Psi^k(e_{i1})$ is the first-period psychological utility, $\psi^k(e_{i1})$ is the probability of agent i obtaining a second-period loan, and $V^k(e_{i2})$ is the second-period psychological utility.

Agent i chooses the effort level, e_{i1}, in period 1. Under all contracts, this results in the expected monetary utility, $EM(e_{i1})$, given by (2.4). In addition, under the joint liability contracts JLI ($T_{JLI} = 1$) and JLP ($T_{JLP} = 1$), agent i may suffer a utility loss $\phi_i(e_{i1})$ from guilt aversion, given by (2.9). In addition, under the public repayment contracts ILP ($T_{ILP} = 1$) and JLP ($T_{JLP} = 1$), agent i may suffer a utility loss $\overline{\phi}_i(e_{i1})$ from shame aversion, given by (2.10). Thus, $\Psi^k(e_{i1})$ in (2.11) is the first-period psychological utility and is given by (2.12).

The first-period project of agent i is successful with probability $p(e_{i1}) = \frac{1+e_{i1}}{2}$. Under the individual liability contracts ILI andILP (either $T_{ILI} = 1$ or $T_{ILP} = 1$, but $T_{JLI} = T_{JLP} = 0$), this is also the probability with which agent i is awarded a second-period contract. Under the joint liability contracts JLI and JLP (either $T_{JLI} = 1$ or $T_{JLP} = 1$, but $T_{ILI} = T_{ILP} = 0$), this probability, $p(e_{i1}) = \frac{1+e_{i1}}{2}$, is multiplied by the probability with which the partner, agent j, in the joint liability contract, is successful, i.e., $p(e_{j1}) = \frac{1+e_{j1}}{2}$. However, at the time agent i chooses the first-period effort level, e_{i1}, agent i has not yet observed the first-period effort level of agent j, e_{j1}. So $p(e_{j1}) = \frac{1+e_{j1}}{2}$ is replaced by its expected value $Ep(e_{j1}; \theta_j)$ for JLI contract or $Ep(e_{j1}; \theta_j | s)$ for JLP contract, given by (2.7). Thus, $\psi^k(e_{i1})$ in (2.11) is the probability with which agent i expects to get a second-period loan from the bank, given by (2.13).

Having received a second-period loan, agent i chooses his/her second-period effort level, e_{i2}. This results in the second-period expected monetary payoff, $EM(e_{i2})$, under all contracts. Under the public repayment contracts ILP and JLP (so that $T_{ILP} = 1$ or $T_{JLP} = 1$), agent i may suffer a utility loss $\overline{\phi}_i(e_{i2})$ from shame aversion, given by (2.10). Thus, $V^k(e_{i2})$ in (2.11) is second-period psychological utility and is given by (2.14). Also note the absence of the term $\phi_i(e_{i2})$ in (2.14). In this respect, recall Remark 1.[19]

[19]Note that U^k, in Definition 1, will also depend on all the model parameters. To simplify notation, we have only indicated the dependence of U^k on e_{i1}, e_{i2}.

Note that if $V^k(e_{i2}) < 0$, so that the second-period psychological utility is negative, then agent i will not accept the second-period contract, even if offered. This could arise if the normative expectation for effort, as perceived by agent i, is so high that agent i does not expect to get a non-negative second-period payoff (however, expected monetary utility, EM, is always positive). A similar comment holds for the first period. So, to make sure that agent i will accept first and second-period contracts, we need, for some effort levels, e_{i1} and e_{i2},

$$U^k(e_{i1}, e_{i2}) > 0 \text{ and } V^k(e_{i2}) > 0. \tag{2.15}$$

3 Optimization

We assume that agents behave optimally given their beliefs. We formalize this in the next definition in a manner analogous to the concept of a subgame perfect equilibrium.

Definition 2. *A psychological best response for agent i $(i = 1, 2)$ is a pair of effort levels $\left(e_{i1}^k, e_{i2}^k(e_{i1})\right)$ with the following properties:*

1. $e_{i1}^k \in [0, 1]$, $e_{i2}^k : [0, 1] \to [0, 1]$.
2. *For each $e_{i1} \in [0, 1]$, $e_{i2} = e_{i2}^k(e_{i1})$ maximizes $U^k(e_{i1}, e_{i2})$ in (2.11), given e_{i1} and second-period beliefs of agent i.*
3. *$e_{i1} = e_{i1}^k$ maximizes $U^k\left(e_{i1}, e_{i2}^k(e_{i1})\right)$ in (2.11), given first-period beliefs of agent i.*

In Definition 2, we have suppressed the dependence of e_{i1}^k and $e_{i2}^k(e_{i1})$ on the model parameters.

Proposition 1. *A psychological best response for agent i $(i = 1, 2)$ exists and is unique. In particular: (a) $V^k(e_{i2})$ has a unique maximum e_{i2}^k; (b) $U^k\left(e_{i1}, e_{i2}^k\right)$ has a unique maximum e_{i1}^k; (c) $U^k\left(e_{i1}^k, e_{i2}^k\right) > 0$ and $V^k\left(e_{i2}^k\right) > 0$; (d) $e_{i2}^k \in (0, 1)$; (e) $e_{i1}^k \in (0, 1)$.*

4 Comparative Statics

We now show that in the absence of the guilt-aversion and the shame-aversion motives, $\mu_i = \overline{\mu}_i = 0$, joint liability induces a lower effort level than individual liability.

Proposition 2. *(Baseline Case: No Psychological or Social Motives) Let e_{i1}^k and e_{i2}^k be the optimal first and second-period effort levels as in Proposition 1. Suppose $\mu_i = \overline{\mu}_i = 0$ and $e_{i1}^k \in (0, 1)$. Then, $e_{i1}^{JLI} < e_{i1}^{ILI}$ and $e_{i1}^{JLP} < e_{i1}^{ILP}$.*

Under joint liability, the probability of getting a second-period loan is the joint probability that the projects of both agents succeed, $p(e_{i1})\,p(e_{j1})$. This is lower than the individual probabilities, $p(e_{i1})$ and $p(e_{j1})$ with which individual liability projects succeed. Thus, in the first period, the marginal product of effort is relatively higher under an IL contract, so $e_{i1}^{JLI} < e_{i1}^{ILI}$, $e_{i1}^{JLP} < e_{i1}^{ILP}$ (Proposition 2). Hence, the probability of repaying the loan is also relatively lower in a JL contract, and banks are predicted to strictly prefer an IL contract to a JL contract.

Proposition 3. *(Period 1) Let e^k_{i1} and e^k_{i2} be the optimal effort levels as in Proposition 1.*

(I) Suppose $e^k_{i1} \in (0,1)$. Then:

(a) Comparative statics with respect to θ_i.
For $\theta_i \in (0,1)$, $\frac{\partial e^k_{i1}}{\partial \theta_i} \geq 0$. If $\mu_i > 0$, then $\frac{\partial e^{JLI}_{i1}}{\partial \theta_i} > 0$ and $\frac{\partial e^{JLP}_{i1}}{\partial \theta_i} > 0$.

(b) Comparative statics with respect to θ_j.
For $\theta_j \in (0,1)$, $\frac{\partial e^{JLI}_{i1}}{\partial \theta_j} > 0$ and $\frac{\partial e^{JLP}_{i1}}{\partial \theta_j} > 0$.

(c) Effects of μ_i and $\overline{\mu}_i$.

(i) If $\mu_i = 0$, then $e^{ILI}_{i1} > e^{JLI}_{i1}$. Thus, if $e^{ILI}_{i1} \leq e^{JLI}_{i1}$, then $\mu_i > 0$.

(ii) If $\overline{\mu}_i = 0$, then $e^{ILI}_{i1} = e^{ILP}_{i1}$. Thus, if $e^{ILI}_{i1} < e^{ILP}_{i1}$, then $\overline{\mu}_i > 0$.

(II) Comparing period 1 and period 2 effort levels.
Suppose $e^k_{i1}, e^k_{i2} \in (0,1)$. Then: $e^k_{i1} > e^k_{i2}$, $k = ILI, JLI, ILP, JLP$.

Proposition 3-I-a highlights the role of guilt aversion in *JL* contracts (*JLI*, *JLP*). A higher value of θ_i makes it more likely that the partner in a *JL* contract expects a higher effort level from agent i. Thus, agent i adjusts the optimal effort upwards to reduce the disutility arising from guilt. Proposition 3-I-b brings out the role of contractual linkages in the *JL* contracts. If agent i expects a high first-period effort by the partner (high value of θ_j), then the expected joint probability of success of both first-period projects is also high. This raises the marginal benefit of additional effort for agent i in period 1. The parameters μ_i and $\overline{\mu}_i$, on guilt aversion and shame aversion, respectively, are not directly observable. However, their consequences are observable. Thus, if $e^{ILI}_{i1} \leq e^{JLI}_{i1}$, then necessarily $\mu_i > 0$ (Proposition 3-I-c-i), and if $e^{ILI}_{i1} < e^{ILP}_{i1}$, then necessarily $\overline{\mu}_i > 0$ (Proposition 3-I-c-ii).

Proposition 3-II establishes that, at an interior optimum, first-period effort is higher than second-period effort in all contracts. This is because in the first period there is the extra incentive to increase effort in order to increase the chance of getting a second-period loan. However, since the second period is the final period, this extra incentive is absent in the second period.

Remark 2. *The effect of the public signal, s, on optimal first-period effort in ILP and JLP contracts is the sum of two opposing effects. (i) On the one hand, agent i would like to increase first-period effort to reduce disutility from shame. (ii) On the other hand, since the effect of s on the continuation payoff is negative (Lemma 2-d, Appendix A), the overall effect depends on the parameter values. Our empirical estimates strongly suggest that effect (i) overrides effect (ii). If borrowers were myopic[20], then they do not take account of the latter effect. Hence, the optimal first-period effort would increase with s.*

Proposition 4. *(Period 2) Let e^k_{i1} and e^k_{i2} be the optimal effort levels as in Proposition 1.*

(I) $e^{ILI}_{i2} = e^{JLI}_{i2}$ and $e^{ILP}_{i2} = e^{JLP}_{i2}$.

[20]Much empirical evidence suggests the presence of myopia, for instance, due to loss aversion (e.g., see Benartzi and Thaler (1995) and Gneezy and Potters (1997)).

(II) *Suppose* $e^k_{i2} \in (0,1)$. *Then, for all* $s \in (0,1)$ $\dfrac{\partial e^k_{i2}}{\partial s} \geq 0$. *If* $\overline{\mu}_i > 0$, *then,*

(a) $\dfrac{\partial e^{ILP}_{i2}}{\partial s} > 0$ *and* $\dfrac{\partial e^{JLP}_{i2}}{\partial s} > 0$,

(b) $e^{ILP}_{i2} > e^{ILI}_{i2}$ *and* $e^{JLP}_{i2} > e^{JLI}_{i2}$.

Proposition 4-I stems from the fact that in the second period all contracts are effectively individual liability contracts (Remark 1). Proposition 4-II-a holds because a higher s implies that the relevant social group holds higher normative expectations of effort from its members. Thus, in response to an increase in s, agent i increases optimal second-period effort to reduce the disutility from shame. Proposition 4-II-b holds because the marginal benefit of additional effort is relatively higher in the public repayment contracts, as compared to the private repayment contracts, due to the shame-aversion motive.

5 Experimental Design

Our experimental design closely implements our theoretical model. The parameter values used in the experiments are given in Table 2.

Table 2: Parameter Values

Variables	L	Y	r	e_{it}	$c(e_{it})$	$p(e_{it})$
Parameter Values	50	75	30%	$\{1, 2, ..., 10\}$	$\dfrac{e^2_{it}}{8}$	$0.5 + \dfrac{e_{it}}{20}$

In the first period, each borrower received a loan, L, of 50 units of experimental currency (EC) to finance their project. The interest rate, r, on the loan was set at 30%. The project had two outcomes: success or failure. Borrowers could influence the outcome of the project by choosing an effort level from a set integers $\{1, 2, ..., 10\}$. Once the effort level was chosen, the probability of success was determined by the probability function, $p(e_{it})$, given in Table 2. Since our subjects chose effort from a set of integers ranging from 1 to 10 (rather than 0 to 1), we transformed the probability function (2.2) by dividing e_{it} by 10. The probability function assumes that every project has an exogenously given 50% chance of being successful. The probability of success can be further increased by 5% with every additional unit of effort. Exerting the maximum effort level, $e_{it} = 10$, makes the success of the project certain.

If the project succeeded, the borrower earned $Y = 75$ EC from the project, which amounted to a 50% return on the investment. The interest inclusive repayment amount of 65 EC was automatically deducted from the project's gross return. After the repayment, a successful project yielded a gross return of 10 EC. If the project failed, it gave zero return and the borrower could not make the repayment (recall our assumption of limited liability). Irrespective of the outcome, success or failure, subjects were required to pay the cost of effort, $c(e_{it})$, given by the cost function in Table 2. If the gross project return was not sufficient to pay the cost of effort, then the cost was deducted from the participation fee of the subject. Note that the project return could fall short of the cost of effort if either the project was unsuccessful and gave zero return, or the project was successful and the borrower chose an effort level above 8. For effort levels 9 and 10, effort is too costly so the net return from the project is negative.

To convert the experimental currency, EC, into Pakistani rupees (PKR) and to make the choices salient, both the project return and the cost of effort were multiplied by 10. So, the gross return on a successful project yielded $10 \times 10 = 100$ PKR.

In *IL* contracts (*ILI*, *ILP*), subjects proceeded to the second period if, and only if, their projects were successful. In *JL* contracts (*JLI*, *JLP*), the projects of both group members needed to be successful to proceed to the second period, otherwise they exited the experiment. Subjects in the second period received another loan of 50 EC. They again made an effort choice for their second-period project, which determined the outcome of their project probabilistically. The total earnings from the two periods were paid to the subject at the end of the experiment.

For the baseline case ($\mu_i = \overline{\mu}_i = 0$) and using Table 2, it is easily shown that $V^k(e_{i2})$ is maximized at $e_{i2} = e_{i2}^k = 2$.[21] Given $e_{i2} = 2$, $U^{IL}(e_{i1}, 2)$ is maximized at $e_{i1}^{IL} = 3.1$ and $U^{JL}(e_{i1}, 2)$ is maximized at $e_{i1}^{JL} = 2 + 1.1Ep$. Table 3, below, gives the first-period optimal effort level, e_{i1}^{JL}, for agent i, for all possible values of $\overline{b}_i^1$ (average first-order beliefs of agent i) and Ep (expected probability of obtaining a second-period loan). For our parametrization, this establishes a lower bound of 2.61 and an upper bound of 3.10 for optimal effort in the baseline model, for any beliefs of the agents.

Table 3: First-period Best Response to Beliefs in JL Contracts in the Baseline Model

$\overline{b}_i^1$	1	2	3	4	5	6	7	8	9	10
Ep	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00
e_{i1}^{JL}	2.61	2.66	2.72	2.77	2.83	2.88	2.94	2.99	3.05	3.10

Since we present effort choices as a set of integers to our subjects, we round the first-period optimal efforts in both *IL* and *JL* contracts to 3, $e_{i1}^{JL} = e_{i1}^{IL} = 3$.[22]

From (2.5), the parameter values in Table 2 imply that the bank makes an expected positive profit if, and only if, the effort level, e_{it} (in integer values), satisfies $e_{it} > 5$. Thus, in the baseline case, where effort equals 3, the bank makes a loss in each period for every contract and should not lend. However, the empirical evidence below shows that, on average, effort is greater than 5 for *ILP*, *JLI*, and *JLP* contracts, but not for *ILI*. This potentially explains why either public repayment or joint liability is a feature of microfinance contracts.

[21] see Dhami, Arshad, and al-Nowaihi (2020) for the calculations.

[22] Consider the CARA utility function, $u(y) = \frac{1-e^{-ry}}{r}$, $r > 0$ (and $u(y) = y$ if $r = 0$), where $y = Y - L(1+r)$ and r is the parameter of constant absolute risk aversion. For the parameter values that we have chosen, it can be shown that if an individual is risk averse for monetary outcomes, then risk aversion reduces optimal effort (results available from authors on request). However, it is difficult to speculate on the generality of this result for other utility functions, and for utility functions in which risk aversion may also arises with respect to the psychological and social factors in the model.

5.1 Treatments

Based on our 2×2 design, we formed four treatments, as explained in subsection 2.2. Treatments are characterized by a liability structure (individual or joint) and a repayment method (private or public); see Table 1. For the liability structure, individual liability is treated as a control, and for the repayment method, private repayment is our control.[23]

Private Repayment (*ILI* and *JLI*)

In the *ILI* treatment, borrowers were individually liable for their own loans, and once they had chosen their effort levels, they were privately informed about the outcome of their project. If the project was successful, they repaid the loan, otherwise not.

In the *JLI* treatment, subjects were *randomly* matched in pairs. Subjects were unaware of the identity of their partner. In the first period, both group members separately received a loan to invest in their independent projects. Before subjects made their effort choice, their first-order positive beliefs were elicited with a modification of the *induced beliefs design* in Ellingsen et al. (2010) that addresses concerns about subject deception.[24]

Unlike Ellingsen et al. (2010), who use point beliefs, in our model players have a distribution of beliefs that is unobservable to the other players. We do not elicit entire belief distributions of subjects, but rather ask them to state a measure, θ_i, of their first-order belief distribution in an incentive-compatible manner.[25] If the subject's guess matched with the partner's chosen effort level, then he/she received an additional 50 PKR. Once subjects reported their signal θ_i, they were asked if it could be transmitted to their partners. At the time of signal elicitation, subjects were not aware that they would have the opportunity to transmit their signal. This allows us to control for the possible strategic manipulation of signals while at the same time, it gives subjects complete control over the transmission of their signals.

Once the signals were elicited, subjects were informed about their partner's signal, provided that their partner had consented to transmit his/her signal. No subject refused to transmit his/her signal to the partner. The signals (i) correspond to proxies for diverse real-world channels through which players exert peer pressure on their partners, and (ii) allow players to guess with better precision, the underlying belief distributions of their partners in a manner that is not subject to the false consensus effect. The signals were common knowledge within each pair of a *JL* contract subjects but other subjects did not observe these signals. Thus, we classify them as *private signals*. After observing the private signal of their paired partner, subjects chose an effort level for their projects.

At the end of the first period of the *JLI* contact, the effort level, the outcome of the project, and the repayment status of each group member were privately reported to both members of

[23]For example, when we compare *ILI* with *JLI*, *ILI* is the control, and in comparison between *JLI* and *JLP*, *JLI* is the control.

[24]Ellingsen et al. (2010) showed that *direct belief elicitation* is subject to the *false consensus effect*. Essentially, in forming their second-order beliefs about the first-order beliefs of others, players ascribe to other players, their own first-order beliefs. In the induced belief design, instead of eliciting player i's second-order beliefs, the experimenter elicits j's first-order beliefs and report them to i before i takes the decision. This method induces i's second-order beliefs without being subject to the false consensus effect.

[25]Problems with eliciting entire belief distributions are well known, see Dhami (2020, Vol. 5, Section 4.3).

the group. The pair was only allowed to proceed to the second period if both borrowers in the group were successful. The second period of the *JLI* contract was identical to the *ILI* contract.

Public Repayment (*ILP* and *JLP*)

The public repayment treatments had three *additional* features that are essential for invoking the shame-aversion motive in our model (see subsection 2.6.2). First, shame aversion requires commonly shared beliefs about established social norms, so subjects were publicly informed about actual effort decisions and a signal of the normative expectations of borrowers from a similar earlier pilot experiment (see details below).[26] At the end of the experimental instructions, subjects received the following publicly announced messages:

- The majority of borrowers who participated in a similar earlier experiment chose effort level 5 or greater than 5.
- On average, the borrowers who participated in a similar earlier experiment said that other borrowers should choose effort level 6.

The first message induces empirical expectations about norm compliance in our subjects. The second message corresponds to a *public signal* of normative expectations, $s = 6$.

Second, subjects were informed that at the end of each period, each subject's effort choice and their project outcomes would be made public to all subjects in the treatment. This ensured that effort choices below the normative expectation became common knowledge amongst subjects.

Third, subjects were informed that after observing each subject's effort choice and the outcome of the project, all other subjects in the room would be able to express their social approval (show of a green card) or social disapproval (show of a red card). This allowed for non-pecuniary sanctioning by the social group, which has been shown to be a powerful determinant of norm complicance (Fehr and Schurtenberger, 2018).[27]

We measure the combined effect of these three features. While the study of the individual components of norm compliance might be of independent interest (see Biccheiri and Xiao, 2009), it is not the focus of our work. Subjects who proceeded to the second period did not receive the public signal, s, again because norms for effort are slow and inertial to change, so we have kept them fixed during the experiment. However, the effort choices and the outcome of each subject's projects were made public for social approval/disapproval in each period.

5.2 Lab-in-the-Field and Subject Pool

To conduct our lab-in-the-field experiment, we collaborated with the National Rural Support Program (NRSP) Microfinance Bank to recruit 400 subjects in Pakistan. At the time of the

[26] We are grateful to Gary Charness and Chris Starmer for suggesting this feature of our experimental design.

[27] In the treatment *JLP*, subjects first publicly received the public signal, s, and then their positive beliefs θ_i, θ_j were elicited by the induced belief method as in *JLI*. This particular sequence was implemented because norms typically pre-exist in societies where people interact and form expectations about others. It allows us to see how, if at all, norms interact with positive beliefs and affect effort decisions.

experiment, all our subjects were active borrowers of the NRSP Microfinance Bank. We conducted 10 sessions in 10 rural towns of 4 districts in central and southern Punjab of Pakistan.[28] These districts were selected because the NRSP Bank maintained a mixed portfolio of individual and group loan borrowers in these districts. We hired Research Consultants (RCons), a data collection firm based in Lahore, independent of the NRSP Bank to conduct the experiments in March and April 2018. To avoid any reputational or relational concerns, no loan officers who interacted with our subjects in the real world were present in the experiment. For each session, 40 *randomly* selected subjects were invited from a chosen town to take part in the experiment. Subjects were invited one or two days before the actual session. The time and the location were announced to the subjects in advance. Once all subjects arrived at the designated place (mostly after school hours in local schools), they were *randomly* allocated amongst four treatments, ten subjects in each. All four treatments were run simultaneously in separate rooms. In each room, a specially trained experimenter assigned each subject an identity number and recorded each subject's relevant economic and demographic details (age, gender, education, marital status, number of previous loans, and the type of loans).

To ensure a high level of understanding of the game, we explained the rules of the experiment with the help of visuals and poster-slides in the local language, Punjabi. After giving instructions, experimenters went through four examples of the game with subjects, who then also answered a series of practice questions individually with the experimenter. The effort choices of subjects were made by encircling the chosen effort level on a decision sheet. For each subject, the outcome of the risky project was determined by the experimenter in front of the subject, using a randomizing device, and recorded on the decision sheet. The experimenter then informed the subject about the outcome of the project and his/her repayment status. Subjects were assured anonymity of their choices, and their names were not recorded. At the end of the experiment, the decision sheets from each room were passed on to the fifth experimenter who entered the data into a computer to calculate each subject's payment. Subjects were called out by their identification number from each room where their payments were made privately.

Participants received 500 PKR as participation fee for taking part in the experiment and could earn additional money through their choices in the game. On average, a subject earned 550.49 PKR ($4.75) in an experimental session. A session lasted, on average, 90 minutes.

5.3 Pilot

Before the actual experiment, we conducted a pilot session to record the actual effort decisions and normative expectations from a similar cohort of borrowers to be reported in the main experiment. Subjects in the pilot were also NRSP Bank's clients. We invited 40 borrowers and randomly allocated them to four treatments. To elicit normative expectations, before subjects in the public treatments could choose their effort, we privately asked each subject what effort level do they think that other subjects *should* choose in this experiment. Subjects were incentivized with a monetary reward of 50 PKR if their normative belief matched with the modal normative

[28] The four districts and ten towns were: Ahmadpur East, Hasilpur, Bahawalpur, and Yazman in district Bahawalpur; Pirmahal and Kamalia in district Toba Tek Singh; Sahiwal and Chichawatani in district Sahiwal; Jaranwala and Tandlianwala in district Faisalabad.

belief.[29] The average normative expectation in each public treatment was publicly announced. Subjects played the game as described above.

There were two differences in the public treatments between the pilot and the actual experiment. First, subjects in the pilot did not receive any message about the actual effort levels from a *similar earlier experiment* as their effort choices were reported in the actual experiment to induce empirical expectations. Second, the average normative expectation from the pilot was given to the pilot subjects as the public signal, s, and the same signal was then used in the actual experiment. Due to these differences, we do not include the data from the pilot for our analysis.

5.4 Baseline Characteristics

Table B1 in the Appendix shows the sample means and standard deviations of the demographic and self-reported borrower characteristics of the subject pool. On average, our subjects were in their early thirties; completed nine years of schooling; predominantly male; and married. Our subjects, on average, had taken three loans in the past. The majority of subjects had taken *IL* loans, but there was a significant proportion who had taken group loans. Table B1 also reports the absolute standardized differences of subject characteristics between the treatments.[30] Randomization generated similar subject-pools across the four treatments. The differences are either zero or small. We control for these characteristics in one of the regression specifications; their coefficients are small and insignificant.

5.5 Estimation Specifications

We now present the estimating equations to test the predictions of our theoretical model. We begin by estimating the following regression specification:

$$Y_{it} = \beta_0 + \beta_1 T_{ILP} + \beta_2 T_{JLI} + \beta_3 T_{JLP} + \varepsilon_{it}, \tag{5.1}$$

where Y_{it} is the chosen effort level of individual i in period t, $t = 1, 2$. T_{ILP} is a dummy variable that equals 1 for the treatment *ILP*, and 0 otherwise. The dummy variables T_{JLI} and T_{JLP}, respectively, for the treatments *JLI* and *JLP* are defined analogously. ε_{it} is the standard error term. We estimate equation (5.1) separately for each of the two time periods. β_0 captures the mean effort in the baseline treatment, *ILI*. β_1, β_2, and β_3 measure the impact of treatments *ILP*, *JLI*, and *JLP*, respectively.

To make a complete comparison across the treatments, we estimate three other specifications of equation (5.1) in Table 5. In specification 2, we consider *ILP* as a control group and estimate the differences for the other three treatments. In specification 3, we consider *JLI* as a control. Finally, in specification 4, we test for subject characteristics.

To analyze the role of the players' own first-order positive beliefs and the private signals of their partner's expectations in the *JL* treatments, we use the following regression specification:

$$Y_{i1} = \alpha_0 + \alpha_1 Public + \alpha_2 Signal + \alpha_3 FOB + \alpha_4 SignalPub + \alpha_5 FOBPub + \varepsilon_{i1}, \tag{5.2}$$

[29] See Krupka and Weber (2013) for eliciting norms in an incentive-compatible way.

[30] The standardized difference is defined as the difference in means between the two treatments, divided by the square root of half the sum of two treatment variances. See Imbens and Rubin (2015) for further details.

where Y_{i1} is the first-period effort level chosen by individual i in the *JL* treatments (*JLI*, *JLP*). *Public* is a binary variable ($0 =$ *JLI*, $1 =$ *JLP*) to distinguish between private and public repayment in *JL* contracts. The effect of the private signal, θ_i, of the first-order positive belief of the partner in the *JL* contract is captured by the variable *Signal*. *FOB* is the subject's own best guess, θ_j, about the partner's effort and captures a measure of the player's first-order beliefs. *SignalPub* and *FOBPub* represent interactions of the variable *Public*, respectively, with the variables *Signal* and *FOB*. α_0 captures the mean effort in *JLI*, α_1 measures the overall treatment effect of public repayment in *JL* contracts. α_2 and α_3, respectively, capture the effect of *Signal* and *FOB* in both *JLI* and *JLP*. α_4 measures the treatment effect of public repayment on the private signal of the partner's first-order belief in *JLP* relative to *JLI*. Similarly, α_5 captures the effect of the player's own first-order positive beliefs in *JLP* relative to *JLI*.[31]

We estimate four specifications of equation (5.2). First, we estimate the overall treatment difference by estimating just α_1. Then, we estimate the following three specifications: different intercepts but the same slopes for private signals and first-order positive beliefs for both *JL* treatments (i.e., $\alpha_4 = \alpha_5 = 0$); different intercepts and slopes in both treatments (unrestricted specification); and finally, we allow only slopes to vary but keep the intercept same (i.e., $\alpha_1 = 0$). We cannot separately test for the effect of the public signal, s, in the two public repayment treatments through regression analysis because s does not vary across the individuals. However, comparing the effort decisions between private and public treatments establishes the effect of the public signal in Section 6 below.

6 Results

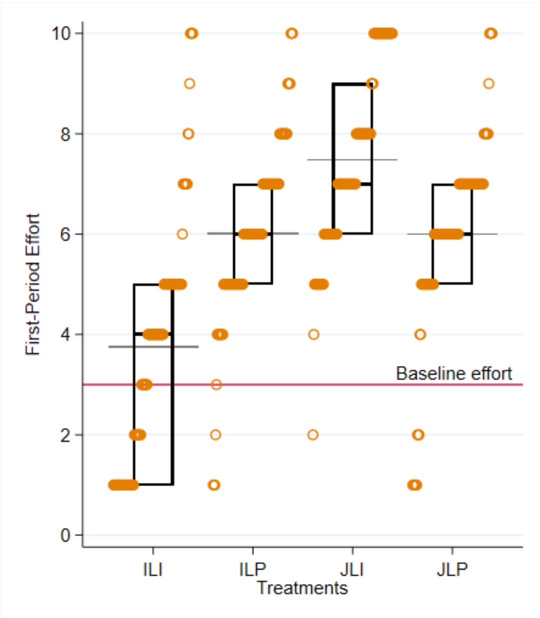
We start presenting our experimental results with the first-period effort comparisons between the treatments. We then analyze the determinants of effort in the *JL* treatments and the role of social disapproval in the public treatments. Next, we examine the second-period effort differences across the treatments, followed by the evidence on the intertemporal effort comparison. Finally, we discuss the implications of our results for contractual choices by the bank.

Figure 1(a) and 1(b) show, respectively, the first and second-period effort distributions in all four treatments; effort decisions varied significantly across the treatments. The baseline optimal first and second-period predictions (respectively, 3 and 2) are not representative of any of the distributions. A visual inter-period comparison shows that the effort distributions of *ILP*, *JLI*, and *JLP* have shifted upwards in the second period, implying a rightward shift in these distributions which does not support the optimization approach.

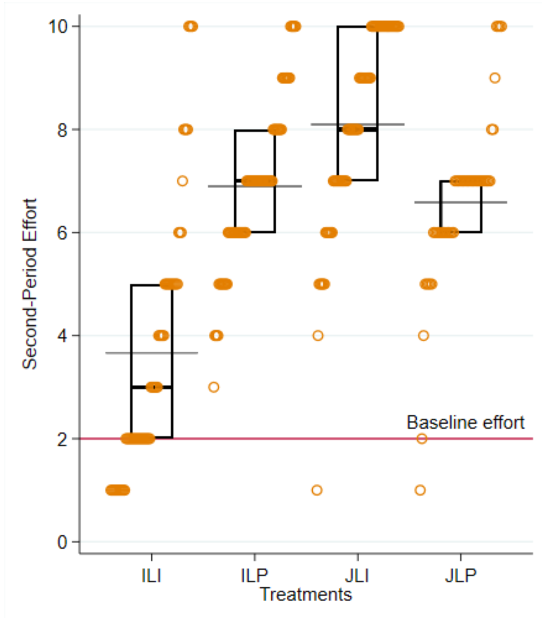
6.1 First Period

In this subsection, we discuss the results of the first period from our microfinance game. Table 4 shows the descriptive statistics for period 1. Only 8 subjects in *ILI*, 1 in *ILP* and no subject in

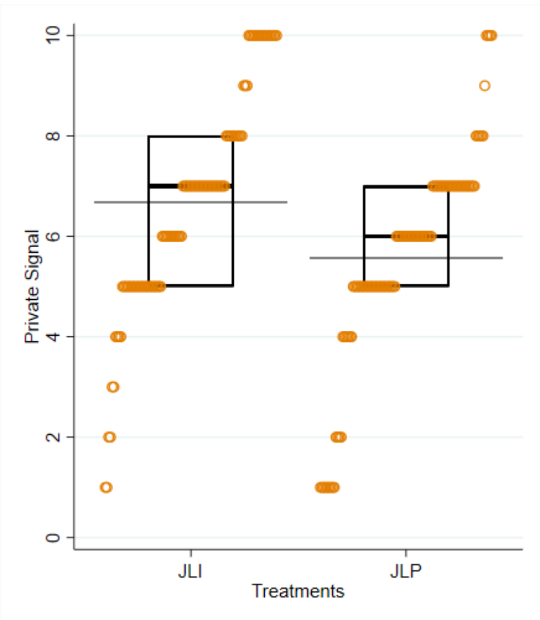
[31] Since subjects can only report integer-valued effort levels, we have a case of the limited dependent variable with ten categories $\{1, 2, ..., 10\}$. In Section 6.1, we report the OLS estimates of equation (5.2) because of a relatively large number of categories of the dependent variable, and it conveniently allows us to incorporate robust standard errors. We also estimate an ordered logit model and report the estimates in Appendix B. The results are similar to the OLS estimation, and the statistical significance does not change.



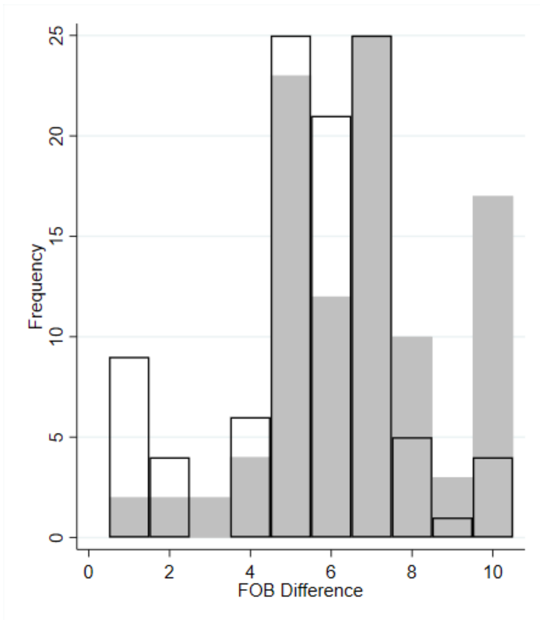
(a) 1^{st} Period Effort



(b) 2^{nd} Period Effort



(c) Signals in Joint Liability Groups



(d) FOB

Figure 1: Strip and Box plots for effort and private signals, θ_i. Histogram for *FOB* in *JLI* and *JLP*. A long thin horizontal line over a box represents the mean. A thick line within a box represents the median. The shaded bars in (d) represent frequency in *JLI* and the white bars with black borderline in *JLP*.

Table 4: First-period Descriptive Analysis

Contract	e_1				Pvt. Signal					
	$\bar{e}_1$	SD	No. $e_{i1} = 3$	p-value $\bar{e}_1 = 3$	$\bar{\theta}$	SD	$\bar{e}_1 - \bar{\theta}$	s	Rep rate	N
ILI	3.76	2.37	8	0.002					66%	100
ILP	6.02	1.75	1	0.000				6	81%	100
JLI	7.48	1.81	0	0.000	6.67	2.15	0.81		88%	100
JLP	6.00	1.88	0	0.000	5.56	2.10	0.44	6	73%	100

Note: A bar on the variable refers to the average and SD to the standard deviation. The p-value is for two-sided t-test. Rep Rate shows the repayment rate.

JLI and *JLP* chose the effort level 3 in the first period, column 4.[32] The average effort levels in all four treatments are significantly different from 3. The significant difference from the baseline predictions suggests that the explanation may lie in psychological and social motivations.

6.1.1 Treatment Differences in First-Period Effort

We now present the evidence on the pairwise contrasts of the first-period effort between the treatments that allows us to examine the effects of peer pressure and social capital.

Private Repayment - Individual vs Joint Liability

Consider a change in the liability structure of the contract from individual to joint liability under private repayment, *ILI vs JLI*. This contrast allows us to examine the guilt-aversion motive while shutting down the shame-aversion motive (see Table 1). The discussion on the determinants of effort in *JLI* is postponed to subsection 6.1.2. Our null hypothesis is that there is no difference in the first-period effort decisions between *ILI* and *JLI* contracts.

Figure 1(a) shows that the distributions of effort are significantly different in the two treatments. The Epps-Singleton test confirms the graphical observation ($p = 0.000$). In the control group, *ILI*, 86% of the effort decisions lie in the range of 1 and 5. By contrast, the same percentage of effort decisions lies strictly above 5 in *JLI*. The average effort in *ILI* is 3.76, while it is 7.48 in *JLI* (Table 4). Conditional on receiving a private signal θ_i about the partner's first-order positive beliefs, the average effort level in the *JLI* treatment almost doubled relative to *ILI*. The higher effort level in *JLI* yields a 33% increase in the repayment rate of loans relative to *ILI* (two-sided t-test, $p = 0.000$).

These results are corroborated by the OLS estimation of equation (5.1) in Table 5. For the comparison between *ILI* and *JLI*, the coefficient of interest is β_2, as it captures the treatment effect of joint liability. In the absence of guilt aversion, we should expect $\beta_2 = 0$ in equation (5.1). On the contrary, we find a highly significant positive coefficient $\beta_2 = 3.72$ in specification 1. At the aggregate level, the higher effort level in *JLI* relative to *ILI* strongly indicates that the subjects are guilt averse (Proposition 3-I-c-i).

[32]Recall that in the baseline model (absence of psychological and social motives) the first-period optimal effort level in the *IL* contracts (*ILI*, *ILP*) is 3.1. In the *JL* contracts (*JLI*, *JLP*) it lies between 2.61 to 3.1 (Table 3). We have used the rounded figure of 3 because subjects chose integer effort levels.

Table 5: First-period Effort - Treatment Differences

Dependent Variable	1^{st} period effort			
Model No.	1	2	3	4
ILP	2.26***			2.31***
	(0.29)			(0.30)
JLI	3.72***	1.46***		3.75***
	(0.30)	(0.25)		(0.30)
JLP	2.24***	−0.02	−1.48***	2.30***
	(0.30)	(0.26)	(0.26)	(0.30)
Age				0.01
				(0.01)
Education				0.02
				(0.03)
Marital Status				−0.16
				(0.25)
Liability Type				0.28
				(0.21)
No of Loans				−0.06
				(0.04)
Control Group	*ILI*	*ILP*	*JLI*	*ILI*
Mean	3.76***	6.02***	7.48***	3.25***
	(0.24)	(0.17)	(0.18)	(0.76)

Notes: OLS regressions. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. $N = 400$, $R^2 = 0.32$.

This result suggests that joint liability alone, without public repayment, can induce borrowers to choose significantly higher effort and increase the repayment rates. Carpena et al. (2013) also find that *JL* contracts significantly improve repayment rates when the repayment is private (this corresponds to our *JLI* contracts). They *speculate* that peer pressure is the main explanation for the higher repayment. Below in subsection 6.1.2, we provide further evidence that in the treatment *JLI*, effort and repayments under the private repayment method increase due to the guilt-aversion motive (the underlying mechanism for peer pressure in our model).

Public Repayment - Individual vs Joint Liability

Now assume that repayments are made in public, and change the liability structure from individual to joint liability, *ILP vs JLP*. This contrast allows us to consider the effect of guilt that arise in *JLP* but not in *ILP* when repayments are made in public. Our null hypothesis is that subject choices in the *JLP* treatment are not influenced by guilt aversion that might play a role under joint liability.

From Figure 1(a), the effort distributions in the two treatments are remarkably similar. Both effort distributions are highly concentrated between 5 and 7. In *ILP*, 70% of the effort choices lie within the range of 5 and 7; the corresponding figure is 78% in *JLP*. In both treatments, the average and the median effort matched the public signal of normative expectations, $s = 6$. The Epps-Singleton test suggests no significant difference between the effort distributions of the two groups ($p = 0.122$).

In *ILP*, 24% of the effort choices are exactly equal to 6 and 38% exceed 6 (i.e., 7 or greater). This implies that 62% of the effort decisions are either equal to or greater than the public signal, s. Similarly, in *JLP*, 31% of the effort choices match exactly 6 and 42% exceed 6, implying that 73% are either equal to or greater than the public signal, $s = 6$. This suggests that a large majority of the decisions in both treatments are consistent with our shame-aversion hypothesis. 25% decisions exactly match the lower bound of empirical expectations, 5, in *ILP* and the corresponding percentage in *JLP* is 16%. Only 13% of the effort decisions in *ILP* and 11% in *JLP* are below both the public signal of normative expectations and empirical expectations. This illustrates the powerful role played by empirical and normative expectations and highlights the human predisposition to follow norms.

The estimated coefficients in Table 5 (specification 1) for *ILP* and *JLP* are almost identical, 2.26 and 2.24 respectively. The difference between these coefficients is negligible and insignificant (Table 5, specification 2). We fail to reject the null hypothesis of no difference in effort levels between *ILP* and *JLP*. The repayment rate in *ILP* is 81% and in *JLP* it is 73% (Table 4). Since the average effort level is the same in both groups and the distributions of effort are almost identical, the difference in repayment rates (or the outcome of the project) is entirely due to the probabilistic outcomes of the projects. The difference is not statistically significant (two-sided t-test, $p = 0.181$).

This comparison shows that the shame-aversion motive, on its own, arising through public repayment can be effective in disciplining borrowers' behavior. The treatment *JLP* involves both key features of Grameen-I, namely public repayments and joint liability. Its similarity in effort/repayment rates to the *ILP* treatment explains why Grameen-II may have retained public repayment and dropped the restrictive condition of joint liability that requires the projects of both borrowers to succeed for them to get another loan. The same mechanism is likely to contribute towards the recent findings of no difference in default rates between *IL* and *JL* treatments when borrowers make repayments in public meetings in Giné and Karlan (2014).

Individual Liability: Private vs Public Repayment

We now examine the first-period effort decisions under private and public repayments when borrowers are individually liable for their loans, *ILI vs ILP*. This comparison allows us to examine the role of public repayment that gives rise to shame aversion while shutting down the guilt-aversion channel. Our null hypothesis is that there is no difference in the first-period effort between *ILI* and *ILP*.

From Figure 1(a), the two effort distributions in the first period are visibly different. The Epps-Singleton test confirms this observation ($p = 0.000$). From Table 4, we see an increase of 60% in the average effort in *ILP* relative to *ILI*. The higher average effort level in *ILP* increases the repayment rate by 23% (two-sided t-test, $p = 0.016$). For the regression analysis, in the absence of shame aversion, we expect $\beta_1 = 0$ in equation (5.1). Table 5, column 1, shows a highly significant positive coefficient for the *ILP* treatment, $\beta_1 = 2.26$. At the aggregate level, the higher effort level in *ILP* relative to *ILI* strongly indicates that the subjects' effort decisions are driven by the shame-aversion motive (Proposition 3-I-c-ii). Our experimental estimates strongly suggest that effect (i) dominates effect (ii) in Remark 2 so that shame-aversion increases first period effort.

The public repayment method may be efficacious through other channels, such as facilitating greater risk-sharing even under *IL* contracts (Feigenberg, Field, and Pande, 2013). While these results from the field data need to assume a positive, although unobserved, relation between public meetings and risk sharing, our experimental results show a direct link between shame aversion and higher effort provision (and repayment rate) under public repayment.

Joint Liability: Private vs Public Repayment

Next, consider the contrast between private and public repayment under joint liability, *JLI vs JLP*. Our null hypothesis is that the first-period effort decisions in the *JLP* treatment are not influenced by public repayment, so there is no difference in the two treatments.

Figure 1(a) shows that in comparison to *JLI*, the effort distribution in *JLP* is more concentrated between 5 and 7. The Epps-Singleton test shows that there is a significant difference between the two effort distribution ($p = 0.000$). The median effort in *JLI* is 7 as compared to 6 in *JLP*. The average first-period effort in *JLP* is 1.48 units lower than *JLI*. The difference is statistically significant (Table 5, specification 3). This average difference in effort results in a 17% lower repayment rate in *JLP* relative to *JLI*.

What accounts for these differences? Insofar as individuals are motivated by social norms of effort, the public signal $s = 6$ in *JLP* plays a powerful role in concentrating the effort of subjects between 5 and 7. However, there is no public signal in the treatment *JLI*, where effort is instead motivated by the feeling of guilt that results from putting in a lower effort relative to the private signal, θ_i. The average private signal in *JLI* is $\overline{\theta} = 6.67$, which is higher than the public signal in *JLP*. If instead, we had $s > \overline{\theta}$ then it is possible that we might have observed a higher effort level in *JLP*.

In the *JLI* contract, guilt aversion plays an important role. However, it appears to play a subservient role in the *JLP* treatment relative to shame aversion that stems from a desire to follow the social norm for effort. The results in subsection 6.1.2 confirm this insight further.

ILP vs JLI

We now test if public repayment without joint liability (*ILP*) can be as effective as joint liability without public repayment (*JLI*) in disciplining borrowers' behavior. This contrast allows us to directly compare the effect of shame aversion arising from public repayment with guilt aversion arising from joint liability.

We can make this comparison by testing the difference between β_2 and β_1 in equation (5.1), which is equivalent to the coefficient of *JLI* in specification 2 in Table 5. The coefficient is positive, 1.46, and statistically significant. The average effort level is slightly higher in *JLI*, but the difference in repayment rates is not statistically significant (two-sided t-test, $p = 0.173$).

This comparison shows that either the individual liability with public repayment (*ILP*) or the joint liability without public repayment (*JLI*) may be equally effective. As described in

Table 6: Determinants of Effort in Joint Liability Contracts

Dependent Variable	1^{st} period effort in *JLI* & *JLP*			
Model No.	1	2	3	4
Public	-1.48^{***}	-0.71^{***}	-0.59	
	(0.26)	(0.21)	(1.02)	
Signal (θ_i)		0.20^{***}	0.32^{***}	0.35^{***}
		(0.05)	(0.07)	(0.07)
FOB (θ_j)		0.50^{***}	0.38^{***}	0.41^{***}
		(0.07)	(0.09)	(0.08)
SignalPub			-0.28^{***}	-0.32^{***}
			(0.09)	(0.09)
FOBPub			0.26^{*}	0.21^{**}
			(0.14)	(0.09)
Constant	7.48^{***}	2.85^{***}	2.78^{***}	2.42^{***}
	0.18	(0.56)	(0.73)	(0.52)
R^2	0.14	0.49	0.52	0.52
AIC	814.25	715.40	704.70	703.25
BIC	820.85	728.59	724.49	719.74

Notes: OLS regressions. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. $N = 200$. See Table B2 in Appendix for the ordered logit estimates.

the previous sections, the effort level in the public repayment treatments (e.g., *ILP*) is highly influenced by the public signal s, while the effort decisions in *JLI* were influenced by the effort expectation of partners, as embodied by the private signal θ_i. Thus, the relative sizes of θ_i and s are important in the various treatments, and so also the differences in effort levels among the treatments. Therefore, maintaining a norm of high effort or repayment is critical to the effectiveness of public repayment.

6.1.2 Determinants of Effort in Joint Liability Contracts.

We now consider the determinants of first-period effort in the *JL* treatments (*JLI*, *JLP*). Specifically, we are interested in two variables. (i) The role of the private signal received by player i of the partner's (player j's) first-order positive beliefs, θ_i, (the variable *Signal* in (5.2)) that underpins the guilt-aversion channel. (ii) A measure of player i's own first-order positive beliefs about the partner's (player j's) effort, θ_j, (the variable *FOB* in (5.2)) that takes account of contractual linkages. Under our induced beliefs design, these two variables are different and allow for an appropriate econometric analysis of beliefs. The Pearson correlation coefficient between *Signal* and *FOB* is 0.01, indicating that there are no issues of false consensus.

Guilt Aversion in JLI and JLP

If borrowers are guilt averse, then the first-period effort should increase with the private signal of the partner's expectations θ_i in the *JLI* and *JLP* treatments (Proposition 3-I-a). Table 4 shows that the average first-period effort, $\bar{e}_1$, and the average private signal, $\bar{\theta}$, in *JLI* are respectively 7.48 and 6.67. This implies that on average, subjects exceeded the partner's expectation by 0.81 effort units in *JLI* (two-sided t-test, $p = 0.004$). Almost half of the subjects, 49%, chose effort greater than their partner's expectation, 31% exactly matched the partner's expectation, and only 20% chose effort lower than their partner's expectation. Out of 20 subjects who chose effort lower than their partner's expectations, 11 received the private signal of either 9 or 10. As noted earlier, matching or exceeding these expectations gives a negative return from the project; hence, these expectations are unreasonably high. The Spearman correlation coefficient between the private signals, θ_i, and the first-period effort choices is 0.42 ($p = 0.000$).

Table 6 shows the determinants of effort in the *JL* treatments (*JLI*, *JLP*) by estimating equation (5.2). The coefficient of *Signal* in *JLI*, α_2, is positive, highly significant, and ranges between $0.32 - 0.35$ in specifications 3 and 4 in Table 6.[33] Thus, the effort decisions in *JLI* are partly driven by guilt aversion; Proposition 3-I-a is verified for the treatment *JLI*.

In the treatment *JLP*, the average private signal of the partner's first-order positive belief, $\overline{\theta}$, is 5.56 which is 1.11 units lower than the corresponding average private signal in *JLI*.[34] On average, subjects in the *JLP* group chose 0.44 units of effort higher than the signals they received about partner's expectation (two-sided t-test, $p = 0.120$), which is almost half the observed difference of 0.81 between average effort and the average private signal in *JLI*. The Spearman correlation coefficient between the signal of the partner's expectation, θ_i, and the first-period effort in *JLP* is 0.21, ($p = 0.035$) which is also half the corresponding correlation coefficient of 0.42 in *JLI*. In comparison to *JLI*, this suggests a weaker correlation between private signals and the effort decisions in *JLP*; we examine the reason for this below.

From the regression analysis, the effect of the private signal on effort in *JLP* is measured by the sum of coefficients $\alpha_2 + \alpha_4$ in equation (5.2). A significant and positive (negative) value of α_4 implies that the effect of private signals has increased (decreased) in *JLP* relative to *JLI*. In specifications 3 and 4 of Table 6, the values of α_4 are -0.28 and -0.32 respectively, and both are statistically significant. Since α_2 ranges between $0.32 - 0.35$, the effect of private signals on the first-period effort is almost zero in *JLP*. In comparison with the results from *JLI*, this shows that the role of guilt aversion is absent in *JLP*. The mostly likely reason is that in the *JLP* treatment, individuals also subscribe to the norm of the effort level expected in their group, as captured by the public signal, s. Hence, the partner's expectation plays a more muted role, and shame aversion appears to trump guilt aversion.

The Effect of θ_j in JLI and JLP

The first-period effort in *JLI* and *JLP* increases with a measure of agent's own first-order positive belief, θ_j, (Proposition 3-I-b). From Figure 1(d), approximately 90% of our subjects in *JLI* expected their partner to choose effort level 5 or greater. The Spearman correlation coefficient between the subject's own first-order beliefs and his/her first-period effort decision is 0.43 ($p = 0.000$). The coefficient of *FOB* in *JLI* ranges between $0.38 - 0.41$ in Table 6(specifications 3 and 4). The coefficient is highly significant in both specifications. This is substantially larger

[33]Only specifications 3 and 4 separately estimate the effect of signals and *FOB* in two joint liability groups. Specification 2 shows the joint estimates of the two *JL* treatments.

[34] Recall that in the *JLP* treatment the public signal $s = 6$ was given to the subjects prior to the elicitation of the private signal, θ_i. This is likely to have lead to a lower average private signal relative to the *JLI* treatment in which there was no anchoring effect of the public signal on private signals. Also note that in our formal analysis of beliefs (subsection 2.5), the distribution of first-order positive beliefs for *JLP* is conditioned on s.

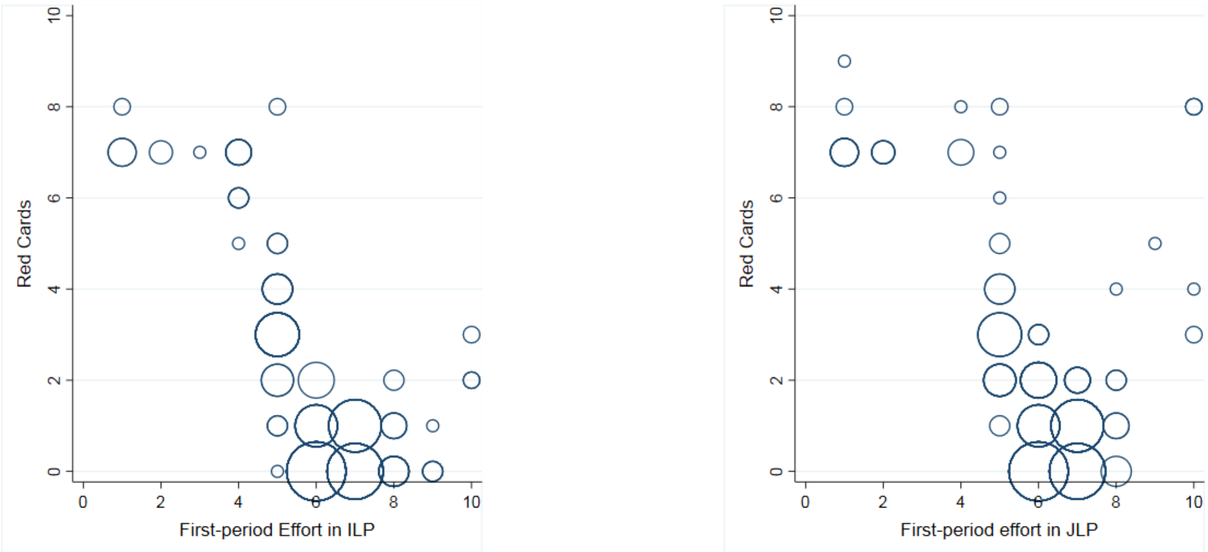


Figure 2: The Relationship between the Number of Red Cards Displayed and the First-period Effort in Public Repayment Treatments.

than the coefficient (0.06 from Table 3) implied by the baseline model (with no psychological and social motivations). Coupled with effort choices that are much higher than 3, the results show that the baseline model underestimates the effect of first-order positive beliefs on effort.

The distribution of first-order positive beliefs in *JLP* shifts to the left relative to *JLI* (recall footnote 34 and see Figure 1(d)). There is a sharp increase (75%) at $e = 6$ and sharp decrease (76%) at $e = 10$ in *JLP*. The Epps-Singleton test confirms significant differences between the two *FOB* distributions ($p = 0.001$). In the treatment *JLP*, the Spearman correlation coefficient between the subject's own first-order beliefs and effort decision is 0.61 ($p = 0.000$). Using (5.2), the overall effect of first-order positive beliefs on effort in *JLP* is estimated by $\alpha_3 + \alpha_5$. At the 5% significance level, the overall effect ranges between $0.38 - 0.62$ (Table 6, specifications 3 and 4).[35] Thus, the correlation between first-order positive beliefs and effort decisions significantly increases in *JLP* relative to *JLI*. The increase in the coefficient of *FOB* further shows that the relationship between first-order beliefs and effort cannot be explained by the best response to beliefs within the baseline model. The difference in *FOB* between *JLI* and *JLP* suggests that the presence or absence of the public signal, s, influences the formation of *FOB*. The public signal appears to coordinate the expectations of subjects about what they expect from others.

6.1.3 Social Disapproval in Public Repayment

Our data show active social disapproval of effort that falls below the public signal, s. Subjects appear to have correctly anticipated these consequences. On average, the chosen effort levels conformed well with the public signal. Figure 2 shows the relationship between the number of red cards and the chosen first-period effort levels in the public repayment treatments (*ILP*, *JLP*). The size of the bubble reflects the frequency of a particular combination of red cards and the first-period effort level. Both public repayment treatments (*ILP*, *JLP*) have very similar

[35] At 10% significance level, the range of effect of *FOB* reduces to $0.62 - 0.64$. In specification 3, the estimated coefficient on *SignalPub*, α_5, is positive, 0.26, and only significant at 10% significance level.

Table 7: Probability of Receiving a Red Card in the First Period in Public Repayment

Probability	*ILP*	*JLP*
$P(R \mid e_{i1} < 5)$	0.74	0.82
$P(R \mid e_{i1} = 5)$	0.36	0.39
$P(R \mid e_{i1} \geq 6)$	0.05	0.15

distributions and show three trends. (1) Subjects who chose effort level equal to or above the public signal $s = 6$ received either zero or very few red cards. (2) Subjects who chose effort level less than the lower bound of empirical expectations 5 received high social disapproval in the form of 7 or more red cards. (3) Subjects who chose effort level 5 received a mixed response, so there is heterogeneity among punishers on the appropriate yardstick for punishment.

Table 7 shows the probability of receiving a red card for three effort categories in the first period. Regardless of the liability structure, in the public repayment treatments, the probability of receiving a red card is very high for those who chose effort below the public signal and the empirical expectation (74% in *ILP* and 82% in *JLP*), i.e. for those who chose effort less than 5. It reduces significantly for those who adhered to the lower bound of empirical expectation, 5, but chose effort below the public signal $s = 6$ (36% in *ILP* and 39% in *JLP*). The probability is the lowest for those who conformed with or exceeded the empirical expectation and the public signal (5% in *ILP* and 15% in *JLP*), i.e. for those who chose effort level 6 or above.

6.2 Second Period

In the second period, all contracts are effectively *IL* contracts, the only difference is in the method of repayment (private or public). We now test the theoretical predictions for the effort level in the second period. Table 8 presents the descriptive analysis of the second period.

Individual vs Joint Liability Contracts

Private Repayment - ILI vs JLI. There are no psychological or social factors involved in the second period of the private repayment treatments (see Table 1). Using Proposition 4-I and our parametrization, the second-period optimal effort in *ILI* and *JLI* is identical and equal to 2. At the individual level, 20 subjects (30%) in *ILI* and no subject in *JLI* chose the effort level 2 (Table 8, column 2). The actual average effort in the second period, $\bar{e}_2$, is substantially higher than 2 in both treatments (Table 8, columns 3 and 4). Moreover, the regression coefficients in Table 9 reveal that the average effort in *JLI* is 4.43 points (120%) higher than *ILI*, and the difference is highly significant. This result shows that the effort differences from the first period persist in the second period even in the absence of any interpersonal or contractual linkages. Thus, our experimental data do not verify Proposition 4-I for the private repayment contracts. We explain this behavior in Section 7 below.

Public Repayment - ILP vs JLP. In the public repayment treatments, we cannot make a

Table 8: Second-period Descriptive Analysis

Contract	No. $e_{i2} = 2$	$\bar{e}_2$	$\bar{e}_2 - 2$	$\hat{e}_1$	$\bar{e}_2$ - $\hat{e}_1$	p-value	No. $e_2 \geq e_1$	Rep rate	N
ILI	20	3.67	1.67	4.06	-0.39	0.178	44	67%	66
ILP	0	6.89	4.89	6.25	0.64	0.003	75	81%	81
JLI	0	8.10	6.10	7.64	0.46	0.018	65	92%	76
JLP	1	6.58	4.58	6.44	0.14	0.405	46	84%	50

Notes: A bar on a variable refers to the average. $\hat{e}_1$ reports the first-period average efforts of subjects who succeeded in getting a second-period loan. The p-value is for the two-sided t-test for temporal average differences. Rep Rate shows the repayment rate.

precise quantitative prediction about the effort level without prior knowledge of the value of the shame-aversion parameter, $\overline{\mu}_i$, and the belief distributions of agents. Qualitatively, our model predicts that second-period optimal efforts are identical in *ILP* and *JLP* (Proposition 4-I). The Epps-Singleton test finds no significant difference between the two effort distributions in public repayment contracts ($p = 0.133$). The average second-period effort levels in *ILP* and *JLP* are, respectively, 6.89 and 6.58 (Table 8, column 3). The average effort difference, 0.31, is statistically insignificant (Table 9, specification 3). These results are consistent with Proposition 4-I for the public repayment contracts.

Private vs Public Repayment

Proposition 4-II-b states that the second-period optimal effort is higher under the public repayment contracts, for each liability structure (*IL* and *JL*), relative to the private repayment contracts. We first test whether public repayment, regardless of liability type, makes any difference to effort choices in the second period. On average, under public repayment (pooled for *ILP* and *JLP*), subjects chose 0.74 points (12%) higher effort relative to private repayment (pooled for *ILI* and *JLI*) (two-sided t-test, $p = 0.015$). However, testing for the effort difference by keeping fixed the liability structure (*IL* or *JL*) but varying the repayment method (private or public) gives a more nuanced result. Specification 1 of Table 9 shows that effort in *ILP* is 3.22 units higher (88% higher) relative to *ILI*. However, specification 2 in Table 9 shows that the average effort is 1.51 units lower (19% lower) in *JLP* relative to *JLI*. Thus, Proposition 4-II-b is only verified for the individual liability and not for the joint liability.

6.3 Intertemporal Comparison

Proposition 3-II states that the first-period optimal effort is strictly higher than the second-period optimal effort in all four contracts. Figure 1(b) shows that, except in *ILI*, the second-period effort distributions of all contracts have shifted to the right, relative to the first period. The mean and median efforts in *ILP*, *JLI*, and *JLP* have increased in the second period, while in *ILI*, both have decreased.

Table 8 reports the number of subjects whose chosen effort in the second period is equal to or greater than their first-period effort (column 8). Contrary to the prediction of Proposition

Table 9: Second-period Effort - Treatment Differences

Dependent Variable	2^{nd} period effort		
Model No.	1	2	3
JLI	4.43^{***}		
	(0.38)		
ILP	3.22^{***}	-1.20^{***}	
	(0.36)	(0.28)	
JLP	2.91^{***}	-1.51^{***}	-0.31
	(0.39)	(0.32)	(0.29)
Control Group	*ILI*	*JLI*	*ILP*
Mean	3.67^{***}	8.09^{***}	6.89^{***}
	(0.32)	(0.22)	(0.18)

Notes: OLS regressions. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. $N = 273$, $R^2 = 0.41$.

3-II, the overwhelming majority of subjects chose second-period effort either equal to or greater than their first-period effort: 67% in *ILI*, 93% in *ILP*, 86% in *JLI*, and 92% in *JLP*.

In the contract *ILI*, the average temporal difference in effort ($\bar{e}_2 - \bar{e}_1$) of subjects who participated in both periods is negative, -0.39, but statistically insignificant (p-values are reported in Table 8). The average differences in *ILP* and *JLI* are positive, respectively, 0.64 and 0.46, and significant. Finally, the difference in *JLP* is also positive, 0.14, but insignificant. Thus, for most subjects who participated in the second period, Proposition 3-II is not confirmed. Section 7 explains this behavior with a heuristics-based approach.

6.4 Choice of Contract

What implications do our results have for contractual choices by the bank?[36] The last column of Table 8 shows that, in the public repayment treatments (*ILP*, *JLP*), the number of loans granted in the second period in *ILP* is 81, while this number is 50 in *JLP*. This implies that all 81 successful subjects from period 1 in *ILP* were offered second-period loans, but only 50 out of 73 successful subjects in *JLP* were able to get loans in the second period due to more stringent borrowing requirements (both partners in *JLP* need to be successful). The first-period effort levels in these two treatments were almost identical, but due to the probabilistic nature of the projects, the repayment rate was slightly lower in *JLP* (10% lower, which is statistically insignificant). Nonetheless, even if we had the same repayment rates in two treatments, the number of loans granted in the second period would have been lower in *JLP* due to more stringent borrowing conditions. In our data, the bank's lending in the second period is 62% higher in *ILP* as compared to *JLP*. If we make the same comparison under private repayment, then 66 subjects in *ILI* and 88 in *JLI* were successful in the first period. All 66 subjects in *ILI* and 76 in *JLI* were able to get loans in the second period.

This contrast shows that a microfinance bank may prefer individual liability under public repayment and joint liability under private repayment. The reason is that, under public re-

[36]Proposition 2 implies that, under the baseline model, the bank should prefer an *IL* contract to a *JL* contract.

payment, *ILP* and *JLP* contracts induced similar effort levels because subjects were guided by norm compliance, while the role of other psychological factors diminishes (recall our shame aversion trumps guilt aversion result above). Under private repayment, where issues of norm compliance do not arise, joint liability induces guilt aversion in *JLI* that encourages higher effort and repayment relative to the contract *ILI*. Consequently, the bank is able to lend to more joint liability borrowers in the second period under private repayment. Distinguishing between private and public repayment is a potential explanation for the contractual change from joint liability to individual liability in Grameen-II, while retaining public repayment.

7 A Heuristics-Based Approach

Thus far, we have followed a strict optimization approach (which also entails using backward induction in solving a two-period problem). Our model predicts that the first-period effort should be greater than the second-period effort in all contracts (Proposition 3-II). However, our data does not support this prediction for *ILP*, *JLI*, and *JLP* contracts. For the *ILI* contract, our experimental results are in line with this prediction, but only qualitatively.

The main alternative to optimization is the *heuristics* and *biases* approach associated with Tversky and Kahneman (1974). What heuristics might our subjects be using? Our respondents live in close-knit rural communities in Pakistan, where peer pressure and social norms, often backed by sanctions for non-compliance, can be powerful influences on behavior. In light of the evidence above, we conjecture that most borrowers follow three heuristics, H1, H2, H3:

H1 : Under the contract *ILP*, the first-period effort level is $\widetilde{e}_{i1}^{ILP} \simeq s$ and the second-period effort level is $\widetilde{e}_{i2}^{ILP} \simeq s$, where s is the socially acceptable normative effort level.

Under the contract *ILP*, agents do not optimize in its strict sense. In each period, they choose effort close, or equal, to the public signal, s, to avoid shame or loss of social capital. Thus, social norm conformity may serve as the relevant heuristic to choose effort in both periods.

H2 : Under the contract *JLP*, the first-period effort level is $\widetilde{e}_{i1}^{JLP} \simeq s$ and the second-period effort level is $\widetilde{e}_{i2}^{JLP} \simeq s$, where s is the socially acceptable normative effort level.

In the first period of the contract *JLP*, agent i receives both a private signal, θ_i, of the partner's expectation of effort and the public signal, s, specifying a socially appropriate effort level. Thus, both guilt-aversion and shame-aversion motives influence effort in the first period. Our results suggests that shame trumps guilt, hence, social norm compliance is consistent with agent i giving less attention to θ_i, and setting $\widetilde{e}_{i1}^{JLP} \simeq s$. In the second period, the *JLP* contract is effectively an individual liability contract, so there is no guilt aversion, just the shame-aversion motive. Hence, agent i chooses $\widetilde{e}_{i2}^{JLP} \simeq s$.

H3 : Under the contract *JLI*, the first-period effort level is $\widetilde{e}_{i1}^{JLI} \simeq \theta_i$ and the second-period effort level is $\widetilde{e}_{i2}^{JLI} \simeq \theta_i$, where θ_i is the first-period expectation of the partner in a *JLI* contract, provided θ_i is not unreasonably high.

In the first period of the contract *JLI*, agent i sets effort level close, or equal, to θ_i to avoid guilt. In the second period, there is no interdependence among the decisions of agents, so θ_i should be irrelevant. However, θ_i serve as an anchor for agents' effort in the second period. Our data is consistent with $\widetilde{e}_{i2}^{JLI} \simeq \theta_i$, in agreement with the *anchoring heuristic* (Tversky and Kahneman, 1974).

This leaves out the contract *ILI*, which is effectively assumed in typical theoretical analyses that do not incorporate public repayments. There are no signals, s or θ_i, in an *ILI* contract to induce greater effort, and Conjectures H1-H3 do not apply. Our analysis clarifies that the *ILI* contract is not observed in actual practice because it does not provide the necessary incentives to enhance effort. Yet it serves as a benchmark that lacks psychological and social factors, allowing us to switch those factors on and off in our four treatments.

8 Conclusion

The microfinance literature lacks precise microfoundations of peer pressure and social capital; hence, it has not been able to determine their relative importance in influencing borrower choices. In this paper, we propose a theoretical model that defines peer pressure and social capital in an empirically testable and precise manner. Our experimental results disentangle and confirm the importance of these motivations under various contractual forms.

Our theoretical framework shows how *guilt aversion* is critical in formalizing *peer pressure* in joint liability contracts. *Shame aversion* likewise allows us to formalize the effects of *social capital* arising through the *public repayment* of loans. We identify guilt as the main determinant of effort in *JL* contracts under *private repayment* (*JLI*). However, in *JL* contracts under public repayment (*JLP*), borrowers appear keener to avoid *shame* arising from effort that falls below the social norm, relative to avoiding *guilt* from falling behind their partner's expectations. Hence, shame appears to trump guilt. Our results also show that an effective mechanism to discipline borrowers' behavior can arise either from joint liability (irrespective of the mode of repayment) or from public repayment (irrespective of the liability structure). These findings provide a compelling explanation for the move from joint liability to individual liability contracts in recent years (as from Grameen-I to II), provided that the repayment is in public.

The dynamic optimization approach in our theoretical model relies on an end-game effect in a two-period model that is not supported by our experimental evidence. We argue that the lack of an end-game effect may be consistent with *heuristics-based choices*, such as anchoring.

Overall our results highlight the importance of psychological and social motivations in microfinance contracts. Evidence from diverse fields, including our study, suggests that emotions constitute potent drivers of decision making, and humans often employ simple heuristics to solve economic problems. The interaction between classically rational reasoning, emotions, and heuristics requires further research that may also inform the design of better policies/institutions, and foster a greater understanding of human behavior.

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Appendix A : Proofs

Intermediate Results

We first present some intermediate results. The first three results draw on the assumed differentiability of the distribution functions.

Property B2 implies that

$$\frac{\partial F_i^1\left(e_{j1};\theta_j\right)}{\partial \theta_j} < 0,\ \frac{\partial F_i^1\left(e_{j1};\theta_j|s\right)}{\partial \theta_j} < 0,\ \forall e_{j1} \in (0,1)\,,\ \forall \theta_j \in (0,1)\,. \tag{A.1}$$

$$\frac{\partial F_i^1\left(e_{j1};\theta_j|s\right)}{\partial s} < 0,\ \forall e_{j1} \in (0,1)\,,\ \forall s \in (0,1)\,. \tag{A.2}$$

Property B4 implies that

$$\frac{\partial F_i^2\left(e_{i1} \mid \theta_i\right)}{\partial \theta_i} < 0,\ \forall e_{i1} \in (0,1)\ \ \forall \theta_i \in (0,1)\,,\ i = 1,2. \tag{A.3}$$

Property B6 implies that

$$\frac{\partial G_i^2\left(e_{it} \mid s\right)}{\partial s} < 0,\ \forall e_{it} \in (0,1)\ \ \forall s \in (0,1)\,,\ i = 1,2. \tag{A.4}$$

The following results (first and second partial derivatives) immediately follow by substitution or differentiation from (2.1), (2.2), (2.4), (2.7), (A.1), (A.2), (A.3), (A.4), (2.9), (2.10), (2.11), (2.12), (2.13), (2.14), (2.15).

Table 10: First Partial Derivatives

1	$\frac{\partial EM(e_{it})}{\partial e_{it}} = \frac{1}{2}\left[Y - L(1+r)\right] - c'(e_{it})$
2	$\frac{\partial U^k(e_{i1},e_{i2})}{\partial e_{i1}} = \frac{\partial \Psi^k(e_{i1})}{\partial e_{i1}} + \frac{\partial \psi^k(e_{i1})}{\partial e_{i1}} V^k(e_{i2})$
3	$\frac{\partial \Psi^k(e_{i1})}{\partial e_{i1}} = \frac{\partial EM(e_{i1})}{\partial e_{i1}} + (T_{JLI} + T_{JLP})\mu_i\left[1 - F_i^2(e_{i1} \mid \theta_i)\right] + (T_{ILP} + T_{JLP})\overline{\mu}_i\left[1 - G_i^2(e_{i1} \mid s)\right]$
4	$\frac{\partial \psi^k(e_{i1})}{\partial e_{i1}} = \frac{1}{2}\left[T_{ILI} + T_{ILP} + T_{JLI}Ep(e_{j1}) + T_{JLP}Ep(e_{j1} \mid s)\right]$
5	$\frac{\partial EM(e_{i2})}{\partial e_{i2}} = \frac{1}{2}\left[Y - L(1+r)\right] - c'(e_{i2})$
6	$\frac{\partial U^k(e_{i1},e_{i2})}{\partial e_{i2}} = \psi^k(e_{i1})\frac{\partial V^k(e_{i2})}{\partial e_{i2}}$
7	$\frac{\partial V^k(e_{i2})}{\partial e_{i2}} = \frac{\partial EM(e_{i2})}{\partial e_{i2}} + (T_{ILP} + T_{JLP})\overline{\mu}_i\left[1 - G_i^2(e_{i2} \mid s)\right]$
8	$\frac{\partial U^k(e_{i1},e_{i2})}{\partial \theta_i} = (T_{JLI} + T_{JLP})\mu_i \int_{e'_{i1}=e_{i1}}^{1} \frac{\partial F_i^2(e'_{i1} \mid \theta_i)}{\partial \theta_i} de'_{i1}$
9	$\frac{\partial U^k(e_{i1},e_{i2})}{\partial s} = \frac{\partial \Psi^k(e_{i1})}{\partial s} + \frac{\partial \psi^k(e_{i1})}{\partial s} V^k(e_{i2}) + \psi^k(e_{i1})\frac{\partial V^k(e_{i2})}{\partial s}$
10	$\frac{\partial \Psi^k(e_{i1})}{\partial s} = (T_{ILP} + T_{JLP})\overline{\mu}_i \int_{e'_{i1}=e_{i1}}^{1} \frac{\partial G_i^2(e'_{i1} \mid s)}{\partial s} de'_{i1}$
11	$\frac{\partial \psi^k(e_{i1})}{\partial s} = -T_{JLP}\frac{1+e_{i1}}{4}\int_{e_{j1}=0}^{1} \frac{\partial F_i^1(e_{j1} \mid s)}{\partial s} de_{j1}$
12	$\frac{\partial V^k(e_{i2})}{\partial s} = (T_{ILP} + T_{JLP})\overline{\mu}_i \int_{e'_{i2}=e_{i2}}^{1} \frac{\partial G_i^2(e'_{i2} \mid s)}{\partial s} de'_{i2}$
13	$\frac{\partial U^k(e_{i1},e_{i2})}{\partial \theta_j} = \frac{\partial \psi^k(e_{i1})}{\partial \theta_j} V^k(e_{i2})$
14	$\frac{\partial \psi^k(e_{i1})}{\partial \theta_j} = -\frac{1+e_{i1}}{4}\left[T_{JLI}\int_{e_{j1}=0}^{1} \frac{\partial F_i^1(e_{j1})}{\partial \theta_j} de_{j1} + T_{JLP}\int_{e_{j1}=0}^{1} \frac{\partial F_i^1(e_{j1} \mid s)}{\partial \theta_j} de_{j1}\right]$

Proofs of Propositions

Lemma 1. *(a)* $\int_{e_{j1}=0}^{1} e_{j1} dF_i^1(e_{j1}; \theta_j) = 1 - \int_{e_{j1}=0}^{1} F_i^1(e_{j1}; \theta_j) de_{j1}$.

(b) $\int_{e_{j1}=0}^{1} e_{j1} dF_i^1(e_{j1}; \theta_j \mid s) = 1 - \int_{e_{j1}=0}^{1} F_i^1(e_{j1}; \theta_j \mid s) de_{j1}$.

(c) $\int_{e'_{i1}=e_{i1}}^{1} (e'_{i1} - e_{i1}) dF_i^2(e'_{i1} \mid \theta_i) = 1 - e_{i1} - \int_{e'_{i1}=e_{i1}}^{1} F_i^2(e'_{i1} \mid \theta_i) de'_{i1}$.

(d) $\int_{e'_{it}=e_{it}}^{1} (e'_{it} - e_{it}) dG_i^2(e'_{it} \mid s) = 1 - e_{it} - \int_{e'_{it}=e_{it}}^{1} G_i^2(e'_{it} \mid s) de'_{it}$.

Proof. The results follow from integration by parts. □

Lemma 2. *(a)* $\psi^k(e_{i1}) > 0$, *for all* $e_{i1}, s, \theta_j \in [0,1]$.

(b) $\frac{\partial^2 V^k(e_{i2})}{\partial e_{i2}^2} < 0$, *for all* $e_{i2}, s \in [0,1]$.

(c) $\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i1}^2} < 0$, *for all* $e_{i1}, e_{i2}, \theta_i, s, \theta_j \in [0,1]$.

(d) $\frac{\partial V^{ILP}(e_{i2})}{\partial s} < 0$, $\frac{\partial V^{JLP}(e_{i2},s)}{\partial s} < 0$.

Proof. (a) From (2.2), (2.7), (2.13), we get $\psi^k(e_{i1}) > 0$, for all $e_{i1}, s, \theta_j \in [0,1]$.

(b) From (2.1) and row 11 of Table 11 we get that $\frac{\partial^2 V^k(e_{i2})}{\partial e_{i2}^2} < 0$, for all $e_{i2}, s \in [0,1]$.

Table 11: Second Partial Derivatives

1	$\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i1}^2} = -c''(e_{i1}) - (T_{JLI}+T_{JLP})\,\mu_i f_i^2(e_{i1}\mid\theta_i) - (T_{ILP}+T_{JLP})\,\overline{\mu}_i g_i^2(e_{i1}\mid s)$
2	$\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i1}\partial e_{i2}} = \frac{1}{2}\left[T_{ILI}+T_{ILP}+T_{JLI}Ep(e_{j1})+T_{JLP}Ep(e_{j1}\|s)\right]\frac{\partial V^k(e_{i2})}{\partial e_{i2}}$
3	$\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i1}\partial\theta_i} = -(T_{JLI}+T_{JLP})\,\mu_i\frac{\partial F_i^2(e_{i1}\|\theta_i)}{\partial\theta_i}$
4	$\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i1}\partial s} = \frac{\partial^2\Psi^k(e_{i1})}{\partial e_{i1}\partial s} + \frac{\partial^2\psi^k(e_{i1})}{\partial e_{i1}\partial s}V^k(e_{i2}) + \frac{\partial\psi^k(e_{i1})}{\partial e_{i1}}\frac{\partial V^k(e_{i2})}{\partial s}$
5	$\frac{\partial^2\Psi^k(e_{i1})}{\partial e_{i1}\partial s} = -(T_{ILP}+T_{JLP})\,\overline{\mu}_i\frac{\partial G_i^2(e_{i1}\|s)}{\partial s}$
6	$\frac{\partial^2\psi^k(e_{i1})}{\partial e_{i1}\partial s} = -\frac{1}{4}T_{JLP}\int_{e_{j1}=0}^{1}\frac{\partial F_i^1(e_{j1}\|s)}{\partial s}de_{j1}$
7	$\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i1}\partial\theta_j} = -\frac{1}{4}\left[T_{JLI}\int_{e_{j1}=0}^{1}\frac{\partial F_i^1(e_{j1})}{\partial\theta_j}de_{j1} + T_{JLP}\int_{e_{j1}=0}^{1}\frac{\partial F_i^1(e_{j1}\|s)}{\partial\theta_j}de_{j1}\right]V^k(e_{i2})$
8	$\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i2}\partial s} = \frac{\partial\psi^k(e_{i1})}{\partial s}\frac{\partial V^k(e_{i2})}{\partial e_{i2}} + \psi^k(e_{i1})\frac{\partial^2 V^k(e_{i2})}{\partial e_{i2}\partial s}$
9	$\frac{\partial^2 V^k(e_{i2})}{\partial e_{i2}\partial s} = -(T_{ILP}+T_{JLP})\,\overline{\mu}_i\frac{\partial G_i^2(e_{i2}\|s)}{\partial s}$
10	$\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i2}\partial\theta_j} = \frac{\partial\psi^k(e_{i1})}{\partial\theta_j}\frac{\partial V^k(e_{i2})}{\partial e_{i2}}$
11	$\frac{\partial^2 V^k(e_{i2})}{\partial e_{i2}^2} = -c''(e_{i2}) - (T_{ILP}+T_{JLP})\,\overline{\mu}_i g_i^2(e_{i2}\mid s)$
12	$\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i2}^2} = \psi^k(e_{i1})\frac{\partial^2 V^k(e_{i2})}{\partial e_{i2}^2}$
13	$\frac{\partial^2 U^{ILP}(e_{i1},e_{i2})}{\partial e_{i1}\partial s} = -\overline{\mu}_i\frac{\partial G_i^2(e_{i1}\|s)}{\partial s}$

(c) From (2.1) and row 1 of Table 11 we get that $\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i1}^2} < 0$, for all $e_{i1}, e_{i2}, \theta_i, s, \theta_j \in [0,1]$.

(d) Follows from (A.4) and row 12 of Table 10. □

Proof of Proposition 1

(a) From (2.11) and Lemma 2-a, we see that maximizing $U^k(e_{i1}, e_{i2})$ with respect to e_{i2}, given $e_{i1}, \theta_i, s, \theta_j \in [0,1]$, is equivalent to maximizing $V^k(e_{i2})$ with respect to e_{i2}, given $s \in [0,1]$. Since, for each $s \in [0,1]$, $V^k(e_{i2})$ is a continuous function of e_{i2} on the compact set $\{e_{i2} \in [0,1]\}$, an optimum, $e_{i2}^k \in [0,1]$, does exist. From Lemma 2 b, it follows that e_{i2}^k is unique, given s.

(b) From (2.1), (2.2), (2.4), (2.7), (2.9), (2.10), (2.11)-(2.14), we see that, for each $\theta_i, s, \theta_j \in [0,1]$,
$U^k\left(e_{i1}, e_{i2}^k\right)$ is a continuous function of e_{i1} on the compact set $[0,1]$. Hence, a maximum $e_{i1}^k \in [0,1]$ exists. From Lemma 2-c, we get that $e_{i1}^k \in [0,1]$ is unique, given $\theta_i, s, \theta_j \in [0,1]$.

(c) Follows from (2.15) and parts (a) and (b).

(d) $e_{i2}^k \in (0,1) \Rightarrow \left[\frac{\partial V^k(e_{i2})}{\partial e_{i2}}\right]_{e_{i2}=e_{i2}^k} = 0$ follows from part (a).

(e) $e_{i1}^k \in (0,1) \Rightarrow \left[\frac{\partial U^k(e_{i1},e_{i2})}{\partial e_{i1}}\right]_{e_{i1}=e_{i1}^k, e_{i2}=e_{i2}^k} = 0$ follows from part (b). □

Lemma 3. *: Let e_{i2}^k, e_{i1}^k be as in Proposition 1-a,b, respectively. Then:*

(a) $e_{i2}^k \in (0,1) \Rightarrow sign\frac{\partial e_{i2}^k}{\partial s} = sign\left[\frac{\partial^2 V^k(e_{i2})}{\partial e_{i2}\partial s}\right]_{e_{i2}=e_{i2}^k}.$

Table 12: Utilities Under Four Contracts in a Two-Period Game

1	$\Psi^{ILI}(e_{i1}) = EM(e_{i1})$
2	$\Psi^{JLI}(e_{i1}, \theta_i) = EM(e_{i1}) + \phi_i(e_{i1}, \theta_i)$
3	$\Psi^{ILP}(e_{i1}, s) = EM(e_{i1}) + \overline{\phi}_i(e_{i1}, s)$
4	$\Psi^{JLP}(e_{i1}, \theta_i, s) = EM(e_{i1}) + \phi_i(e_{i1}, \theta_i) + \overline{\phi}_i(e_{i1}, s)$
5	$\psi^{ILI}(e_{i1}) = p(e_{i1})$
6	$\psi^{JLI}(e_{i1}, \theta_j) = p(e_{i1}) Ep(e_{j1}; \theta_j)$
7	$\psi^{ILP}(e_{i1}) = p(e_{i1})$
8	$\psi^{JLP}(e_{i1}, s, \theta_j) = p(e_{i1}) Ep(e_{j1}; \theta_j \mid s)$
9	$V^{ILI}(e_{i2}) = EM(e_{i2})$
10	$V^{JLI}(e_{i2}) = EM(e_{i2})$
11	$V^{ILP}(e_{i2}, s) = EM(e_{i2}) + \overline{\phi}_i(e_{i2}, s)$
12	$V^{JLP}(e_{i2}, s) = EM(e_{i2}) + \overline{\phi}_i(e_{i2}, s)$
13	$U^{ILI}(e_{i1}, e_{i2}) = \Psi^{ILI}(e_{i1}) + \psi^{ILI}(e_{i1}) V^{ILI}(e_{i2})$
14	$U^{JLI}(e_{i1}, e_{i2}, \theta_i, \theta_j) = \Psi^{JLI}(e_{i1}, \theta_i) + \psi^{JLI}(e_{i1}, \theta_j) V^{JLI}(e_{i2})$
15	$U^{ILP}(e_{i1}, e_{i2}, s) = \Psi^{ILP}(e_{i1}, s) + \psi^{ILP}(e_{i1}) V^{ILP}(e_{i2}, s)$
16	$U^{JLP}(e_{i1}, e_{i2}, \theta_i, s, \theta_j) = \Psi^{JLP}(e_{i1}, \theta_i, s) + \psi^{JLP}(e_{i1}, s, \theta_j) V^{JLP}(e_{i2}, s)$

(b) $e_{i1}^k \in (0,1) \Rightarrow sign \frac{\partial e_{i1}^k}{\partial \omega} = sign \left[\frac{\partial^2 U^k(e_{i1}, e_{i2})}{\partial e_{i1} \partial \omega}\right]_{e_{i1}=e_{i1}^k, e_{i2}=e_{i2}^k}$, $\omega \in \{\theta_i, s, \theta_j\}$.

Proof. (a) From Proposition 1-d, we have identity

$$\left[\frac{\partial V^k(e_{i2})}{\partial e_{i2}}\right]_{e_{i2}=e_{i2}^k(s)} = 0. \tag{A.5}$$

Differentiating (A.5) respect to s gives

$$\left[\frac{\partial^2 V^k(e_{i2})}{\partial e_{i2}^2}\right]_{e_{i2}=e_{i2}^k} \frac{\partial e_{i2}^k}{\partial s} = -\left[\frac{\partial^2 V^k(e_{i2})}{\partial e_{i2} \partial s}\right]_{e_{i2}=e_{i2}^k}. \tag{A.6}$$

Part (a) then follows from (A.6) and Lemma 2-b.

(b) From Proposition 1-e, we have identity

$$\left[\frac{\partial U^k(e_{i1}, e_{i2})}{\partial e_{i1}}\right]_{e_{i1}=e_{i1}^k, e_{i2}=e_{i2}^k} = 0. \tag{A.7}$$

Differentiating (A.7) with respect to s gives

$$\left[\frac{\partial^2 U^k(e_{i1}, e_{i2})}{\partial e_{i1}^2}\right]_{e_{i1}=e_{i1}^k, e_{i2}=e_{i2}^k} \frac{\partial e_{i1}^k}{\partial s} + \left[\frac{\partial^2 U^k(e_{i1}, e_{i2})}{\partial e_{i1} \partial e_{i2}}\right]_{e_{i1}=e_{i1}^k, e_{i2}=e_{i2}^k} \frac{\partial e_{i2}^k}{\partial s}$$
$$= -\left[\frac{\partial^2 U^k(e_{i1}, e_{i2})}{\partial e_{i1} \partial s}\right]_{e_{i1}=e_{i1}^k, e_{i2}=e_{i2}^k}. \tag{A.8}$$

From row 2 of Table 11 and Proposition 1-d we get

$$\left[\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i1}\partial e_{i2}}\right]_{e_{i1}=e_{i1}^k,e_{i2}=e_{i2}^k}=0. \tag{A.9}$$

From (A.8) and (A.9) we get

$$\left[\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i1}^2}\right]_{e_{i1}=e_{i1}^k,e_{i2}=e_{i2}^k}\frac{\partial e_{i1}^k}{\partial s}=-\left[\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i1}\partial s}\right]_{e_{i1}=e_{i1}^k,e_{i2}=e_{i2}^k}. \tag{A.10}$$

From (A.10) and Lemma 2-c we get

$$sign\frac{\partial e_{i1}^k}{\partial s}=sign\left[\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i1}\partial s}\right]_{e_{i1}=e_{i1}^k,e_{i2}=e_{i2}^k}.$$

The case for θ_i and for θ_j are similar. This establishes part (b). □

Proof of Proposition 4 (Period 2)

(I) Comparing rows 9 and 10 of Table 12 we see that $V^{ILI}(e_{i2})=V^{JLI}(e_{i2})$. Hence, from the uniqueness of the optimum (Proposition 1-a), we get $e_{i2}^{ILI}=e_{i2}^{JLI}$. Similarly, comparing rows 11 and 12 of Table 12 we get $e_{i2}^{ILP}=e_{i2}^{JLP}$.

(II) From (A.4), row 9 of Table 11, and Lemma 3-a we get $\frac{\partial e_{i2}^k}{\partial s}\geq 0$ and, if $\overline{\mu}_i>0$, then $\frac{\partial e_{i2}^k}{\partial s}>0$ for $k=ILP,JLP$. This establishes part (a).

Since e_{i2}^k is an interior optimum we get, from row 5 and 7 of Table 10:

$$\frac{1}{2}[Y-L(1+r)]-c'\left(e_{i2}^{ILI}\right)=0, \tag{A.11}$$

$$\frac{1}{2}[Y-L(1+r)]-c'\left(e_{i2}^{ILP}\right)+\overline{\mu}_i\left[1-G_i^2\left(e_{i2}^{ILP}\mid s\right)\right]=0, \tag{A.12}$$

$$\frac{1}{2}[Y-L(1+r)]-c'\left(e_{i2}^{JLI}\right)=0, \tag{A.13}$$

$$\frac{1}{2}[Y-L(1+r)]-c'\left(e_{i2}^{JLP}\right)+\overline{\mu}_i\left[1-G_i^2\left(e_{i2}^{JLP}\mid s\right)\right]=0. \tag{A.14}$$

From (A.11) and (A.12), we get

$$c'\left(e_{i2}^{ILP}\right)=c'\left(e_{i2}^{ILI}\right)+\overline{\mu}_i\left[1-G_i^2\left(e_{i2}^{ILP}\mid s\right)\right]. \tag{A.15}$$

Since $G_i^2\left(e_{i2}^{ILP}\mid s\right)$ has full support (Assumption B3) and $e_{i2}^{ILP}\in(0,1)$, we get $G_i^2\left(e_{i2}^{ILP}\mid s\right)\in(0,1)$. Since $\overline{\mu}_i>0$ we get, from (A.15), that $c'\left(e_{i2}^{ILP}\right)>c'\left(e_{i2}^{ILI}\right)$. Since c' is strictly increasing (2.1), we get $e_{i2}^{ILP}>e_{i2}^{ILI}$. In a similar manner, we can derive $e_{i2}^{JLP}>e_{i2}^{JLI}$ from (A.13) and (A.14). This establishes part (b). □

Proof of Proposition 3 (Period 1)

(I) Suppose $e_{i1}^k\in(0,1)$.

(a) From (A.3) and row 3 of Table 11 we get that $\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i1}\partial\theta_i}\geq 0$ and that if $\mu_i>0$ then $\frac{\partial^2 U^k(e_{i1},e_{i2})}{\partial e_{i1}\partial\theta_i}>0$ under contracts JLI and JLP. The required results then follow from Lemma 3-b for $\omega=\theta_i$.

(b) The required results then follow from (A.1), row 7 of Table 11 and Lemma 3-b for $\omega = \theta_j$.

(c) Effect of μ_i and $\overline{\mu}_i$. Since $e_{i1}^k \in (0,1)$. From Proposition 1-e, rows 1-4 of Table 10, and rows 13-16 of Table 12, it follows that

$$\frac{1}{2}\left[Y - L\left(1+r\right)\right] - c'\left(e_{i1}^{ILI}\right) + \frac{1}{2}V^{ILI}\left(e_{i2}^{ILI}\right) = 0. \tag{A.16}$$

$$\frac{1}{2}\left[Y - L\left(1+r\right)\right] - c'\left(e_{i1}^{JLI}\right) + \mu_i\left[1 - F_i^2\left(e_{i1}^{JLI} \mid \theta_i\right)\right] + \frac{1}{2}Ep\left(e_{j1};\theta_j\right)V^{JLI}\left(e_{i2}^{JLI}\right) = 0. \tag{A.17}$$

$$\frac{1}{2}\left[Y - L\left(1+r\right)\right] - c'\left(e_{i1}^{ILP}\right) + \overline{\mu}_i\left[1 - G_i^2\left(e_{i1}^{ILP} \mid s\right)\right] + \frac{1}{2}V^{ILP}\left(e_{i2}^{ILP}, s\right) = 0. \tag{A.18}$$

$$\begin{aligned}\frac{1}{2}\left[Y - L\left(1+r\right)\right] - c'\left(e_{i1}^{JLP}\right) + \mu_i\left[1 - F_i^2\left(e_{i1}^{JLP} \mid \theta_i\right)\right] + \overline{\mu}_i\left[1 - G_i^2\left(e_{i1}^{JLP} \mid s\right)\right]&\\ + \frac{1}{2}Ep\left(e_{j1};\theta_j|s\right)V^{JLP}\left(e_{i2}^{JLP}, s\right) = 0.&\end{aligned} \tag{A.19}$$

From (A.16) and (A.17), we get

$$c'\left(e_{i1}^{ILI}\right) - c'\left(e_{i1}^{JLI}\right) = \frac{1}{2}V^{ILI}\left(e_{i2}^{ILI}\right) - \frac{1}{2}Ep\left(e_{j1};\theta_j\right)V^{JLI}\left(e_{i2}^{JLI}\right) - \mu_i\left[1 - F_i^2\left(e_{i1}^{JLI} \mid \theta_i\right)\right]. \tag{A.20}$$

From Proposition 4-I we have $e_{i2}^{ILI} = e_{i2}^{JLI}$ and, hence, $V^{ILI}\left(e_{i2}^{ILI}\right) = V^{JLI}\left(e_{i2}^{JLI}\right)$. Thus, (A.20) becomes

$$c'\left(e_{i1}^{ILI}\right) - c'\left(e_{i1}^{JLI}\right) = \frac{1}{2}\left[1 - Ep\left(e_{j1};\theta_j\right)\right]V^{ILI}\left(e_{i2}^{ILI}\right) - \mu_i\left[1 - F_i^2\left(e_{i1}^{JLI} \mid \theta_i\right)\right]. \tag{A.21}$$

From (2.8) and Proposition 1-c we get that $\frac{1}{2}\left[1 - Ep\left(e_{j1};\theta_j\right)\right]V^{ILI}\left(e_{i2}^{JLI}, s\right) > 0$. Hence, if $\mu_i = 0$, then, from (A.21), we get $c'\left(e_{i1}^{ILI}\right) > c'\left(e_{i1}^{JLI}\right)$. Since c' is strictly increasing (2.1), we must have $e_{i1}^{ILI} > e_{i1}^{JLI}$. Therefore, if $e_{i1}^{ILI} \le e_{i1}^{JLI}$, then, necessarily, $\mu_i > 0$. This establishes part (i).

If $\overline{\mu}_i = 0$, then from (2.10) and rows 1,3,5,7,9,11,13,15 of Table 12, we see that $U^{ILI} = U^{ILP}$. Since the optima are unique (Proposition 1-b), we get $e_{i1}^{ILI} = e_{i1}^{ILP}$. Therefore, if $e_{i1}^{ILI} < e_{i1}^{ILP}$, then, necessarily, $\overline{\mu}_i > 0$. This establishes part (ii).

(II) Comparing period 1 and period 2 effort levels.

Since $e_{i2}^k \in (0,1)$ we get, from rows 5 and 7 of Table 10, and Proposition 1-d:

$$c'\left(e_{i2}^k\right) = \frac{1}{2}\left[Y - L\left(1+r\right)\right] + \left(T_{ILP} + T_{JLP}\right)\overline{\mu}_i\left[1 - G_i^2\left(e_{i2}^k \mid s\right)\right]. \tag{A.22}$$

Assume that

$$e_{i2}^k \ge e_{i1}^k. \tag{A.23}$$

Since $e_{i1}^k \in (0,1)$ we get, from Lemma 2-c and Proposition 1-e,

$$\left[\frac{\partial U^k\left(e_{i1}, e_{i2}\right)}{\partial e_{i1}}\right]_{e_{i1}=e_{i2}^k, e_{i2}=e_{i2}^k} \le 0. \tag{A.24}$$

From rows 1-4 of Table 10 and (A.24), we get

$$\frac{1}{2}\left[Y-L\left(1+r\right)\right]-c'\left(e_{i2}^{k}\right)+\mu_i\left(T_{JLI}+T_{JLP}\right)\left[1-F_i^2\left(e_{i2}^{k}\mid\theta_i\right)\right]$$
$$+\overline{\mu}_i\left(T_{ILP}+T_{JLP}\right)\left[1-G_i^2\left(e_{i2}^{k}\mid s\right)\right]$$
$$+\frac{1}{2}V^k\left(e_{i2}^{k},s\right)\left[T_{ILI}+T_{ILP}+T_{JLI}Ep\left(e_{j1};\theta_j\right)+T_{JLP}Ep\left(e_{j1};\theta_j|s\right)\right]\leq 0. \quad (A.25)$$

From (A.22) and (A.25), we get

$$\mu_i\left(T_{JLI}+T_{JLP}\right)\left[1-F_i^2\left(e_{i2}^{k}\mid\theta_i\right)\right]$$
$$+\frac{1}{2}V^k\left(e_{i2}^{k},s\right)\left[T_{ILI}+T_{ILP}+T_{JLI}Ep\left(e_{j1};\theta_j\right)+T_{JLP}Ep\left(e_{j1};\theta_j|s\right)\right]\leq 0. \quad (A.26)$$

However, from (2.7) and Proposition 1-c, we have

$$V^k\left(e_{i2}^{k},s\right)\left[T_{ILI}+T_{ILP}+T_{JLI}Ep\left(e_{j1};\theta_j\right)+T_{JLP}Ep\left(e_{j1};\theta_j|s\right)\right]>0. \quad (A.27)$$

Since $\mu_i\left(T_{JLI}+T_{JLP}\right)\left[1-F_i^2\left(e_{i2}^{k}\mid\theta_i\right)\right]\geq 0$, (A.26) and (A.27) together give $0>0$, which cannot be. Hence, our starting assumption (A.23) is false. Hence, $e_{i2}^{k}<e_{i1}^{k}$. This establishes part (II). □

Proof of Proposition 2 (Baseline Case)

$e_{i1}^{JLI}<e_{i1}^{ILI}$ follow from Proposition 3-II-c-i for the special case $\mu_i=0$.

For $e_{i1}^{JLP}<e_{i1}^{ILP}$, from (A.18) and (A.19), we get

$$c'\left(e_{i1}^{ILP}\right)-c'\left(e_{i1}^{JLP}\right)=\overline{\mu}_i\left[G_i^2\left(e_{i1}^{JLP}\mid s\right)-G_i^2\left(e_{i1}^{ILP}\mid s\right)\right]$$
$$+\frac{1}{2}\left[V^{ILP}\left(e_{i2}^{ILP},s\right)-Ep\left(e_{j1};\theta_j|s\right)V^{JLP}\left(e_{i2}^{JLP},s\right)\right]-\mu_i\left[1-F_i^2\left(e_{i1}^{JLP}\mid\theta_i\right)\right]. \quad (A.28)$$

From Proposition 4-I we know that $e_{i2}^{ILP}=e_{i2}^{JLP}$ and, hence, $V^{ILP}\left(e_{i2}^{ILP},s\right)=V^{JLP}\left(e_{i2}^{JLP},s\right)$. From (A.28), we then get

$$c'\left(e_{i1}^{ILP}\right)-c'\left(e_{i1}^{JLP}\right)=\overline{\mu}_i\left[G_i^2\left(e_{i1}^{JLP}\mid s\right)-G_i^2\left(e_{i1}^{ILP}\mid s\right)\right]$$
$$+\frac{1}{2}\left[1-Ep\left(e_{j1};\theta_j|s\right)\right]V^{ILP}\left(e_{i2}^{ILP},s\right)-\mu_i\left[1-F_i^2\left(e_{i1}^{JLP}\mid\theta_i\right)\right]. \quad (A.29)$$

For $\mu_i=\overline{\mu}_i=0$, (A.29) gives

$$c'\left(e_{i1}^{ILP}\right)-c'\left(e_{i1}^{JLP}\right)=\frac{1}{2}\left[1-Ep\left(e_{j1};\theta_j|s\right)\right]V^{ILP}\left(e_{i2}^{ILP},s\right). \quad (A.30)$$

From (2.8), Proposition 1-c and (A.30), we get $c'\left(e_{i1}^{ILP}\right)>c'\left(e_{i1}^{JLP}\right)$. From (2.1), c' is strictly increasing. Hence, $e_{i1}^{ILP}>e_{i1}^{JLP}$. □

Appendix B : Tables

Table B1: Baseline Characteristics

Contract	Age	Education	No of Loans	Type of Loan IL/GL	%Male	%Married	N
ILI	35.37	9.22	3.19	54/46	98	85	100
	(8.89)	(3.48)	(2.37)				
JLI	33.75	9.09	2.92	57/43	98	74	100
	(9.10)	(3.46)	(2.56)				
ILP	32.79	9.25	3.24	57/43	98	74	100
	(8.43)	(3.56)	(3.47)				
JLP	33.84	8.32	3.26	59/41	97	80	100
	(8.90)	(3.70)	(2.94)				
Combined	33.94	8.97	3.15	57/43	98	78	400
	(8.85)	(3.56)	(2.86)				
Absolute Standardized Differences							
ILI vs JLI	0.180	0.037	0.109	0.060	0.000	0.273	
ILI vs ILP	0.298	0.009	0.017	0.060	0.000	0.273	
ILI vs JLP	0.172	0.251	0.026	0.110	0.063	0.131	
JLI vs ILP	0.109	0.046	0.105	0.000	0.000	0.000	
JLI vs JLP	0.010	0.215	0.123	0.044	0.063	0.142	
ILP vs JLP	0.121	0.256	0.006	0.044	0.063	0.142	

Notes: Standard deviations in parentheses. IL/GL refers to ratio of individual loan borrowers to group loan.

Table B2: Determinants of Effort in Joint Liability Contracts

Dependent Variable	1^{st} period effort in *JLI* & *JLP*			
Model No.	1	2	3	4
Public	-1.36^{***}	-0.82^{***}	-0.44	
	(0.27)	(0.27)	(1.41)	
Signal (θ_i)		0.29^{***}	0.49^{***}	0.51^{***}
		(0.08)	(0.11)	(0.11)
FOB (θ_j)		0.66^{***}	0.56^{***}	0.58^{***}
		(0.12)	(0.14)	(0.12)
SignalPub			-0.40^{***}	-0.43^{***}
			(0.14)	(0.13)
FOBPub			0.32^{*}	0.29^{**}
			(0.20)	(0.13)
con_1	-4.35	0.48	0.72	1.03
	(0.43)	(0.71)	(1.19)	(0.62)
con_2	-3.81	1.22	1.59	1.88
	(0.36)	(0.70)	(1.18)	(0.69)
con_3	-3.53	1.66	2.06	2.35
	(0.33)	(0.73)	(1.18)	(0.75)
con_4	-2.18	3.55	4.07	4.33
	(0.27)	(0.83)	(1.17)	(0.84)
con_5	-0.98	5.13	5.70	5.96
	(0.23)	(0.88)	(1.21)	(0.92)
con_6	0.29	6.79	7.44	7.70
	(0.21)	(0.94)	(1.27)	(0.99)
con_7	1.11	7.92	8.59	8.86
	(0.23)	(0.99)	(1.33)	(1.05)
con_8	1.28	8.17	8.83	9.10
	(0.24)	(1.01)	(1.35)	(1.07)
AIC	723.12	627.35	618.36	616.50
BIC	752.80	663.63	661.24	656.08
Log Likelihood	-352.56	-302.68	-269.18	-296.25

Notes: Ordered logit estimates of equation (5.2). Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. $N = 200$.