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

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Abstract

Microfinance contracts have enormous economic and welfare significance. We study, theoretically and empirically, the problem of effort choice under individual liability (*IL*) and joint liability (*JL*) contracts when loan repayments are made either privately, or publicly in front of one's social group. Our theoretical model identifies guilt from letting down the expectations of partners in a *JL* contract, and shame from falling short of normatively inadequate effort, 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, which is consistent with recent empirical results. This indicates that shame-aversion plays a more important role as compared to guilt-aversion. Under *IL*, repayment in public relative to private repayment increases effort by 60%, confirming our shame-aversion hypothesis. Under *JL*, a comparison of private and public repayment shows that shame trumps guilt in explaining effort choices of borrowers.

Keywords: Microfinance; joint/individual liability; public/private repayment; belief-dependent motivations; guilt; shame; peer pressure; social capital; lab-in-the-field experiment

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

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We still seem to be missing the right experiment here, and I am not entirely sure what that would be...it is entirely possible that the theory is missing something essential. On the theoretical side, the idea that behavioral issues are key to understanding borrower and lender behavior is in the air... Banerjee (2013, p. 494, 495, 514).

The best evidence will come from well-designed, deliberate experiments in which loan contracts are varied but everything else is kept the same... Armendariz and Morduch (2010, p. 114).

1 Introduction

Microfinance is a hugely significant economic activity; the 2016 data from BNP PARIBAS reveals 123 million customers worldwide who receive 102 billion US dollars worth of loans. Microfinance institutions (MFIs) offer relatively small, short-term, loans to borrowers who lack collateral to borrow from the conventional banking sector. Despite impressive advances in the theoretical and empirical literature, several outstanding issues remain unresolved (Banerjee, 2013). For instance, borrowers typically engage in risky projects, but the risk can be mitigated by greater effort that improves the probability of success of the projects. However, we know little about the determinants of effort and repayment decisions by borrowers. This paper studies, theoretically and experimentally, the factors that underpin borrowers' effort choices and repayment rates under different microfinance contracts.

Two main 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 can get a future loan if, and only if, he/she repays the current loan. Under *JL* contracts, groups of borrowers borrow jointly; any borrower in the group qualifies for a future loan if, and only if, all group members repay the current loan. Group members may pursue their individual, possibly independent, projects; there is no requirement to work on a joint project (production independence, but contractual dependence).[2]

The Grameen Bank in Bangladesh and its founder Mohammed Yunus broke new ground by successfully lending to poor borrowers and achieving high repayment rates (99.6% in 2016); they also won the 2006 Nobel Peace Prize. The success of the Grameen Bank was associated with the joint liability feature of the contract. The contract also included other features such as *public repayment meetings*,[3] small weekly repayments of loans, and the requirement of regular

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

[2]This description abstracts from other features of these contracts such as the weekly loan repayment. In the case of frequent payments, group members in a *JL* contract may pay for each other if needed, providing mutual insurance. However, there is no presumption that over the entire duration of a loan, group members must pay a net balance towards the contributions of others. For these and other features of such contracts, see Armendáriz and Morduch (2010, Chapter 4). 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]Under *public repayment*, the loan repayments are made in front of one's relevant social group. By contrast,

savings deposits. This contractual package is known as *Grameen-I*. In recent years, there has been a surge in *IL* contracts; this has been associated with the transformation of Grameen-I into *Grameen-II*. In Grameen-II, the joint liability requirement was dropped, but repayment in public meetings was retained from Grameen-I (Rai and Sjöström, 2013). The Grameen Bank continued to flourish under the new contractual arrangements.

The success of *JL* contracts in Grameen-I (when *IL* contracts were available), and the success of *IL* contracts in Grameen-II (when *JL* contracts were available), is not straightforward to explain. In the basic neoclassical model, borrowers in *JL* contracts should ignore the positive externality that they create for others (greater own effort improves chances of loan repayment of all borrowers in the group). This begs the question of why *JL* contracts were chosen in Grameen-I.

The theoretical literature on microfinance has justified the existence of *JL* contracts by addressing information and enforcement concerns (Ghatak and Guinnane, 1999). Under adverse selection, if borrowers can observe each others' risk types, *assortative matching* ensures low-risk types match with each other in a *JL* contract (Ghatak, 1999, 2000; Van Tassel, 1999). This sorting advantage of *JL* contracts enables banks to offer lower interest rates and ensures relatively higher repayment. Despite its undeniable importance, adverse selection does not play any role in our analysis. Another strand of the literature deals with moral hazard issues. MFIs may not observe a borrower's effort level, but borrowers may observe signals of each other's effort levels. This enables them to exert *peer pressure* and *social sanctions* on each other in *JL* contracts in order to induce greater effort. Borrowers can then, through private monitoring and enforcement, ensure a relatively greater repayment rate under *JL* contacts (Stiglitz, 1990; Besley and Coate, 1995) and ensure that their partners undertake less risky projects (Banerjee et al., 1994).[4] Our analysis is closely tied to models of moral hazard.

The empirical evidence on the effectiveness of joint liability is mixed. Thus far, the clearest test of the efficacy of joint liability relative to individual liability contracts comes from Giné and Karlan (2014) in the Philippines. In their first experiment, the authors compare the repayment performance of borrowers by randomly switching half of the *JL* lending centers to *IL* contracts. They find no significant difference in default rates. However, in both cases, repayments were made in public. It is not clear if the comparable default rates in the two contracts were due to *assortative matching* in the switched borrowers before the conversion to *IL* contracts or the anticipation of a loss of social capital from defaulting under the public repayment method. Carpena et al. (2013) report data from India on missed payments (but not defaults) in the opposite direction, a switch from *IL* to *JL* loans, and find a significant reduction in missed payments in *JL* loans. However,

under *private repayment*, the loan repayment between a borrower and the lender is not observed by a third party. This distinction plays a critical role in our explanation of contractual choices and effort levels.

[4]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.

this switch was also accompanied by changes in the interest rate; the amount of the loan; and the instalment amounts. Loans repayments were made using the private repayment method. Attanasio et al. (2015) compare default rates in *JL* loans relative to *IL* loans in Mongolia under private loan repayment. They find no difference in default rates, albeit *IL* loans were larger in magnitude; most *IL* loans (92%) were collateralized; and *JL* loans had shorter maturity. These selection and endogeneity issues may lead to differences in the outcomes between the *JL* and *IL* contracts whose source might be hard to pinpoint and lead to unwarranted inferences. Although many of these issues are unavoidable, they lead to difficulties in interpreting the field data and in determining the relative efficacy of *JL* and *IL* contracts.

The limitations of field studies may be addressed by controlled lab experiments in the field with actual microfinance borrowers. Such lab experiments have been used to examine the degree of riskiness under *JL* and *IL* contracts (Giné et al., 2010) and the degree of risk-taking (Fischer, 2013). However, neither field studies, nor experimental studies, nor lab-in-the-field experiments have been used to compare, jointly, the repayment rates and effort levels in *IL*/*JL* contracts, or to study the determinants of effort, or to study the implications of public repayment of loans.

From our perspective, the most important observation is that Grameen-II has retained the crucial feature of *repayments in public group meetings* from Grameen-I. Thus, potential non-repayment of loans in front of one's social network is likely to invite *public shame*. While this critical feature has been recognized (Giné and Karlan, 2014), it plays no formal role in the literature, but it plays a central role in our analysis. Similarly, in the existing literature, peer pressure and social sanctions are either not formally defined, or they are introduced in a reduced form manner without specifying the exact empirical counterparts/proxies (e.g., Besley and Coate, 1995; de Quidt et al., 2016). Other papers offer plausible, but not formal, definitions of these concepts to explain the data (Giné and Karlan, 2014). This gives rise to great difficulties in comparing results across different studies.[5] Perhaps, for this reason, Banerjee (2013, p. 492) cautions: "The danger here is that we may not find what we were looking for and may mistakenly conclude that it is not there." In our analysis, peer pressure is formally defined and tested through the guilt-aversion motive.

A central focus of our paper is to address the opening quotes from Banerjee (2013) and Armendáriz and Morduch (2010). We believe that this requires a two-pronged approach. First, we need to construct a theoretical model that is able to provide rigorous microfoundations for commonly used constructs in the microfinance literature, such as peer pressure and social capital. In particular, the model needs to make predictions for the individual determinants of effort levels/repayment across various contractual forms. Second, we need to stringently test the pre-

[5]Different proxies are used for social capital. Group membership, e.g., acquaintances, strangers, all-female, friends (Wydick, 1999); whether subjects registered for the experiment singly or in groups (Abbink et al., 2006); 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.

dictions of this model using a lab-in-the-field experiment with actual microfinance borrowers. In particular, we need to ensure that the only variation across the treatments should be in the contractual forms offered while keeping the rest of the economic environment unchanged. Microfinance borrowers should then be randomly assigned to different treatments. The objective of our paper is to provide such an approach.

1.1 Psychological motivations in individual behavior

The evidence on human cognitive evolution suggests that a process of *self-domestication* has provided humans with a *norm psychology*. In this process, humans have evolved to (1) conform to the *normative expectations* of their social group, (2) interpret others' behavior as being influenced by social norms, (3) punish those who violate norms, and (4) internalize norms as goals (Henrich, 2016; Gintis, 2017; Hare, 2017). Over time, humans also developed emotions such as *shame* to ensure norm conformity, and *guilt* to mediate social interaction (Bowles and Gintis, 2003; Fessler, 2007). Kandel and Lazear (1992) argue that guilt and shame differ along the dimension of internal/external pressure. They classify peer pressure as *internal*, which arises from guilt by hurting (or letting down) others, even if third parties cannot identify the offender. On the other hand, shame arises from *external pressure*, such as from the act of norm violation, which is observed by the rest of the social group that might sanction the actions of others; this operationalizes social capital.

To rigorously formalize these insights with an explicit consideration of beliefs, we employ the machinery of *psychological game theory* (Geanakoplos et al., 1989; Battigalli and Dufwenberg, 2009). In this framework, beliefs about others and 'beliefs about the beliefs of others' directly enter into the utility function. This allows us to undertake a formal analysis of the emotions of *guilt* and *shame* that underpin, respectively, peer pressure and social capital. The example below shows how peer pressure works in our model.

Example 1 *(The role of guilt-aversion/surprise-seeking in fostering effort in JL contracts): An MFI enters into an IL contract with Irene and a two-person JL contract with Gill and a partner. Gill forms expectations of her partner's actual effort level (Gill's first-order positive beliefs). Gill also receives a private signal θ from her partner on the effort level that the partner expects from Gill, capturing diverse real-world mechanisms that partners use to exert peer pressure on other group members. Gill uses the private signal to form conditional second-order beliefs about the partner's first-order beliefs. If Gill is guilt-averse, she might feel guilty from exerting effort below that which she believes is expected of her by her partner. This gives rise to the guilt-aversion motive (Battigalli and Dufwenberg, 2007). The flip side of guilt-aversion, the surprise-seeking motive, arises when Gill derives extra utility from putting an effort level higher than the private signal (Khalmetski et al., 2015). Guilt-aversion/surprise-seeking, the analogues of internal peer pressure in Kandel and Lazear (1992), both may induce Gill to increase her effort in a JL contract.*

In contrast, for Irene, the fulfilment of her contract does not require interaction with anyone else, so she might lack the extra motivations to put in the extra effort that Gill has. However, the situation is more nuanced when we compare private versus public repayment of loans below.

As noted earlier, *public repayment* of loans is an important feature in Grameen-I and II. The next example shows how this is essential in capturing shame (which we formally define later) and represents social capital or external pressure in the sense of Kandel and Lazear (1992). By contrast, in the existing literature, repayments are either on an individual basis (one to one between the borrower and the MFI), which we term *private repayments*, or if they are public repayments, it does not matter for the predictions because shame is not formally introduced in these models.

Example 2 *(Private or public repayment: shame-aversion/approval-seeking): Peter and Norma enter into IL contracts with different MFIs. The contract requires Peter to make a private repayment, and Norma to make a public repayment. Norma also observes (a) a social signal s of the level of effort others in her social group believe is appropriate for her to exert (normative expectations*[6]*), and (b) the actual effort level of others in her social group (empirical expectations). As noted in Bicchieri (2006), normative and empirical expectations play a central role in norm compliance. Assume also that the normative and empirical expectations are aligned.*[7]

Peter does not anticipate any shame from defaulting on his loan repayment, even if he were shame-averse. However, if Norma is shame-averse, she anticipates disutility from shame by letting down the normative expectations of her social group in the event she shirks on her project. This is particularly the case when her shirking becomes common knowledge in her group, and her group can sanction her (Fessler, 2004; Bicchieri, 2006; Elster, 2011). Anticipating this, she puts in greater effort and is more likely to repay her loan than Peter. Norma might even wish to exceed the normative expectations, s, of her social group (the flip side of shame-aversion), i.e., she might be approval-seeking.

Internal peer pressure in the form of guilt-aversion/surprise-seeking has been used before (Charness and Dufwenberg, 2006; Khalmetski et al., 2015; Dhami et al., 2019). However, our formal treatment of external pressure in the form of shame-aversion/approval-seeking is a novel feature of our model that is based squarely on the theory of social norms (Bicchieri, 2006; Elster, 2011).

[6] By contrast, the 'positive expectations' in Example 1 are expectations about the effort one expects others to 'actually' undertake.

[7] 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 if, as in our case, the two expectations are aligned. For the theory, references, and other examples see Bicchieri (2006) and Dhami (2019, Section 5.7).

Table 1: Emotions and signals in four contracts in both periods.

Repayment / Liability	Individual (I) Unobservable to a third party	Public (P) Observable to a third party
First-period Contracts		
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/Approval 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/Surprise Private Signal θ_i No Public Signal	***JLP*** Guilt/Surprise & Shame/Approval Private Signal θ_i Public Signal s
Second-period Contracts		
Individual Liability (IL) Only individual liability loans in the 2^{nd} period.	***ILI*** Emotions absent No Private Signal No Public Signal	***ILP*** Shame/Approval No Private Signal Public Signal s

1.2 Our approach

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, privately on an individual basis (I) or publicly in a group (P). This gives rise to four different contracts shown in Table 1: *ILI* (individual liability, individual repayment), *ILP* (individual liability, public repayment), *JLI* (joint liability, individual repayment), *JLP* (joint liability, public repayment).

We examine the levels of effort and repayment rates within a two-period microfinance game with moral hazard. Players undertake independent, but identical, risky projects that are more likely to succeed if they put in a higher level of costly effort, which is not observed by the lender. All projects have identical loan amounts and interest rates that allow for a strict comparison between the contracts. In choosing the first-period effort, players can take account of the consequences for second-period loans. In *IL* contracts, second-period loans are given only if the borrower repays the first-period loan, while in *JL* contracts all group members must repay their first-period loans for each of them to qualify for a second-period loan (dynamic incentives). In the second period, there are no future consequences of current actions; hence, the second period of a *JL* loan is effectively identical to that of an *IL* loan. Yet, public repayment in the second period, in which low effort may invite social disapproval, continues to play an important role in contracts *ILP* and *JLP*.

In the baseline contract *ILI*, there is neither joint liability nor public repayment, so emotions play no role (see Table 1). The *ILP* contract activates the emotion of shame-aversion and its flip side, approval-seeking; there is no private signal, but there is a social signal, s (as in Norma's behavior in Example 2). The *JLI* contract, in the presence of a private signal θ, activates the emotions of guilt-aversion and surprise-seeking, that arise in joint liability contracts and captures *internal peer pressure* (as in Gill's behavior in Example 1). The *JLP* contract, the most psychologically rich contract, activates the emotions of guilt-aversion/surprise-seeking generated through the private signal θ (from the joint liability aspect) and shame-aversion/approval-seeking from the social signal s (from the public repayment aspect). An interesting question that arises in this contract is the relative roles played by internal and external peer pressure. We address this question in our empirical results; see also Example 3 below.

The pairwise contrasts between the contracts allow us to determine the endogenous effects of *internal peer pressure* and *external social capital.* (i) Keeping fixed the liability structure but varying the mode of repayment, each of the two contrasts *ILI vs. ILP* and *JLI vs. JLP* determines the effects of social capital alone. (ii) Keeping fixed the mode of repayment but varying the liability structure, each of the two contrasts *ILI vs. JLI* and *ILP vs. JLP* determines the effects of peer pressure alone. (iii) Changing the liability structure and the mode of repayment, the contrast *JLI vs. ILP* is mediated by the effects of both peer pressure and social capital.

Our psychological model requires that borrowers play a psychological best response to their beliefs.[8] 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] For this reason, in Section 9, we briefly consider *heuristics-based effort choices.* The next example shows how microfinance borrowers might use simple heuristics.

Example 3 *(Using Heuristics to Make Decisions): Hugh follows simple heuristics in making decisions and enters into a JLP contract with an MFI. He receives a private signal, θ, of the level of effort that his partner in the JLP contract expects him to "actually" undertake. He also receives a social signal, s, which gives the normative expectations of the social group about the effort level that Hugh "ought" to undertake. Hugh is particularly deterred by the social disapproval of his group, on account of shame aversion, which arises from choosing effort below the social signal, s. So, he uses a simple rule of thumb and matches the normative expectations, s of his*

[8]The main solution method in theoretical work in psychological game theory relies on players playing the best response to their beliefs and the mutual consistency of beliefs and actions. However, while players may play a best response to their beliefs in the early rounds of most games, the evidence shows that consistency between beliefs and equilibrium actions required in variations of sequential Nash equilibrium does not hold. For useful surveys of the evidence, see Crawford (2018), Mauersberger and Nagel (2018), Dhami (2016, Part 4) and Camerer (2003). See also Bellemare et al. (2011) who show a lack of consistency between actions, first-order beliefs, and second-order beliefs.

[9]The seminal paper is Tversky and Kahneman (1974). Useful surveys can also be found in Kahneman et al. (1982) and Dhami (2016, Part 7). For a recent survey which contrasts the Kahneman-Tvesky approach with that of the approach of Gerd Gigerenzer, see Dhami et al. (2018). Some examples of recent attempts to use heuristics include the explanation of several results from static games (al Nowaihi and Dhami, 2015) and bidding behavior in common value auctions (Charness et al., 2019).

group. Even if $\theta > s$ (i.e., his partner wishes him to put in a level of effort greater than s), Hugh believes that ex-post, he will be able to justify his choice of effort (equal to s) as being socially appropriate.

If, on the other hand, Hugh were to take a JLI loan from the MFI, there is no social signal and he only receives a private signal, θ, from his partner. In this case, if θ is not unreasonably high, he uses a simple heuristic of putting in an effort level equal to θ in order to avoid guilt from letting down his partner's expectations. Indeed, many of our subjects behave just like Hugh.

To test the predictions of our model, we conducted a lab-in-the-field experiment with 400 microfinance borrowers in 10 rural towns in Punjab, Pakistan. Our subjects were active borrowers of the National Rural Support Program (NRSP) Microfinance Bank and had, on average, taken three loans in the past. In each session, 40 subjects were randomly assigned to 4 different treatments, *ILI*, *ILP*, *JLI*, and *JLP*, as described in Table 1. In our experiments, we use the same interest rate that these subjects actually face from the NRSP Microfinance Bank, and our specification of *JL* contracts is also similar to the contractual terms they face.

1.3 Results

Our experimental results confirm the importance of psychological motives. The guilt-aversion/surprise-seeking motive is important in *JLI* contracts; and the shame-aversion/approval-seeking motive is vital in the public repayment contracts, *ILP* and *JLP*. The effects of these psychological motives persist even in the second period of our two-period model when there are no future consequences of current actions. We summarize our results as follows.

1.3.1 First-period comparisons

The contrast between the two liability structures under individual repayment (*ILI vs. JLI*) shows that the average effort under *JLI* is almost double relative to *ILI*, and the repayment rate is higher by 33%. We find a strong causal effect of the signals of the partner's first-order beliefs, θ_i, on effort in *JLI*; this is indicative of guilt aversion or internal peer pressure.

Under public repayment, the liability structure (*ILP vs. JLP*) has no significant effect on effort and repayment rate. The average effort decisions in both treatments almost exactly matched the social signal, s (as in Hugh's behavior in Example 3). Thus, preferences for shame-aversion or norm compliance alone, even without joint liability, are effective in ensuring high effort and loan repayment. This may potentially explain why Grameen-II retained public repayment but reduced reliance on joint liability. If effort provision and repayment rates are similar under the two contracts, then borrowers can be freed from the restrictive conditions of joint liability; see also Giné and Karlan (2014) for a similar conjecture. Given the heterogeneity in choices, this effect may well arise from some subjects playing the best responses to their beliefs and others using simple heuristics.

The contrast between private and public repayment under individual liability contracts (*ILI vs. ILP*) shows that public repayment alone increases effort by 60% and the repayment rate by 23%, confirming our norm-compliance hypothesis and the importance of shame-aversion (and, hence, also the importance of social capital). The same comparison between joint liability contracts (*JLI vs. JLP*) shows that shame-aversion is extremely efficacious. Lending credence to the "shame-aversion trumps guilt-aversion" idea in Example 3, the effect of the private signal, θ, which had a strong causal effect on effort in contract *JLI*, is close to zero in *JLP*.

Finally, our 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. In particular, *ILP* which most closely characterizes Grameen-II is equally effective in ensuring high effort, and offers even higher take-up of loans in the second period by giving up the restrictive borrowing conditions (all borrowers in a group must simultaneously succeed) of joint liability.

Our results above have two implications for contractual choices by banks. (1) Under public repayment, given the more restrictive borrowing conditions under *JLP* contracts, the bank may prefer the *ILP* contract. (2) Under private repayments, the bank will prefer a *JLI* contract to an *ILI* contract.

1.3.2 Second-period comparisons

Our theoretical predictions under *ILI* and *JLI* contracts are identical in the second period. However, we find that the average effort in *JLI* is 120% higher than *ILI*. This indicates that the effort differences from the first period persist in the second period even when the second-period game is identical and, additionally, has no future or interpersonal consequences. The comparison between the contracts *ILP* and *JLP*, where shame-aversion continues to be an effective mechanism due to public repayments, shows no significant difference in effort levels and repayment rates.

Varying only the mode of repayment, we find that, on average, subjects chose 12% higher effort under public repayment (*ILP* and *JLP*) relative to private repayment (*ILI* and *JLI*). However, keeping fixed the liability structure and varying the mode of repayment gives a more nuanced result. The effort in the *ILP* contract is 88% higher relative to the *ILI* contract. However, the average effort is 19% lower in *JLP* contracts relative to the *JLI*. This can be accounted for by a lower value of the normative signal, s, in the *JLP* contract, relative to the average private signal, θ, in the *JLI* contract (see, for instance, the intuition in Example 3).

Intertemporal comparisons show that the overwhelming majority of the subjects chose the same or higher effort in the second period relative to the first period. This evidence is not supportive of the optimization approach in both classical and psychological models and suggests a form of anchoring, which is a robust heuristic (see Section 9).

1.4 Plan of the paper

Section 2 formulates the psychological model. Section 3 analyses the optimization problem faced by the agent. Section 4 gives the comparative static results of our model. Sharper results can be derived when there are no psychological motives, as in the classical model; Section 5 is devoted to this. Proofs are contained in Appendix A. Section 6 presents the experimental design. Experimental results and their analysis are given in Section 7. Section 8 contrasts our approach to the standard game-theoretic approach with incomplete information. Section 9 briefly discusses an alternative approach based on heuristics that organizes the evidence relatively well. Section 10 concludes.

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 $t = 1, 2$. Sometimes when we denote an agent by $i = 1, 2$, then we shall denote the other agent by j, $i \neq j$. The bank and the two agents are risk-neutral, expected utility maximizers, and there is no time discounting.[10] The endowments of both agents and their outside options, in each period, are assumed to be zero.

2.1 Production technology of a project

In each time period, $t = 1, 2$, each agent has access (provided a bank loan is received) 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

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

   Moral hazard arises because the effort level is observed by the borrower but not by the lender.

2. *Project outputs*: The outcome of the project is risky. It succeeds with probability $p(e_{it})$, and yields revenue Y, where

$$Y > L(1+r). \tag{2.2}$$

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

The borrower can repay the loan in this case. It 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 this case. 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, $e_{it} \in [0, 1]$, exerted by the agent, increases the success probability, p. We assume a linear form for p in our experiments

$$p(e_{it}) = \frac{1 + e_{it}}{2} \in [0.5, 1], \; p'(e_{it}) = \frac{1}{2} > 0, \; e_{it} \in [0, 1]. \tag{2.3}$$

2.2 Banking technology

The bank does not observe the effort level of the borrower (moral hazard). But it does observe the outcome of the project, success or failure, 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*.[11] If the project fails, the bank gets no repayment on account 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 any one of four types of contracts described in the introduction (see Table 1).

1. **Individual liability with individual 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 agent.

2. **Individual liability with public repayment (*ILP*)**. This is the same as *ILI*, except that repayment or default occurs in public and can be observed by other individuals such as other members of one's social network.[13]

3. **Joint liability with individual repayment (*JLI*)**. In the first period, the bank offers a loan, L, to each of two agents in the joint liability contract. If *both* agents repay the loan and interest, $L(1 + r)$, only then do they receive a second period loan from the bank. If one or the other (or both) of the agents fail to repay, then the bank does not offer a

[11] For issues of strategic default, see Besley and Coate, 1995; Banerjee, 2013, p. 490.

[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 in a developing country. Or whether the banks may have been instructed by the government to provide subsidized loans to microfinance borrowers, sometimes even below costs.

[13] The motivation behind this mode of repayment is that in order to economize on transaction costs, most loan officers in developing countries visit specified areas at discrete intervals of time. At this point, all the borrowers in the area are assembled in one place and their repayment decisions, repay or default, are observed *publicly* by others too.

second-period loan to either. As in *ILI*, whether an agent repays or defaults is private knowledge to the bank and agents.

4. **Joint liability with public repayment (*JLP*)**. This is the same as *JLI*, except that repayment or default occurs in public.

Hence, from (2.3), the probability that an agent gets a second-period loan is given by

$$p(e_{i1}, e_{j1}) = \begin{cases} \frac{1+e_{i1}}{2} & \text{contracts } ILI,\ ILP \\ \frac{1+e_{i1}}{2}\frac{1+e_{j1}}{2},\ i \neq j & \text{contracts } JLI,\ JLP. \end{cases} \tag{2.4}$$

We assume that in joint liability contracts (*JLI* and *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,[14] but (2) they cannot produce verifiable information to a third party.[15] The bank cannot observe the effort levels of agents.

As explained in the introduction, the different contracts elicit various emotions such as *guilt-aversion/surprise-seeking* and *shame-aversion/approval-seeking*. However, the agents experience no guilt or shame with respect to the bank. The evidence suggests that these psychological motives arise in human-human interactions (Dhami, 2016, Section 13.5 and Part 6). To the best of our knowledge, there is no persuasive evidence of the importance of these motives in human-institution interactions.

Remark 1 *In a two-period model, there is no future beyond period $t = 2$, hence joint liability contracts can only be offered in period 1. Thus, if both agents in a joint liability contract are successful in their first-period projects, then they get individual liability loans in the second period. For this reason, all second-period contracts are effectively individual liability contracts (see Table 1). If agents lack any emotions and are purely motivated by economic calculus, then we should expect second period behavior in joint liability contracts to be indistinguishable from individual liability contracts.*

2.3 Single period monetary payoffs from the project

If the bank decides to give a loan L to an agent i who chooses effort e_{it} in period t, then the net of cost monetary payoffs of the agent, $M(e_{it})$, are as follows.

$$\begin{cases} \text{Success with probability } p(e_{it}), & M(e_{it}) = Y - L(1+r) - c(e_{it}) \\ \text{Failure with probability } 1 - p(e_{it}), & M(e_{it}) = -c(e_{it}). \end{cases} \tag{2.5}$$

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

[15] Thus, contracts with cross-reporting of effort levels, as in Rai and Sjöström (2004), are ruled out; these contracts are not empirically observed (Banerjee, 2013).

From (2.5), the *single period expected monetary payoff* of agent i from the project is given by

$$EM\left(e_{it}\right)=p\left(e_{it}\right)\left[Y-L\left(1+r\right)\right]-c\left(e_{it}\right), \tag{2.6}$$

where the expectation operator, E, is taken over the two states of the world, success and failure, of the project, and $p\left(e_{it}\right)$ is given in (2.3). Substitute $e_{it}=0$ in (2.6), and use (2.1), (2.2) and (2.3), to get

$$EM\left(0\right)=\frac{1}{2}\left[Y-L\left(1+r\right)\right]>0. \tag{2.7}$$

From (2.7), the agent prefers to take a loan and invest in the project.

From (2.1), (2.3) and (2.6), we get

$$EM'\left(e_{it}\right)=\frac{\partial EM\left(e_{it}\right)}{\partial e_{it}}=\frac{1}{2}\left[Y-L\left(1+r\right)\right]-c'\left(e_{it}\right), \tag{2.8}$$

where the first and the second terms on the RHS are, respectively, the marginal benefit and marginal cost of effort, and

$$EM''\left(e_{it}\right)=-c''\left(e_{it}\right)<0, \tag{2.9}$$

hence, EM is strictly concave.

2.4 The sequence of moves

The sequence of moves is as follows. In period 1, the bank chooses 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 $c(e_{i1})$, $i=1,2$. Nature then moves to determine success of a project with probability $p(e_{i1})$ or failure with probability $1-p(e_{i1})$. What happens next is determined by the type of the contract, as we now describe.

1. **Individual liability contracts** (*ILI* and *ILP*): If the project of agent i is successful, then the agent is able to repay the loan, otherwise not. Only if the agent repays the first-period loan does the agent receive a second-period loan. Conditional on receiving a second-period loan, L, agent i chooses the second-period effort level, e_{i2}, at a cost $c(e_{i2})$. Nature determines success with probability $p(e_{i2})$, in which case the loan is repaid; or failure with probability $1-p(e_{i2})$, in which case the loan cannot be repaid. In each period, repayments/defaults occur on a private individual basis in the contract *ILI* and in public in the contract *ILP*.

2. **Joint liability contracts** (*JLI*, *JLP*): In a joint liability contract, it is common knowledge that agents can observe each other's chosen effort levels at the end of each period. In this case, the joint probability that both projects are simultaneously successful in period 1 is $p(e_{i1})p(e_{j1})$, $i\neq j$. Only in this case, each agent receives another loan, L, in period 2. The remaining game in the second period is identical to the individual liability contracts (Remark 1) and there are no future consequences of second-period effort choice, either on an agent or the partner. In each

period, in the contract *JLP*, repayments/defaults occur publicly, while in the contract *JLI* only the bank is privy to the repayments/defaults information.

It is pedagogically convenient to introduce dummy variables T_{ILI}, T_{ILP}, T_{JLI}, T_{JLP} to identify a contract that is under consideration. For example, under contract ILI we have $T_{ILI} = 1$ and $T_{ILP} = T_{JLI} = T_{JLP} = 0$. Other dummy variables are defined similarly.

The probability of success (2.4) under each of the contractual forms can now be written as:

$$p\left(e_{i1}, e_{j1}\right) = \frac{1 + e_{i1}}{2}\left[T_{ILI} + T_{ILP} + \left(T_{JLI} + T_{JLP}\right)\frac{1 + e_{j1}}{2}\right]. \tag{2.10}$$

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

2.5 Beliefs

We now define the beliefs of an agent about the effort choices of others (first-order beliefs) and the beliefs about the first-order beliefs (second-order beliefs). Beliefs are private information, but agents may receive private and social signals that enable them to increase the precision of their estimates.

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 joint liability contracts; they enable the modelling of guilt-aversion and surprise-seeking. *Normative beliefs* are beliefs about what *others ought to do*, in a manner that is possibly consistent with some underlying social norm, rather than what *others are actually doing*. *Hierarchies of normative beliefs* are normative beliefs and beliefs about such beliefs; they enable the modelling of shame-aversion and approval-seeking. Beliefs up to order 2 are sufficient to model the relevant emotions in our model.

2.5.1 Positive belief hierarchies

In the second period, which is the last period in any of the 4 contracts, there is no economic interdependence among the decisions of the agents; recall Remark 1. However, under joint liability, the first-period choice of effort levels of both agents affects the probability of each agent obtaining a second-period loan. Hence, we need to define the positive belief hierarchies only for the first period, i.e., at $t = 1$; for this reason, we omit the time indices on beliefs (but not on the effort levels). We construct the *positive belief hierarchies* below in a hierarchically upwards manner, starting with first-order beliefs.

1. First-order beliefs: Let b_i^1 be the *first-order belief* of agent $i = 1, 2$ about the actual effort level, e_{j1}, of agent $j \neq i$ in period $t = 1$. The cumulative distribution of b_i^1 is $F_i^1 : [0,1] \to [0,1]$ and the associated density, when it exists, is $f_i^1\left(e_{j1}\right) = \frac{dF_i^1(e_{j1})}{de_{j1}}$.

2. Second-order beliefs: Let b_i^2 be the *second-order 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, when it exists, is $f_i^2(e_{i1}) = \frac{dF_i^2(e_{i1})}{de_{i1}}$.

   Furthermore, prior to forming second-order beliefs, b_i^2, agent i may observe a signal θ_i about the first-order beliefs of the other agent, b_j^1.[16] In this case, let $F_i^2(e_{i1} \mid \theta_i)$ be the *conditional cumulative distribution of the second-order beliefs* of agent i and let $f_i^2(e_{i1} \mid \theta_i) = \frac{\partial F_i^2(e_{i1} \mid \theta_i)}{\partial e_{i1}}$ be the conditional density, when it exists, of second-order positive beliefs. Given the hierarchical nature of beliefs, the signal θ_i can only be used to update second-order beliefs.

Positive beliefs are assumed to satisfy the following four properties B1–B4.

B1: $F_i^2(e_{i1} \mid \theta_i)$ is differentiable in e_{i1}, $i = 1, 2$, so its density, $f_i^2(e_{i1} \mid \theta_i)$, exists.

B2: $F_i^2(e_{i1} \mid \theta_i)$ is differentiable in θ_i, $i = 1, 2$.

B3: $F_i^2(e_{i1} \mid \theta_i)$ has full support, i.e., for each $e_{i1} \in (0,1)$, $F_i^2(e_{i1} \mid \theta_i) \in (0,1)$.

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

$$\theta_i' > \theta_i \Longrightarrow F_i^2\left(e_{i1} \mid \theta_i'\right) < F_i^2(e_{i1} \mid \theta_i), \text{ for all } e_{i1} \in (0,1), \theta_i, \theta_i' \in [0,1], \ i = 1, 2.$$

Properties B2 and B4 imply that

$$\frac{\partial F_i^2(e_{i1} \mid \theta_i)}{\partial \theta_i} < 0, \text{ for all } e_{i1} \in (0,1) \text{ and all } \theta_i \in (0,1), \ i = 1, 2 \tag{2.11}$$

Thus, a higher signal makes it less likely that the opponent's first-order beliefs about one's effort level are low.[17]

The average effort that agent $i = 1, 2$ expects agent j to exert is given by

$$\bar{b}_i^1 = \int_{e_{j1}=0}^{1} e_{j1} dF_i^1(e_{j1}). \tag{2.12}$$

B5: $\bar{b}_i^1 < 1$.

From B5, agent $i \in \{1, 2\}$ expects agent $j \neq i$ to put in less than maximum effort.

2.5.2 Normative belief hierarchies

Normative beliefs are essential for norm compliance. As noted in the introduction, for norm compliance, normative expectations need to be aligned with *empirical expectations* (i.e., observa-

[16] The signal could be the median of the underlying distribution of agent j (Khalmetski et al., 2015) or the mean, or the mode. Our analysis does not require us to specify which of these or another statistic of the distribution may be employed as the signal.

[17] Also, note that B3 follows from B4. This is because if $F_i^2(e_{i1} \mid \theta_i) = 0$ for some $e_{i1} \in (0,1)$, then $F_i^2(e_{i1} \mid \theta_i)$ cannot be reduced by increasing θ_i. Similarly, if $F_i^2(e_{i1} \mid \theta_i) = 1$ for some $e_{i1} \in (0,1)$, then $F_i^2(e_{i1} \mid \theta_i)$ cannot be increased by reducing θ_i.

tions of the actual actions of others) and in some cases, need to be accompanied by punishments (Bicchieri, 2006; Bicchieri and Xiao, 2009; Fehr and Schurtenberger, 2018).[18]

As noted above, we required positive beliefs only for the first period. However, in the contracts *ILP* and *JLP*, defaults in public repayment can occur in both periods, $t = 1, 2$; these defaults 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 remain the same over the duration of our experiment (it is for this reason that the social signal, s, in Table 1 is identical for both periods). Thus, it is convenient to drop the time subscript for normative beliefs (but not for the effort levels). Let B_{SG}^1 be the *normative first-order beliefs* of the relevant social group about what effort levels *ought to be* exerted by agents at $t = 1, 2$. We define B_i^2 to be the *normative second-order beliefs* of agent $i = 1, 2$, in both periods $t = 1, 2$, about the first-order normative beliefs, B_{SG}^1. We do not restrict these beliefs to be point beliefs; as in the case of positive beliefs, we allow for a distributions of beliefs.

The cumulative distribution of B_i^2 is denoted by $G_i^2 : [0, 1] \to [0, 1]$ and the associated density, when it exists, is $g_i^2 (e_{i1}) = \frac{dG_i^2(e_{i1})}{de_{i1}}$. Agent i also receives a social signal s about B_{SG}^1; this is the analogue of the private signal θ_i that agent $i = 1, 2$ receives when we described positive beliefs. Thus, agents may form *conditional normative second-order beliefs*, $G_i^2 (e_{i1} \mid s) \in [0, 1]$, $e_{i1} \in [0, 1]$. The signal, s, is time independent and common to all agents, but we allow the second-order belief distributions to be heterogeneous across agents.

Analogous to the properties B1-B4 of positive beliefs, we assume the following properties for normative beliefs:

B6: $G_i^2 (e_{i1} \mid s)$ is differentiable in e_{i1}, $i = 1, 2$, so its density, $g_i^2 (e_{i1} \mid s)$, exists.

B7: $G_i^2 (e_{i1} \mid s)$ is differentiable in s, $i = 1, 2$.

B8: $G_i^2 (e_{i1} \mid s)$ has full support, i.e., for each $e_{i1} \in (0, 1)$, $G_i^2 (e_{i1} \mid s) \in (0, 1)$.

B9: A higher signal, s, induces strict first-order stochastic dominance in the conditional distribution of second-order normative beliefs, $G_i^2 (e_{i1} \mid s)$:

$$s' > s \Longrightarrow G_i^2 \left(e_{i1} \mid s'\right) < G_i^2 (e_{i1} \mid s), \text{ for all } e_{i1} \in (0, 1), s, s' \in [0, 1], i = 1, 2.$$

Note that B8 follows from B9 (just as B3 followed from B4).

Properties B7 and B9 imply that

$$\frac{\partial G_i^2 (e_{i1} \mid s)}{\partial s} < 0, \text{ for all } e_{i1} \in (0, 1) \text{ and all } s \in (0, 1), i = 1, 2. \tag{2.13}$$

2.6 Psychological motives

To formally model the relevant emotions we employ the framework of psychological game theory (Geanakoplos et al., 1989; Battigalli and Dufwenberg, 2009). We introduce two functions,

[18] In our experiments, we provide empirical expectations that are roughly aligned with normative expectations and also allow for punishments.

$\phi_i(e_{i1}, \theta_i)$ and $\overline{\phi}_i(e_{it}, s)$; the first captures guilt-aversion/surprise-seeking and the second captures shame-aversion/approval-seeking. Later, in subsection 2.7, we shall augment expected monetary utility (2.6) with the functions $\phi_i(e_{i1}, \theta_i)$ and $\overline{\phi}_i(e_{it}, s)$ to arrive at psychological utility (2.19).

2.6.1 Guilt-aversion/Surprise-seeking

Define the function:

$$\phi_i(e_{i1}, \theta_i) = \alpha_i \int_{e'_{i1}=0}^{e_{i1}} \left(e_{i1} - e'_{i1}\right) dF_i^2\left(e'_{i1} \mid \theta_i\right) - \beta_i \int_{e'_{i1}=e_{i1}}^{1} \left(e'_{i1} - e_{i1}\right) dF_i^2\left(e'_{i1} \mid \theta_i\right),$$
$$\alpha_i \geq 0,\ \beta_i \geq 0,\ \theta_i \in [0,1],\ i = 1,2. \tag{2.14}$$

In (2.14), $e_{i1} \in [0,1]$ is the effort level chosen by agent $i = 1,2$. Based on the second-order *positive* beliefs of agent i, e'_{i1} is the effort level that agent i thinks that agent j believes that agent i will actually exert ($j = 1,2,\ j \neq i$). $F_i^2(e'_{i1} \mid \theta_i)$ is the conditional cumulative probability of e'_{i1}, where θ_i is the private signal that agent i receives about the first-order beliefs of agent j, $f_j^1(e_{i1})$, (recall subsection 2.5). In the interval $e'_{i1} \in (e_{i1}, 1]$, $e_{i1} < e'_{i1}$, thus, $\int_{e'_{i1}=e_{i1}}^{1} (e'_{i1} - e_{i1})\, dF_i^2(e'_{i1} \mid \theta_i)$ measures the *guilt-aversion* motive. In the interval $e'_{i1} \in [0, e_{i1})$, $e_{i1} > e'_{i1}$, thus, $\int_{e'_{i1}=0}^{e_{i1}} (e_{i1} - e'_{i1})\, dF_i^2(e'_{i1} \mid \theta_i)$ measures the *surprise-seeking* motive.[19] The coefficients α_i and β_i give, respectively, the relative strengths of surprise-seeking and guilt-aversion. We adopt the assumption

$$0 \leq \alpha_i < \beta_i. \tag{2.15}$$

Empirically, we observe that (2.15) holds for the majority of subjects when there is no strategic interaction (70% in Khalmetski et al., 2015), and for an even greater percentage of subjects when there is strategic interaction (95% in Dhami et al., 2019). Recalling Remark 1, we can see why $\phi_i(e_{i1}, \theta_i)$ is relevant only to period 1.

2.6.2 Shame-aversion/Approval-seeking

Define the function:

$$\overline{\phi}_i(e_{it}, s) = \overline{\alpha}_i \int_{e'_{it}=0}^{e_{it}} \left(e_{it} - e'_{it}\right) dG_i^2\left(e'_{it} \mid s\right) - \overline{\beta}_i \int_{e'_{it}=e_{it}}^{1} \left(e'_{it} - e_{it}\right) dG_i^2\left(e'_{it} \mid s\right),$$
$$\overline{\alpha}_i \geq 0,\ \overline{\beta}_i \geq 0,\ s \in [0,1],\ \ i = 1,2\ t = 1,2 \tag{2.16}$$

In (2.16), $e_{it} \in [0,1]$ 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} is the effort level that agent i believes is the normative expectation of his/her social group. $G_i^2(e'_{i1} \mid s)$ is the conditional cumulative probability of e'_{i1}, as perceived by agent i, and s is the social signal that agent i receives about

[19] Our definitions of these emotions are motivated by the formal definition of simple guilt aversion in Battigalli and Dufwenberg (2007) and as used in Khalmetski et al. (2015) and Dhami et al. (2019).

the normative first-order beliefs of the social group, B_{SG}^1 (recall subsection 2.5.2). In the interval $e'_{it} \in (e_{it}, 1]$, $e_{it} < e'_{i1}$, thus, $\int_{e'_{it}=e_{it}}^{1} (e'_{it} - e_{it})\, dG_i^2 (e'_{it} \mid s)$ measures the *shame-aversion* motive. In the interval $e'_{i1} \in [0, e_{i1})$, $e_{it} > e'_{i1}$, thus, $\int_{e'_{it}=0}^{e_{it}} (e_{it} - e'_{it})\, dG_i^2 (e'_{it} \mid s)$ measures the *approval-seeking* motive. We may refer to both motives as *norm-compliance* motives.[20] The coefficients $\overline{\alpha}_i$ and $\overline{\beta}_i$ give the relative strengths of approval-seeking and shame-aversion. Corresponding to (2.15), we make the following assumption:

$$0 \leq \overline{\alpha}_i < \overline{\beta}_i. \tag{2.17}$$

This implies that for agent i shame-aversion is relatively more important than the approval-seeking motive.

2.7 Psychological utility

We are now in a position to augment expected monetary utility (2.6) with guilt-aversion/surprise-seeking in (2.14) and shame-aversion/approval-seeking in (2.16) to define intertemporal psychological utility in (2.19) below. The vector of parameters for agent i is:

$$\mathbf{p}_i = \left(\theta_i, s, \mu_i, \overline{\mu}_i, \alpha_i, \beta_i, \overline{\alpha}_i, \overline{\beta}_i, \overline{b}_i^1, Y, L, r, T_{ILI}, T_{ILP}, T_{JLI}, T_{JLP}\right) \tag{2.18}$$

Definition 1 *(Psychological utility): We define the intertemporal psychological utility of agent $i \in \{0, 1\}$ by*

$$U(e_{i1}, e_{i2}, \mathbf{p}_i) = \Psi(e_{i1}) + \psi(e_{i1})\, V(e_{i2}, \mathbf{p}_i), \tag{2.19}$$

where

$$\Psi(e_{i1}) = EM(e_{i1}) + (T_{JLI} + T_{JLP})\, \mu_i \phi_i(e_{i1}, \theta_i) + (T_{ILP} + T_{JLP})\, \overline{\mu}_i \overline{\phi}_i(e_{i1}, s), \tag{2.20}$$

$$\psi(e_{i1}) = p(e_{i1}) \left[T_{ILI} + T_{ILP} + (T_{JLI} + T_{JLP})\, p\left(\overline{b}_i^1\right)\right], \tag{2.21}$$

$$V(e_{i2}, \mathbf{p}_i) = EM(e_{i2}) + (T_{ILP} + T_{JLP})\, \overline{\mu}_i \overline{\phi}_i(e_{i2}, s),\ \mu_i \geq 0,\ \overline{\mu}_i \geq 0. \tag{2.22}$$

Using (2.3), (2.4) and (2.12), we see that

$$\begin{aligned} p\left(\overline{b}_i^1\right) &= \frac{1 + \overline{b}_i^1}{2} = \frac{1 + \int_{e_{j1}=0}^{1} e_{j1} dF_i^1(e_{j1})}{2} \\ &= \int_{e_{j1}=0}^{1} \frac{1 + e_{j1}}{2} dF_i^1(e_{j1}) = \int_{e_{j1}=0}^{1} p(e_{j1})\, dF_i^1(e_{j1}). \end{aligned} \tag{2.23}$$

[20] As noted in the introduction, sufficient conditions for norm compliance are (Bicchieri and Xiao, 2009): (1) empirical expectations are aligned with normative expectations, and (2) monetary or non-monetary punishments are present. Our interest is not in isolating the relative effects of empirical expectations and punishments. In our experiments, we have all three components (normative expectations, empirical expectations that are aligned with normative expectations, and non-monetary disapproval/approval of one's actions), which gives us the best chance of activating norm compliance in the model. All three conditions are eminently reasonable in context of the closely networked societies in developing countries in which microfinance loans are taken up.

We will now explain the psychological utility (2.19) in Definition 1, term by term. It will become clear that $\Psi(e_{i1})$ in (2.19) is the first-period psychological utility, $\psi(e_{i1})$ is the probability of agent i obtaining a second-period loan, and $V(e_{i2}, \mathbf{p})$ is the second-period psychological utility.

Agent i chooses the effort level, e_{i1}, in period 1. This results in the expected monetary utility, $EM(e_{i1})$, given by (2.6). This holds under all contracts. In addition, under the joint liability contracts JLI ($T_{JLI} = 1$) and JLP ($T_{JLP} = 1$), agent i gains the extra utility $\mu_i \phi_i(e_{i1}, \theta_i)$, where ϕ_i, given by (2.14), captures guilt-aversion/surprise-seeking, and $\mu_i \geq 0$ gives the strength of this psychological motive. Note that $\phi_i(e_{i1}, \theta_i)$ could be negative. In addition, under the public repayment contracts ILP ($T_{ILP} = 1$) and JLP ($T_{JLP} = 1$), agent i gains the extra utility $\overline{\mu}_i \overline{\phi}_i(e_{i1}, s)$, where $\overline{\phi}_i$, given by (2.16), captures shame-aversion/approval-seeking, and $\overline{\mu}_i \geq 0$ gives the strength of this contribution. Note that $\overline{\phi}_i(e_{i1}, s)$ could be negative. Thus, $\Psi(e_{i1})$ in (2.19) is the first-period psychological utility and is given by (2.20).

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 and ILP (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 other 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 his/her first-period effort level, e_{i1}, agent i has not yet observed the first-period effort level, e_{j1}, of agent j. So $p(e_{j1}) = \frac{1+e_{j1}}{2}$ is replaced by its expected value, $p\left(\overline{b}_i^1\right)$, given by (2.23). Note that this is possible because (2.19) is linear in probabilities. From B5, we have

$$0 < p\left(\overline{b}_i^1\right) < 1. \tag{2.24}$$

Thus, $\psi(e_{i1})$ in (2.19) is the probability with which agent i expects to get a second-period loan from the bank, and is given by (2.21).

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 receives the extra utility $\overline{\mu}_i \overline{\phi}_i(e_{i2}, s)$. Note that $\overline{\mu}_i \overline{\phi}_i(e_{i2}, s)$ could be negative. Thus, $V(e_{i2}, \mathbf{p}_i)$ in (2.19) is second-period psychological utility and is given by (2.22). Also note the absence of the term $\mu_i \phi_i(e_{i2}, \theta_i)$ in (2.22). In this respect, recall Remark 1.

Note that if $V(e_{i2}, \mathbf{p}_i) < 0$, 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 social norm for effort, as perceived by agent i, is so high that agent i does not expect to get a non-negative second-period payoff (recall, from (2.7), that expected monetary utility, EM, is always positive). And, similarly, for the first period. So, to make sure agent i will accept first and second-period contracts, we need, for some effort levels, e_{i1} and e_{i2},

$$U\left(e_{i1}, e_{i2}, \mathbf{p}_i\right) > 0 \text{ and } V\left(e_{i2}, \mathbf{p}_i\right) > 0. \tag{2.25}$$

3 Optimization

We assume that an agent behaves optimally given his/her beliefs.[21] The next definition gives a formal statement of this.

Definition 2 *: A psychological best response for agent i $(i = 1, 2)$ is a pair of effort levels $\left(e_{i1}^k, e_{i2}^k\right)$ that maximize agent i's psychological utility, $U\left(e_{i1}, e_{i2}, \mathbf{p}_i\right)$, given the beliefs of agent i: F_i^1, F_i^2, G_i^2; where $U\left(e_{i1}, e_{i2}, \mathbf{p}_i\right)$ is given by (2.19) and $k \in \{ILI, ILP, JLI, JLP\}$ indicates the type of contract applied.*

Proposition 1 *: A psychological best response for agent i $(i = 1, 2)$ exists and is unique.*

4 Comparative static results

4.1 Comparing optimal effort levels across contracts

Proposition 2 *: Assume that, for all contracts k, $e_{i1}^k, e_{i2}^k \in (0, 1)$ and that $V\left(e_{i2}^k, \mathbf{p}_i\right) > 0$, i.e., under all contracts k, optimal effort levels are interior points and optimal second-period payoffs are positive. Then,*

(a) $e_{i2}^{ILI} \leq e_{i2}^{ILP}$, $e_{i2}^{JLI} \leq e_{i2}^{JLP}$, and $e_{i2}^k < e_{i1}^k$. If $\overline{\mu}_i > 0$, then $e_{i2}^{ILI} < e_{i2}^{ILP}$, $e_{i2}^{JLI} < e_{i2}^{JLP}$, and $e_{i2}^k < e_{i1}^k$, $\forall k$

(b) $e_{i2}^{ILI} = e_{i2}^{JLI}$

(c) $e_{i2}^{ILP} = e_{i2}^{JLP}$.

$V\left(e_{i2}^k, \mathbf{p}_i\right) > 0$ guarantees that optimal second-period payoffs is positive and, hence, that agent i will accept a second-period loan. If, in addition, $\overline{\mu}_i > 0$, then due to the presence of shame-aversion/approval-seeking, contracts with public repayment (*ILP*, *JLP*) will elicit greater second-period effort, relative to individual repayment contracts (*ILI*, *JLI*) (Proposition 2(a)). The first-period optimal effort is always strictly higher than the second-period optimal effort (second inequality in Proposition 2(a)). This is because increasing first-period effort increases the probability of getting a second-period loan (which, since $V\left(e_{i2}^k, \mathbf{p}_i\right) > 0$, will generate extra utility). The second-period optimal effort within each repayment method, individual or public,

[21] Section 8, below, compares and contrasts our approach to incomplete information with the approach taken by the standard game theoretic literature. The latter is a special case of our approach.

is the same (Proposition 2(b),(c)). This is due to the fact that in the second period all contracts are effectively individual liability contracts and the only difference is the repayment method.

However, for optimal first-period effort levels, none of the pairwise comparisons $e_{i1}^{ILI} \lesseqqgtr e_{i1}^{ILP}$, $e_{i1}^{JLI} \lesseqqgtr e_{i1}^{JLP}$, $e_{i1}^{ILI} \lesseqqgtr e_{i1}^{JLI}$, $e_{i1}^{ILP} \lesseqqgtr e_{i1}^{JLP}$ can be made definite without the knowledge of the values of the preference parameters μ_i, $\overline{\mu}_i$, α_i, β_i, $\overline{\alpha}_i$, $\overline{\beta}_i$, $\overline{b}_i^1$.

4.2 Effect of θ_i and $\overline{b}_i^1$ on first-period effort in joint liability contracts

Proposition 3 *For an interior solution, $e_{i1}^{JLI,JLP} \in (0,1)$, we have:*
(a) (Guilt-aversion: θ_i) Optimal effort of agent i in the first period is increasing in the private signal, θ_i, i.e., $\frac{\partial e_{i1}^{JLI,JLP}}{\partial \theta_i} \geq 0$. If $\mu_i > 0$, then $\frac{\partial e_{i1}^{JLI,JLP}}{\partial \theta_i} > 0$.
(b) (Production complementarity) Optimal effort of agent i in the first period is strictly increasing in the average effort that agent i expects agent j to exert, $\frac{\partial e_{i1}^{JLI,JLP}}{\partial \overline{b}_i^1} > 0$.

If an agent's preferences exhibit guilt-aversion/surprise-seeking motives, then we should expect effort in the first period to increase with the private signal, θ_i in both joint liability contracts (*JLP*, *JLP*). The reason is that a higher value of θ_i makes it more likely that the partner in a joint liability contract holds higher effort expectations from agent i (Assumption B4). Thus, agent i adjusts optimal effort upwards to reduce the disutility arising from guilt-aversion. Proposition 3(b) brings out the role of production complementarity. If agent i expects that the average effort by his/her partner is high (high $\overline{b}_i^1$), then the joint probability of success of both projects, $p(e_{i1})\, p\left(\overline{b}_i^1\right)$ from (2.21), is also high. This raises the marginal benefit of additional effort for agent i. Proposition 3 only lists the comparative statics that we can test with our experimental data. Results for all other parameters $(s, \mu_i, \overline{\mu}_i, \alpha_i, \beta_i, \overline{\alpha}_i, \overline{\beta}_i, Y, L, r)$ are reported in Appendix-B.

5 The classical model (no psychological motives)

The psychological motives of guilt-aversion/surprise-seeking and shame-aversion/approval-seeking (associated with norm compliance) are absent from the classical model which, therefore, is the special case of our model with $\mu_i = \overline{\mu}_i = 0$. We now show that this can also be accommodated within our framework.

Substituting $\mu_i = \overline{\mu}_i = 0$ in Definition 1, we get:

$$U(e_{i1}, e_{i2}, \mathbf{p}_i) = EM(e_{i1}) + p(e_{i1}) \left[T_{ILI} + T_{ILP} + (T_{JLI} + T_{JLP})\, p\left(\overline{b}_i^1\right)\right] EM(e_{i2}), \tag{5.1}$$

where $EM(e_{i1})$ and $EM(e_{i2})$ are given by (2.6), $p(e_{i1})$ is given by (2.3) and, from (2.23), $p\left(\overline{b}_i^1\right)$ is given by:

$$p\left(\overline{b}_i^1\right) = \int_{e_{j1}=0}^{1} p(e_{j1})\, dF_i^1(e_{j1}). \tag{5.2}$$

Since $\overline{\mu}_i = 0$, there is no distinction between the two individual liability contracts (*ILI* and *ILP*) or between the two joint liability contracts (*JLI* and *JLP*). Thus, we shall use *IL* to stand for either *ILI* or *ILP* and T_{IL} to stand for either T_{ILI} or T_{ILP}. Similarly, we shall use *JL* to stand for either *JLI* or *JLP* and T_{JL} to stand for either T_{JLI} or T_{JLP}. Thus, (5.1) takes the form:

$$U\left(e_{i1}, e_{i2}, \mathbf{p}_i\right) = EM\left(e_{i1}\right) + p\left(e_{i1}\right)\left[T_{IL} + \left(T_{JL}\right) p\left(\overline{b}_i^1\right)\right] EM\left(e_{i2}\right). \tag{5.3}$$

First, consider an individual liability contract *IL*. Setting $T_{IL} = 1$ and $T_{JL} = 0$ in (5.3) gives:

$$U\left(e_{i1}, e_{i2}, \mathbf{p}_i\right) = EM\left(e_{i1}\right) + p\left(e_{i1}\right) EM\left(e_{i2}\right). \tag{5.4}$$

Under the contract *ILI* (or *ILP*), agent i simply chooses her effort levels, e_{i1}^{IL}, e_{i2}^{IL}, so as to maximize (5.4).

Next, consider a joint liability contract *JL*. Set $T_{IL} = 0$ and $T_{JL} = 1$ in (5.3) to get:

$$U\left(e_{i1}, e_{i2}, \mathbf{p}_i\right) = EM\left(e_{i1}\right) + p\left(e_{i1}\right) p\left(\overline{b}_i^1\right) EM\left(e_{i2}\right). \tag{5.5}$$

Finally, let $\left(e_{11}^{JL}, e_{21}^{JL}\right) \in (0,1) \times (0,1)$ form a Nash equilibrium of first-period effort levels under a joint liability contract, *JL*. Note that e_{11}^{JL} is not necessarily equal to e_{21}^{JL}. To capture the Nash equilibrium in our framework, define equilibrium beliefs $F_i^1\left(e_{j1}\right)$ as follows:

$$F_i^1\left(e_{j1}\right) = 0,\ e_{j1} \in [0, e_{j1}^{JL}). \tag{5.6}$$

$$F_i^1\left(e_{j1}\right) = 1,\ e_{j1} \in \left[e_{j1}^{JL}, 1\right]. \tag{5.7}$$

Substitute from (5.6) and (5.7) into (5.2), to get:

$$p\left(\overline{b}_i^1\right) = p\left(e_{j1}^{JL}\right). \tag{5.8}$$

Substitute from (5.8) into (5.5), to get:

$$U\left(e_{i1}, e_{i2}, \mathbf{p}_i\right) = EM\left(e_{i1}\right) + p\left(e_{i1}\right) p\left(e_{j1}^{JL}\right) EM\left(e_{i2}^{JL}\right). \tag{5.9}$$

Agent i first chooses her second-period effort, e_{i2}^{JL}, so as to maximize $EM\left(e_{i2}\right)$. Given the first-period effort level of agent j, e_{j1}^{JL}, agent i then chooses her first-period effort level, e_{i1}, so as to maximize (5.9). This gives the equilibrium effort level of agent i, e_{i1}^{JL}. Since this is a joint liability contract, agent i gets a second-period loan if, and only if, both agents repay their first-period loans. The joint probability of this is $p\left(e_{i1}^{JL}\right) p\left(e_{j1}^{JL}\right)$. Proposition 3, below, summarizes the predictions of the classical model.

Remark 2 : *We differentiate below in Proposition 4 between the predictions based on optimal effort (when the objective function is given in (5.5)) and the special case of optimal effort, as given in a Nash equilibrium (here, in addition, (5.8) holds).*

Proposition 4 *: Consider the classical model (no psychological motives). Let $e_{i2}^{k} \in (0,1)$ be the optimal second-period effort for agent i under contract k. Let $e_{i1}^{IL} \in (0,1)$ be the optimal first-period effort for agent i under an individual liability contract, ILI or ILP. Let $e_{i1}^{JL} \in (0,1)$ be the optimal first-period effort for agent i under a joint liability contract, JLI or JLP. Then,*
(a) Optimal second-period effort is the same for both agents and all contracts, i.e.,

$$e_{i2}^{k} = e_{i2}^{JL} = e_{i2}^{IL}, \;\; i = 1,2 \text{ and } \forall k.$$

(b) Optimal first-period effort is the same for both agents and both independent liability contracts, i.e.,

$$e_{i1}^{IL} = e_{i1}^{k}, \; i = 1,2 \text{ and } k \in \{ILI, ILP\}.$$

(c) For each agent, the optimal second-period effort under any contract is less than the optimal first-period effort under a joint liability contract which, in turn, is less than the optimal first-period effort under an independent liability contract, i.e.,

$$e_{i2}^{k} < e_{i1}^{JL} < e_{i1}^{IL}, \; i \in \{1,2\} \text{ and } \forall k.$$

(d) In particular, let $\left(e_{11}^{JL}, e_{21}^{JL}\right) \in (0,1) \times (0,1)$ form a Nash equilibrium of first-period effort levels under a joint liability contract, JLI or JLP. Then part (c) still holds.

Discussion on Proposition 4

From Proposition 4(c) we see that in the classical model, under all contracts, the first-period effort level (e_{i1}^{JL} or e_{i1}^{IL}) is higher than the second-period effort level (e_{i2}^{k}). The reason is that increasing effort in any period increases the probability of success. However, there is an extra marginal benefit to increasing first-period effort - it makes it more likely that one gets a future loan. This is consistent with our empirical results only for contract *ILI*. It is not corroborated for contracts *ILP*, *JLI* and *JLP*; see Table 10.

Also from Proposition 4(c) we see that in the classical model, under the individual liability contracts (*ILI* and *ILP*), the first-period effort level (e_{i1}^{IL}) is higher than the first-period effort level (e_{i1}^{JL}) under the joint liability contracts (*JLI* and *JLP*). The reason is that under joint liability, the probability of getting a second-period loan is the joint probability that the projects of both partners in the contract succeed, which is lower than any of the individual probabilities. Hence, the marginal product of effort is relatively higher under individual liability contracts.

Proposition 4(c) implies that effort level is lower under joint liability contracts (*JLI* and *JLP*) relative to individual liability contracts (*ILI* and *ILP*). Hence, the probability of repaying the loan is lower in the joint liability contracts, so a bank should strictly prefer individual liability contracts. If Proposition 4(c) described empirical behavior, it would be puzzling why banks offer joint liability contracts at all? One answer could be that joint liability contracts introduce peer pressure to increase effort (Varian 1990; Stiglitz, 1990; Banerjee et al., 1994).[22] This is captured by our psychological model but not the classical model.

6 Experimental design

6.1 The basic game 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

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

In the first period, each borrower received a loan, L, of 50 units of experimental currency (EC) to finance his/her 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 from 1 to 10 (rather than 0 to 1), we transformed the probability function (2.3) by dividing e_{it} by 10. The probability function assumes that every project has an exogenous 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 total repayment amount of 65 EC $(50(1 + 0.30))$ 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

[22]As noted in the introduction, assortative matching under asymmetric information is another explanation, but these issues do not play a role in our model.

Table 3: Decision Table

Effort Level	1	2	3	4	5	6	7	8	9	10
Prob of Success	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Cost of Effort in EC	0.125	0.5	1.125	2.0	3.125	4.5	6.125	8.0	10.125	12.5
Cost of Effort in PKR	1.25	5	11.25	20	31.25	45	61.25	80	101.25	125

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, the net return from the project is negative.

To convert 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. Table 3 presents the probability of success and the cost schedule for each effort level as presented to the subjects.

In individual liability contracts, subjects proceeded to the second period if and only if their project was successful. In joint liability contracts, the projects of both group members needed to be successful for them to proceed to the second period. 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 accumulated earnings from the two periods were paid to the subject at the end of the experiment.

For the parametrization in Table 2, the calculations for various optimal effort levels are given in Appendix-C. The classical model (Section 5) gives the optimal first-period effort level in an individual liability contract to be 3.1. For the joint liability contract, when subjects play a best response to beliefs, as in Definition 2, the first-period optimal effort levels, e_{i1}^{JL}, for all possible beliefs are given in Table 4. The first-period Nash equilibrium for the joint liability contract is the effort pair $(2.7, 2.7)$. The first-period optimal effort (see Remark 2 and Proposition 4(c)) in joint liability contract is strictly lower than the optimal effort in individual liability contracts.

For the empirical analysis in the classical model (Section 5), we focus only on the Nash equilibrium choices. In the classical model, the *optimal effort in the best response to beliefs* (Remark 2), given in Table 4, is close to the Nash equilibrium effort choice of 2.7. Since we present effort choices as a set of integers to our subjects, we round the first-period optimal efforts in both individual and joint liability contracts to 3, $e_{i1}^{JL} = e_{i1}^{IL} = 3$. In the second period, the optimal effort level in all contracts, $k \in \{T_{ILI}, T_{ILP}, T_{JLI}, T_{JLP}\}$, is 2, i.e., $e_{i2}^{k} = 2$; Proposition 4(a).

The parameter values in Table 2 imply that the bank breaks even if, and only if, the effort

Table 4: Best Response to Beliefs in the Classical Model

$\bar{b}_i^1$	1	2	3	4	5	6	7	8	9	10
e_{i1}^{JL}	2.61	2.66	2.72	2.77	2.83	2.87	2.94	3.00	3.05	3.11

level, e_{it}, satisfies

$$e_{it} \geqslant 5, \tag{6.1}$$

see Appendix-C for details. Thus, in the classical model, the bank makes a loss in each period in every contract and should not give loans. However, the empirical evidence below shows that on average (6.1) is satisfied for *ILP*, *JLI*, and *JLP* contracts, but not for *ILI*. This potentially explains why joint liability contracts and public repayment are a feature of real world microfinance contracts.

6.2 Treatments

Based on our 2×2 design, we formed four treatments, as explained in subection 2.2. Treatments are characterized by a liability structure (individual or joint liability) and the repayment method (individual or public). In each characterization (liability or repayment), the 'individual' is our control treatment.[23]

Individual Repayments (*ILI* and *JLI*)

In the *ILI* treatment, borrowers were individually liable for their own loans, privately informed about the outcome of their project, and made repayments in private.

In the *JLI* treatment, subjects were randomly matched in pairs. Subjects were unaware of the identity of their partner but knew that their partner was present in the room. In the first period, both group members separately received a loan of 50 EC to invest in their independent projects. Before subjects made their effort choice, their first-order beliefs were elicited with the *induced beliefs design*.[24] Subjects were asked about their first-order beliefs about the effort level of their partner in an incentive-compatible manner. 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 first-order beliefs, they were asked if their beliefs could be transmitted to their partners. At

[23]For example, when we compare *ILI* with *ILP*, *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, 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. We go beyond induced beliefs method in addressing potential problems of subject deception by seeking the permission of each player to transmit these beliefs. In addition to deception concerns, this also addresses the concern that subjects may wonder if some *other* design information was withheld from them.

the time of belief elicitation, subjects were not aware that they would have the opportunity to transmit their beliefs. This allows us to control for the possible strategic manipulation of beliefs while at the same time, it gives subjects complete control over the transmission of their beliefs. Once the first-order beliefs were elicited, subjects were informed about their partner's first-order belief only if the partner had given permission to transmit his/her beliefs. No subject refused to transmit his/her belief to the partner. This transmission of positive beliefs corresponds to the signal, θ_i, about the partner's first-order beliefs in a joint liability contract. The signals were common knowledge within each pair of subjects who were paired in the joint liability contract, but other players did not observe these signals. After observing the signal of their paired partner, subjects chose an effort level for their projects.

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

Public Repayments (*ILP* and *JLP*)

The public repayment treatments differed from the individual repayment treatments in the following three ways. First, since norm compliance depends on commonly shared beliefs, subjects were publicly informed about empirical and normative expectations from a similar earlier pilot experiment (see details below). 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 corresponds to *empirical expectations* and the second to a signal of *normative expectations*, s (see subsection 2.5). Second, after observing these messages, subjects were also informed that at the end of each period, each subject's effort level and the outcome of the project will be publicly announced to all subjects present in the room. Third, after observing the subject's effort level and the outcome of the project, all other subjects in the room expressed their approval (show of a green card) or disapproval (show of a red card).

Thus, our public repayment method involves three features: empirical expectations and a signal about normative expectations; public announcement of the chosen effort level and the outcome of the project; and the expression of social approval/disapproval. We measure the combined effect of these features of the public repayment. As noted in the introduction, these three features together characterize the most successful social norms.[25]

Subjects who proceeded to the second period did not receive the empirical expectations or normative signals again in the second period. This follows our earlier observation that norms of effort (as captured by the empirical and normative expectations) are slow and inertial to change, so we have kept them fixed during the course of the experiment. The effort decisions and the outcome of the projects were made public and subject to social approval/disapproval (this took the form of recording the number of red and green cards for each subject). The liability structure of all four contracts in the second period was the same, i.e., individual liability (see Remark 1).

In the public repayment treatments (*JLP* and *ILP*), subjects publicly received empirical expectations and a signal of normative expectations, s, after receiving instructions. We then elicited their first-order beliefs and privately transmitted signals of the partner's first-order beliefs (as in *JLI*) before subjects could choose their effort level. This particular sequence of conveying empirical expectations, a normative signal, and belief elicitation was implemented because norms typically pre-exist in societies in which people interact and form expectations about others. It allows us to see how, if at all, norms interact with beliefs and affect effort decisions.

6.3 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 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.[26] 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 interact with our microfinance borrowers in the real world, were present in the experiment.

For each session, 40 subjects were invited from a chosen town to take part in the experiment. Subjects were invited one or two days prior to the actual session. The time and the location were announced to the subjects in advance. Once all subjects arrived at the designated place (mostly local schools), they were randomly allocated to four treatments, 10 in each.[27] Experiments with all four treatments were run simultaneously in four different rooms. In each room, a separate, specially trained experimenter, assigned each subject an identity number and recorded the rele-

[25]While the study of the individual components towards norm formation and maintenance might be of independent interest (see Biccheiri and Xiao, 2009), it is not the focus of our work.

[26]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.

[27]The sessions were held after school hours.

vant economic and demographic details of each subject (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, each experimenter 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; see Appendix-D. 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 of the 4 rooms (1 room for each group) 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 Pakistani rupees 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 PKR 550.49 ($4.75) in an experimental session. A session lasted, on average, 90 minutes.

6.4 Pilot: Elicitation of empirical and normative expectations

Before the actual experiment, we conducted a pilot session to elicit empirical and normative expectations to be reported in the actual experiment. Subjects in the pilot were NRSP Bank's clients in one of the villages in Bahawalpur district. We invited 40 borrowers and randomly allocated them to four treatments. To elicit normative expectations, once subjects finished the practice questions, we privately asked each subject what effort level does he/she think that other subjects *should* choose in this experiment. Subjects were incentivized with a monetary reward of PKR 50 if their normative belief matched with the modal normative belief.[28] Once we collected normative beliefs from all the subjects in the room, the average normative expectation was publicly announced. Subjects played the game as described above, and their decisions were subject to social approval/disapproval.

In our 10 experimental sessions, subjects in the public repayment treatments (*ILP* and *JLP*) received empirical and a signal of normative expectations from a *similar earlier experiment.* We used this phrase because of two differences in the pilot public repayment groups. First, subjects in the pilot did not receive empirical expectations as their effort choices were used as empirical expectations for the actual experiment. Second, the average normative expectation in the pilot was elicited and given to the pilot subjects as the signal, s, and the same signal was then used also

[28] See Krupka and Weber (2013) and Gächter et al. (2013) for eliciting norms in an incentive-compatible way.

Table 5: 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.

for the actual experiment. Due to these differences between the pilot and the actual experiment, we do not include the data from the pilot into our analysis.

6.5 Baseline characteristics

Table 5 shows the sample means and standard deviations of the demographic and self-reported borrowing related 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 (see the variable “No of Loans”). The majority of subjects had taken individual liability loans, but there was a significant proportion who had taken group loans. Table 5 also reports the absolute standardized differences of subject characteristics between the treatments.[29] Randomization generated very similar subject-pools across the four treatments. The differences are either zero or *small*. For robustness check, we control for these characteristics in one of the regression specifications; their coefficients are small and insignificant.

[29]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. Imbens and Rubin (2015) suggest using standardized differences instead of usual t-test to assess differences in baseline characteristics.

6.6 Estimation specifications

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

$$Y_{it} = \beta_0 + \beta_1 T_{ILP} + \beta_2 T_{JLI} + \beta_3 T_{JLP} + \varepsilon_{it}, \tag{6.2}$$

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 errors term clustered at the session level. We estimate equation (6.2) separately for each period. 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 (6.2) in Table 7. 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 players' own first-order beliefs and the signals of their partner's expectations in the joint liability treatments (Proposition 3), we use the following regression specification.

$$Y_{i1} = \alpha_0 + \alpha_1 Public + \alpha_2 Signal + \alpha_3 FOB + \alpha_4 SignalPub + \alpha_5 FOBPub + \varepsilon_{i1}, \tag{6.3}$$

where Y_{i1} is the first-period effort level chosen by individual i in joint liability treatments (*JLI* and *JLP*). *Public* is a binary variable (0 = *JLI*, 1 = *JLP*) to distinguish between individual and public repayment in joint liability contracts. The effect of the private signal, θ_i, is captured by the variable *Signal*, which is the first-order belief of the partner in the joint liability contract that is reported to the subject. *FOB* is the subject's own first-order belief about the partner's effort. *SignalPub* and *FOBPub* represent interaction of the variable *Public*, respectively, with the variables *Signal* and *FOB*. α_0 captures the mean effort in *JLI* and α_1 measures the overall treatment effect of public repayment in joint liability contracts.

We cannot separately test for the effect of the social signal, s, in the two public repayment treatments because s does not vary across the individuals. α_2 and α_3, respectively, capture the effect of *Signal* and *FOB* in the group *JLI*. α_4 measures the treatment effect of public repayment on the signal of the partner's first-order belief in *JLP* relative to *JLI*. Similarly, α_5 measures the effect of the player's own first-order beliefs in *JLP* relative to *JLI*. We estimate four specifications of the equation (6.3). First, we estimate the overall treatment difference by estimating just α_1. Then, we estimate three specifications: different intercepts but the same slopes for signals and first-order beliefs for both joint liability treatments ($\alpha_4 = \alpha_5 = 0$); different intercepts and slopes in both treatments (unrestricted specification); and finally, we allow only slopes to vary but keep the intercept same ($\alpha_1 = 0$). We now present results from the experiment.

Table 6: First-period Descriptive Analysis

	e_1				Signal				
Contract	$\bar{e_1}$	SD	No. $e_{i1} = 3$	p-value $\bar{e_1} = 3$	$\bar{\theta}$	SD	$\bar{e_1} - \bar{\theta}$	Rep rate	N
ILI	3.76	2.37	8	0.002				66%	100
ILP	6.02	1.75	1	0.000				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	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.

7 Results

This section presents the experimental results. We start with the first-period effort comparisons between the treatments and then analyze the determinants of effort in the joint liability treatments. Next, we examine the second-period effort differences across the treatments. Finally, we consider the evidence on the inter-period comparison.

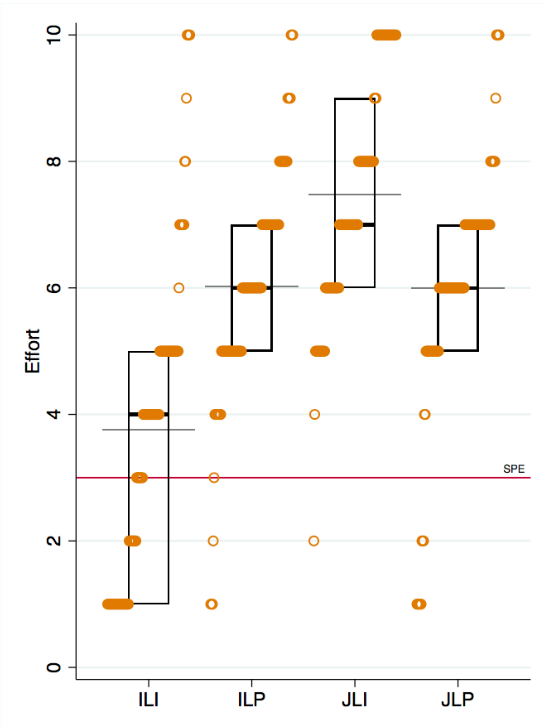
Figure 1(a) and 1(b) show, respectively, the first and second-period effort distributions in all four treatments; effort decisions varied significantly across the treatments. The first and second-period predictions of effort in the Nash equilibrium in the classical model, respectively 3 and 2, are not representative of either of the distributions. Further, a visual inter-period comparison shows that the effort distributions of *ILP*, *JLI* and *JLP* shifted upwards in the second period, implying a rightward shifts in these distributions, which is evidence against the predictions of the psychological and the classical models (see Proposition 2(a) and 4(c)) and can potentially be explained by using heuristics and non-optimization frameworks (Section 9, below).

7.1 First period

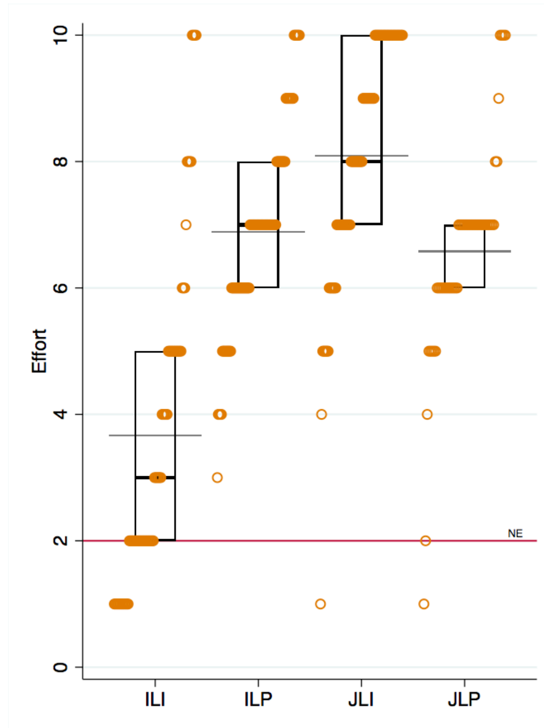
This section presents the results of the first period of the microfinance game. Figure 1(a) and Table 6 present the descriptive statistics for period 1. We begin with testing the predictions of the classical model (without psychological motives) and then present the evidence on the comparison between different treatments under the psychological model. Finally, we examine the determinants of effort in the joint liability treatments.

Testing Proposition 4(a): The classical model

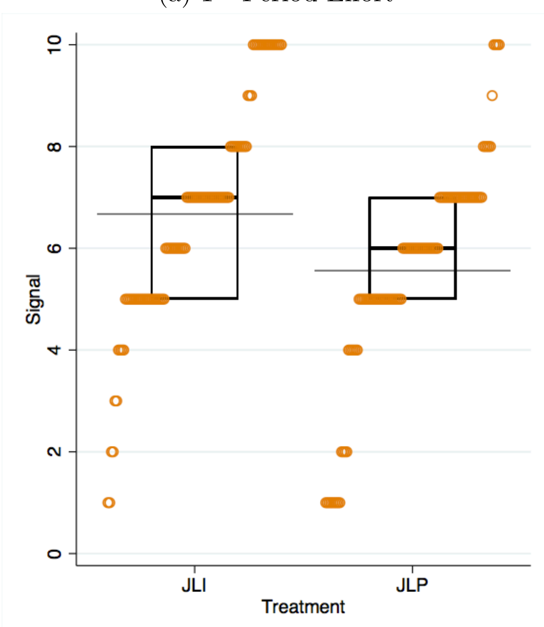
Proposition 4(a) and the parameter values in Table 2 imply that the optimal first-period effort in all four contracts is identical and equal to 3 in the classical model. Table 6, column 4 (titled No. $e_{i1} = 3$) shows that at the individual level, only 8 subjects in *ILI*, 1 in *ILP* and no subject in *JLI*



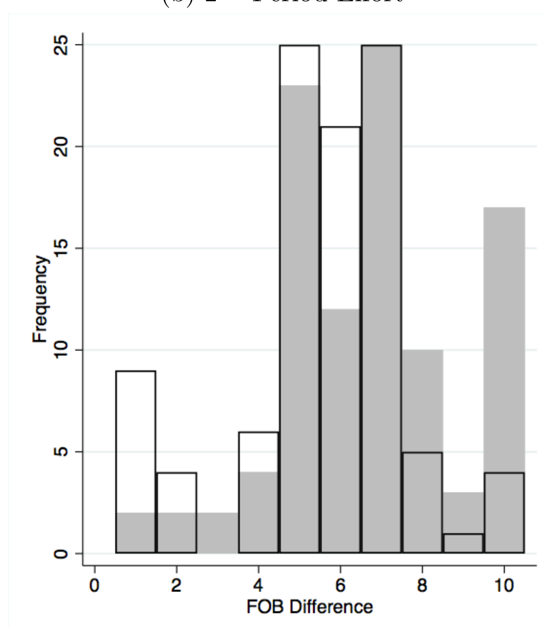
(a) 1^{st} Period Effort



(b) 2^{nd} Period Effort



(c) Signals in Joint Liability Groups



(d) FOB

Figure 1: Strip and Box plots for Effort and Signals, and Histogram for FOB in *JLI* and *JLP*. A long thin horizontal line across 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 in *JLP*.

and *JLP* choose the optimal effort level 3. The table also reports the p-values of the two-sided t-test for the equality between the average effort in each treatment and the optimal first-period effort. The average effort levels in all four treatments are significantly different from 3. The chosen effort levels also vary significantly between treatments except in *ILP* and *JLP*; we argue below that this result has important implications in explaining the move from Grameen-I to II. Under the classical model, the regression coefficients β_1, β_2, and β_3 in (6.2) are equal to zero. Table 7, specification 1, presents the estimation of equation (6.2) for the first period. It shows that all these coefficients are positive and statistically significant; the average effort levels in the three treatments, *ILP*, *JLI*, *JLP*, are significantly higher than the average effort in the baseline treatment *ILI*. The fact that the effort choices of subjects differ significantly from both a Nash equilibrium and a best response in beliefs, in the classical model, suggests that the explanation may lie in human psychological motivations.

Evidence on the psychological model

Without prior knowledge of the values of the psychological parameters, the psychological model does not make definitive predictions about pairwise comparisons of effort in the first period. Below, we present empirical evidence on contrasts between different contracts.

Individual Repayment - Individual vs. Joint Liability

We first consider a change in the liability structure of the contract from individual to joint liability while keeping the repayment method fixed to individual repayment, *ILI vs. JLI*. In our theoretical model, the contrast between the effort levels in *ILI vs. JLI* arises from guilt-aversion/surprise-seeking (see Table 1). The discussion on the determinants of effort in *JLI* is postponed to subsection 7.1.1. Our null hypothesis is that there is no difference in effort decisions between *ILI* and *JLI*.

Figure 1(a) shows that the distributions of effort appear 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*; see Table 6. Conditional on receiving a private signal, θ_i, about the partner's first-order 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 OLS estimation of equation (6.2) in Table 7.[30] For the comparison between *ILI* and *JLI*, the coefficient of interest is β_2, as it captures the treatment

[30] Since subjects can only report integer-valued effort levels, we have a case of the limited dependent variable. Therefore, we also estimated Tobit and ordered logit models. The results were similar, and the statistical significance did not change.

effect of joint liability. In the absence of psychological motivations such as guilt-aversion, surprise-seeking, we should expect $\beta_2 = 0$. On the contrary, we find a highly significant positive coefficient $\beta_2 = 3.72$ in specification 1. This is consistent with the psychological model. Since the only difference between *JLI* and *ILI* is the presence of guilt-aversion/surprise-seeking in the former but not the latter, the observed difference in effort levels is predicted to arise from these psychological motivations. However, our empirical results show that these differences also arose from differences in first-order beliefs in *JLI* and *ILI*; see further evidence below in subsection 7.1.1.

This result suggests that the joint liability contract alone, without public repayment, can induce borrowers to choose significantly higher effort and increase the repayment rates. Carpena et al. (2013) also find that joint liability 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 higher repayment. Below in subsection 7.1.1, we provide further evidence that in joint liability contracts, effort and repayments under the individual repayment method increase due to guilt-aversion/surprise-seeking motives (internal peer pressure).

Public Repayment - Individual vs. Joint Liability

We now assume that repayments are made in public and examine the effects of a change in the liability structure from individual to joint liability, i.e., *ILP vs. JLP*. This contrast allows us to compare the relative importance of guilt/surprise in joint liability contracts when subjects may also feel shame/approval due to low effort provision in front of others. Our null hypothesis is that subjects in the *JLP* treatment are not influenced by emotions that might play a role under joint liability (e.g., guilt-aversion), so there is no difference in effort between the two treatments.

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 social signal, $s = 6$, that captures normative expectations. The Epps-Singleton test suggests no significant difference between the effort distributions in the two treatments ($p = 0.122$).

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 signal, s, of normative expectations. 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 normative expectation. It shows that a large majority of the decisions in both treatments are consistent with our shame-aversion and approval-seeking hypothesis. 25% decisions exactly match the lower bound of empirical expectations, 5, in *ILP* and the corresponding percentage in *JLP* is 16%. Only 13% and 11% effort decisions are below both normative and empirical expectations in *ILP* and *JLP* respectively. This illustrates the powerful role played by empirical and normative expectations that is absent

Table 7: First-period Effort - Treatment Differences

Dep Var	1^{st} period effort			
Model No.	1	2	3	4
ILI		-2.26^{***}	-3.72^{***}	
		(0.25)	(0.48)	
ILP	2.26^{***}		-1.46^{***}	2.31^{***}
	(0.25)		(0.31)	(0.27)
JLI	3.72^{***}	1.46^{***}		3.74^{***}
	(0.48)	(0.31)		(0.49)
JLP	2.24^{***}	-0.02	-1.48^{***}	2.29^{***}
	(0.25)	(0.15)	(0.26)	(0.25)
Age				0.01
				(0.01)
Education				0.02
				(0.03)
Marital Status				-0.12
				(0.12)
Liability Type				0.28
				(0.18)
No of Loans				-0.06
				(0.04)
Control Group	*ILI*	*ILP*	*JLI*	*ILI*
Mean	3.76^{***}	6.02^{***}	7.48^{***}	3.18^{***}
	(0.25)	(0.19)	(0.36)	(0.69)
R^2	0.32	0.32	0.32	0.32
N	400	400	400	400

Notes: OLS regressions. Cluster-Roburst standard errors in parentheses, clustered at the session level. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

in the classical model and highlights the human predisposition to follow norms.

The estimated coefficients in Table 7 for *ILP* and *JLP* are almost identical, 2.26 and 2.24 respectively in specification 1. Further, specification 2 in Table 7 confirms that the difference in coefficients between *ILP* and *JLP*, 0.02, is negligible and insignificant. We fail to reject the null hypothesis of no difference in effort levels between *ILP* and *JLP*. The repayment rate in *ILP* is 81%, while in *JLP* it is slightly lower, 73%. Since the average effort level is the same and the distributions of effort are almost identical, the difference in repayment rate (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 under public repayment, motives for norm compliance alone arising through public repayment can be an effective instrument to discipline 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 both borrowers to succeed to get another loan. The same mechanism is likely to contribute towards the recent findings of no difference in default rates between individual and joint liability treatments when borrowers make repayments in public meetings in Giné and Karlan (2014).

Individual Liability: Individual vs. Public Repayment

We now examine the comparison between individual and public repayments when borrowers are individually liable for their loans, i.e., *ILI vs. ILP*. This comparison allows us to examine the role of public repayment that gives rise to shame-aversion and approval-seeking. 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 6, we see an increase of 60% in the average effort in *ILP* relative to *ILI*. For the regression analysis, in the absence of norm compliance (shame-aversion and approval-seeking), we expect $\beta_1 = 0$ in equation (6.2). Table 7, column 1, shows a highly significant positive coefficient for the *ILP* treatment, $\beta_1 = 2.26$. The higher average effort level in *ILP* increases the repayment rate by 23% (two-sided t-test, $p = 0.016$). This is consistent with the psychological model but not the classical model (Proposition 4(b)).

Since the only difference between *ILI* and *ILP* is the presence of shame-aversion/approval-seeking in the latter but not the former, it follows that the increase in the first-period effort in *ILP* must be due to norm compliance.

The public repayment method may be efficacious through other channels, such as facilitating greater risk sharing even under individual liability contracts, Feigenberg et al. (2013).[31] While these results in the field need to assume a positive, although unobserved, relation between more public meetings and risk sharing, our experimental results show a direct link between norm compliance and greater effort provision under public repayment.

Joint Liability: Individual vs. Public Repayment

Next, we consider the contrast between individual and public repayment when borrowers are jointly liable for their loans, *JLI vs. JLP*. Our null hypothesis is that borrowers in the *JLP* treatment are not influenced by public repayment, so there is no difference in effort between 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

[31] de Quidt et al. (2016) and Rai and Sjöström (2013) make a similar point theoretically.

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; see specification 3 in Table 7. 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 norms of effort, the social signal $s = 6$ in *JLP* plays a powerful role in concentrating the effort of subjects between 5 and 7. However, there is no social signal in the treatment *JLI*, where effort is instead motivated by feelings of guilt that result from putting in a lower effort relative to the private signal. The average private signal in *JLI* is $\theta = 6.67$, which is higher than the social signal in *JLP*. If instead, we had $s > \theta$ then it is quite likely that we would have observed a higher effort level in the *JLP* treatment.

In joint liability contracts, we find that the role of internal peer pressure (private signal, θ) in treatment *JLI* subsides in the *JLP* treatment due to the role of external pressure (social signal, s) that stems from a desire to follow the effort norm. In other words, *shame-aversion trumps guilt-aversion*. The results in subsection 7.1.1 tend to confirm this insight further.

ILP vs. JLI

Another important comparison is between the treatments *ILP* and *JLI*. This contrast allows us to directly compare the effects of psychological motivations (guilt-aversion and surprise-seeking) arising from joint liability with social motivations (shame-aversion and approval-seeking) arising from public repayment. It is important to test if *ILP* can be as effective as joint liability contracts alone (*JLI*) in reducing payment default.

We can make this comparison by testing the difference between β_2 and β_1 in (6.2), which is equivalent to the coefficient of *JLI* in specification 2 in Table 7.[32] 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 joint liability without public repayment (*JLI*) or the individual liability with public repayment (*ILP*) may be fully effective. As described in the previous sections, the effort level in public repayment treatments (e.g., *ILP*) is highly influenced by average normative expectation, s, while the repayment rates in *JLI* were influenced by the effort expectation of partners, as embodied by the 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. In our experiment, s was elicited from a pilot experiment. If s was higher (perhaps in a different pilot), then our regression indicates that the effort in *ILP* would have been even higher. Therefore, maintaining a norm of high effort or repayment through high normative expectations is critical to the effectiveness of public repayment.

[32] Alternatively one can also look at the coefficient of *ILP* in specification 3 of Table 7 where *JLI* is the control group.

Table 8: Determinants of Effort in Joint Liability Contracts

Dep Var	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		0.20^{***}	0.32^{***}	0.35^{***}
		(0.05)	(0.07)	(0.07)
FOB		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
N	200	200	200	200

Notes: OLS regressions. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

7.1.1 Determinants of effort in joint liability contracts.

We now consider the determinants of first-period effort in the joint liability treatments (*JLI* and *JLP*). Specifically, we are interested in the role of the signal of the partner's positive first-order beliefs, θ (the variable *Signal* in (6.3)) that underpins the guilt-aversion channel, and the player's own first-order beliefs about the partner's effort (the variable *FOB* in (6.3)). Under our induced beliefs design, these beliefs are different. By contrast, under direct belief elicitation these beliefs could be nearly identical (false consensus effect), which prevents 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.

Testing Proposition 3(a): Guilt-aversion in *JLI* and *JLP*

Proposition 3(a) states that in *JLI* and *JLP*, on account of guilt-aversion, first-period effort should increase with the signal of the partner's expectations, θ. From Table 6, the average first-period effort and the average signal 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 signal of either 9 or 10. As noted earlier, matching or exceeding these expectations would give rise to a negative return from the project; hence, these expectations are unreasonably high. The Spearman correlation coefficient between the private signals, θ_i, and the effort choices is 0.42 ($p = 0.000$).

Table 8 shows the determinants of effort in the joint liability treatments (*JLI* and *JLP*) by estimating equation (6.3). 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 8.[33] Thus, effort decisions in JLI are partly driven by guilt-aversion; Proposition 3(a) is verified for treatment *JLI*.

In treatment *JLP*, the average signal of the partner's first-order positive belief, θ, is 5.56, which is 1.11 units lower than the corresponding average signal in *JLI*. 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 signal in *JLI*. The Spearman correlation coefficient between the signal of the partner's expectation, θ, and 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 signals and the effort decisions in *JLP*; we examine the reason for this below.

From the regression analysis, the effect of the private signal (θ) on effort in *JLP* is measured by the sum of coefficients $\alpha_2 + \alpha_4$. A significant and positive (respectively, negative) value of α_4 implies that the effect of signals has increased (respectively, decreased) in *JLP* relative to *JLI*. In specifications 3 and 4 in Table 8, 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 signals on effort is almost zero in *JLP*. In comparison with the results from the contract *JLI*, this shows that the role of guilt-aversion is absent in the public treatment. The reason is that in the *JLP* treatment, individuals also subscribe to the norms of the effort level expected in their group, as captured by the normative expectation, s (external pressure). Hence, the partner's expectation (internal pressure) plays a more muted role and shame-aversion appears to trump guilt-aversion.

Testing Proposition 3(b): The effect of $\bar{b}_i$ in *JLI* and *JLP*

According to Proposition 3(b), the first-period effort in *JLI* and *JLP* increases with agent i's own first-order belief, $\bar{b}_i^1$, about the average effort of the other agent (agent j). An increase in $\bar{b}_i^1$ increases effort of agent i in joint liability contracts by increasing the probability of getting a second-period loan and, hence, also increasing the marginal product of agent $i's$ effort (see (2.19), (2.21)). From Table 4 we see that in the classical model, effort increases by 0.06 with every additional unit of first-order belief.

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

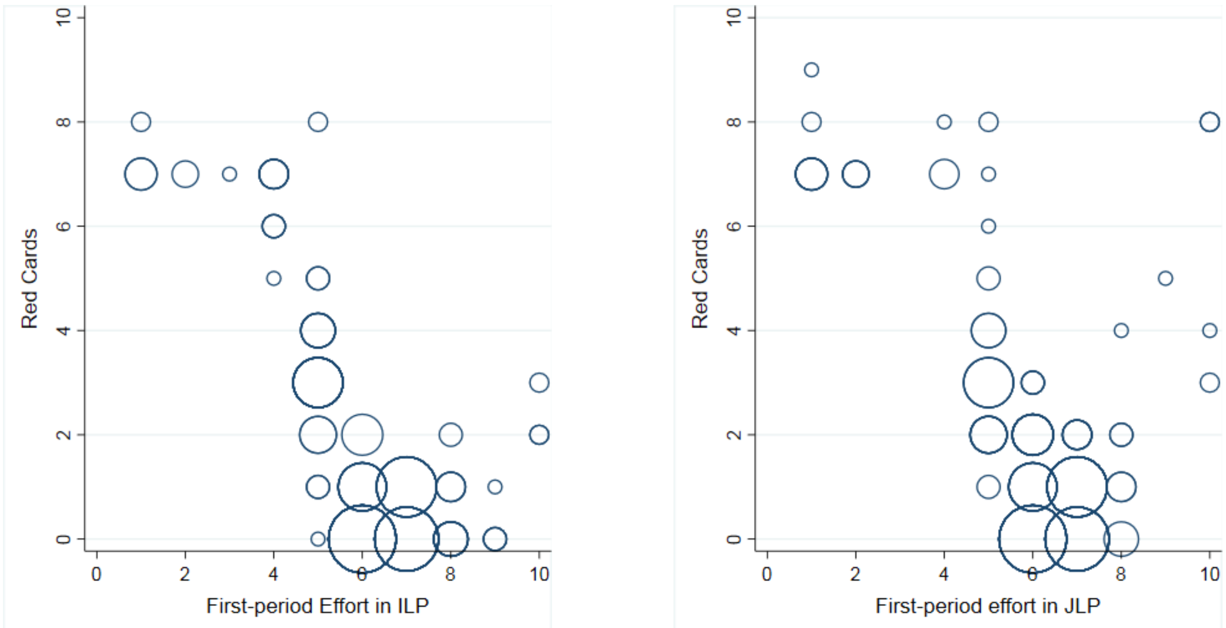


Figure 2: The Relationship between the Number of Red Cards Displayed and the First-period Effort in Public Repayment Treatments.

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 FOB and his/her effort decision is 0.43 ($p = 0.000$). The coefficient of FOB in *JLI* ranges between 0.38−0.41 in Table 8, specification 3 and 4. The coefficient is highly significant in both specifications. This is substantially larger than the coefficient implied by expected monetary utility alone in the classical model (i.e., 0.06 from Table 4). Coupled with effort choices that are much higher than 3 shows that the effect of first-order belief on effort in the classical model is inaccurate.

In Figure 1(d), the distribution of first-order beliefs in *JLP* shifts to the left, relative to *JLI*. In particular, there is a sharp increase (75%) at 6 and sharp decrease (76%) at 10 in *JLP*. The Epps-Singleton test confirms significant differences between the two FOB distributions ($p = 0.001$). In treatment *JLP*, the Spearman correlation coefficient between the subject's own FOB and effort decision is 0.61 ($p = 0.000$). Using (6.3), the overall effect of first-order beliefs on effort in *JLP* is estimated by $\alpha_3 + \alpha_5$. At the 5% significance level, the overall effect ranges between $0.38 - 0.62$; specifications 3 and 4 in Table 8.[34] Thus, the correlation between first-order beliefs and effort decision 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 classical model. The difference in FOB between *JLI* and *JLP* suggests that the presence or absence of the social signal, s, influences the formation of

[34] 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 9: Probability of Receiving a Red Card in the First Period in Public Repayment.

Effort level	ILP	JLP
Less than 5 $P(R \mid e_{i1} < 5)$	0.74	0.82
Equal to 5 $P(R \mid e_{i1} = 5)$	0.36	0.39
Greater than 5 $P(R \mid e_{i1} \geq 6)$	0.05	0.15

FOB. The social signal coordinates the expectations of subjects about what they expect from others.

7.1.2 Social disapproval under public repayment

At the time of making effort decisions, subjects under public repayment had to guess how many red cards (used to express social disapproval) they would receive at the end of the experiment if their effort fell below the normative signal. Figure 2 shows the relationship between the number of red cards and the chosen first-period effort levels in public repayment treatments. 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* and *JLP*) have very similar distributions and show three trends: (1) subjects who chose effort level 6 or above received either zero or very few red cards, and there are also a few incidences of anti-social punishments, which are not uncommon in non-Western subject pools (see Herrmann et al. (2008)); (2) subjects who chose effort level less than 5 (the lower bound of empirical expectations) received high social disapproval in the form of 7 or more red cards; (3) subjects who chose effort level 5 received a mixed response.

Table 9 shows the probability of receiving a red card for three effort categories in the first period. Regardless of the liability structure under public repayment treatments, the probability of receiving a red card is very high for those who chose effort less than both the social signal and the empirical expectation (74% in *ILP* and 82% in *JLP*), i.e. for those who chose effort less than 5. The probability reduces significantly for those who adhered to the lower bound of empirical expectation, 5, but chose effort below the social signal (36% in *ILP* and 39% in *JLP*). The probability of receiving a red card is the lowest for those who conformed with or exceeded the empirical expectation and the social signal (5% in *ILP* and 15% in *JLP*), i.e. for those who chose effort level 6 or above. These data show active social disapproval of effort that falls below the social norm. Our subjects appear to have correctly anticipated these consequences, so on average subjects conformed well with the normative expectations.

Table 10: Second-period Descriptive Analysis

Contract	No. $e_{i2} = e^*$	$\bar{e_2}$	$\bar{e_2} - e^*$	$\bar{e_1}$	$\bar{e_2}$ - $\bar{e_1}$	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. e^* is the optimal effort level in the second period in the classical model and equal to 2. The p-value is for two-sided t-test.

7.2 Second period

Figure 1(b) shows that, except in *ILI*, the distributions of effort in the second period for all four treatments shift to the right, relative to the first period. The average and median effort in *ILP*, *JLI* and *JLP* is higher in the second period, while in *ILI* the mean and median decrease. Table 10 presents the descriptive analysis of the second-period effort. We now test theoretical predictions of both the classical and the psychological models.

Testing Proposition 4(a): The classical model.

The relevant predictions of the classical model for the second period are summarized in Proposition 4(a), which states that the optimal second period effort in all four treatments is identical; in our parametrization, this effort equals 2. Using Table 10, column 2, for the individual level data, 20 subjects (30%) in *ILI*, no subject in *ILP* and *JLI*, and only one subject (2%) in *JLP* chose the effort level 2. The average effort in the second period is substantially higher than 2 in all four treatments. The difference varies by treatment, the highest in *JLI* (6.10) and the lowest in *ILI* (1.67); see Table 10, column 3. Table 11 presents the estimation of (6.2) for the second period. The only insignificant coefficient is the difference between *ILP* and *JLP*, -0.31. This implies that the average second-period effort differed significantly across all treatments, except in the public repayment treatments which indicates that the effort level is predominantly influenced by the normative signal, s, and other psychological motivations are suppressed. These results are inconsistent with the predictions of the classical model.

Testing Proposition 2(b): The psychological model (individual repayment)

Using Proposition 2(b) and our parametrization, in the psychological model, the second-period effort in individual repayment treatments (*ILI* and *JLI*) is identical and equal to 2 ($e_{i2}^{ILI} = e_{i2}^{JLI} = 2$). We have already established that the average effort levels in these two treatments are significantly higher than 2 (see columns 2 and 3 in Table 10). Moreover, the regression coefficients in Table 11 reveal that the average effort in *JLI* is 4.43 points (120%) higher than *ILI* and the

Table 11: Second-period Effort - Treatment Differences

Dep Var	2^{nd} period effort		
Model No.	1	2	3
ILI	–	-4.43^{***}	-3.22^{***}
		(0.47)	(0.27)
JLI	4.43^{***}	–	1.20^{**}
	(0.47)		(0.43)
ILP	3.22^{***}	-1.20^{**}	–
	(0.27)	(0.43)	
JLP	2.91^{***}	-1.51^{***}	-0.31
	(0.30)	(0.32)	(0.32)
Control Group	*ILI*	*JLI*	*ILP*
Mean	3.67^{***}	8.09^{***}	6.89^{***}
	(0.33)	(0.39)	(0.25)

Notes: OLS regressions. Cluster-Robust standard errors in parentheses, clustered at the session level. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. $N = 273$, $R^2 = 0.41$.

difference is highly significant. Proposition 2(b) is not verified by our experimental data. We argue below in Section 9 that the lack of this end period effect, in period 2, may be explained by a heuristics-based effort choice.

Testing Proposition 2(c): The psychological model (public repayment)

Proposition 2(c) states that if an individual assigns positive weight to norm compliance, then the optimal effort levels in public repayment treatments (*ILP* and *JLP*) are identical and, for our parametrization, greater than 2 (Proposition 2(a)). 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. The average effort difference is small, 0.31, and statistically insignificant (see Table 11, specification 3). Our results are consistent with Proposition 2(c).

Next, we 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*, *JLI*) (two-sided t-test, $p = 0.015$). However, testing for the effort difference by keeping fixed the liability structure (individual or joint) but varying the repayment method (private or public) gives a more nuanced result. Specification 1 of Table 11 shows that effort in *ILP* is 3.22 units higher (88% higher) relative to *ILI*. However, specification 2 in Table 11 shows that the average effort is significantly lower by 1.51 units (19% lower) in *JLP* relative to *JLI*.

7.3 Intertemporal comparison

Under the psychological and classical models (Proposition 2(a) and Proposition 4(c)), the optimal first-period effort is higher than the optimal second-period effort in all four treatments. Column 8 of Table 10 reports the number of subjects whose chosen effort in the second period is equal to or greater than their first-period effort. Contrary to the predictions of both models, 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*.

Table 10, column 5, also presents the first-period average effort, $\bar{e_1}$, of subjects who succeeded in getting a second-period loan, and made an effort choice in the second period. The paired average difference between the two periods' effort, $\bar{e_2} - \bar{e_1}$, in each treatment is reported in column 6 of Table 10. We also report p-values for paired t-test (for means) in column 7. In *ILI*, the average temporal difference in effort is negative -0.39, but statistically insignificant. 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, the predictions of Proposition 2(a) and Proposition 4(c) are not confirmed. Section 9 explains this in terms of heuristics-based effort choices.

7.4 Choice of contract by the bank

What implications do our results have for contractual choices by the bank? The last column of Table 10 shows that, in public repayment treatments, the number of loans granted in the second period is higher in *ILP* than *JLP*, 81 in *ILP* and 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 similar, 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. Thus, 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. In contrast to public repayment, the number of loans granted in private repayment was higher in the joint liability contract.

This contrast shows that a profit-maximizing bank may prefer individual liability under public repayment and joint liability under private repayment. The reason is that, under public repayment, individual and joint liability contracts induced similar effort levels because subjects were guided by norm compliance, while other psychological motives diminish (recall our shame-aversion trumps guilt-aversion result above). Under private repayment, where issues of social norms do not arise, joint liability induces guilt-aversion and surprise-seeking that encourage higher effort and repayment relative to individual liability. 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 sheds light on another reason for the contractual change from joint liability to individual liability in Grameen-II while retaining public repayment.

8 On methodology

In the second period of all contracts, players face a purely decision-theoretic problem (no game-theoretic interactions). And this is also the case for the first period of individual liability contracts, *ILI* and *ILP*. However, in the first period of the joint liability contracts, *JLI* and *JLP*, players play what is essentially a two-player static game of incomplete information. In this case, the appropriate solution concept from standard game theory is the Bayesian Nash equilibrium. Incomplete information is modelled by each player knowing her own type but not that of the partner in a joint liability contract. A type here may be considered to be a vector of parameters of the utility function that capture guilt-aversion, shame-aversion, their flip sides surprise-seeking and approval-seeking, and the relative weights put on these motives in the utility function. In the standard game theoretic framework, players are assumed to know the joint distribution of all types. A player then uses this, and the knowledge of her own type, to derive the probability of each type of the other player, using Bayes law. This allows us to define an expected utility function for each type of each player.

Let T_i be the set of types of player i. A pure strategy[35] for player i is an assignment of first-period effort levels, $e_{i1}(\tau_i)$, for player i, and for each type $\tau_i \in T_i$ of player i, i.e., a profile of effort levels, $\{e_{i1}(\tau_i)\}$. The strategy, $\{e_{i1}(\tau_i)\}$, for player i, is a best response to the strategy, $\{e_{j1}(\tau_j)\}$, of player j, $j \neq i$, if for each type, τ_i, of player i, $e_{i1}(\tau_i)$ maximizes player i's expected utility, given the strategy, $\{e_{j1}(\tau_j)\}$, of player j. Since the partner's type is not known, when computing his expected utility, player i of type τ_i takes expectations over all types, τ_j, of player j, using his probability assessment of his rival's types that he derived using his knowledge of his own type and knowledge of the joint probability distribution of all types, and applying Bayes law. A Bayesian Nash equilibrium is then a pair of strategies $(\{e_{11}(\tau_1)\}, \{e_{21}(\tau_2)\})$ such that $\{e_{11}(\tau_1)\}$ is a best response to $\{e_{21}(\tau_2)\}$ and $\{e_{21}(\tau_2)\}$ is a best response to $\{e_{11}(\tau_1)\}$.

Given a Bayesian Nash equilibrium, $(\{e_{11}(\tau_1)\}, \{e_{21}(\tau_2)\})$, we can work out the first-order beliefs of each type of player i about effort levels of player j, and the second-order beliefs of each type of player i about the first-order beliefs of player j about the effort levels of player i. However, we do not know the joint probability distribution of all types of players; and we doubt

[35] Since our utility functions turn out to be strictly concave, we do not have to consider mixed strategies.

whether the players themselves know this. So we follow the recent literature in psychological game theory and work directly with first and second-order beliefs; and we assume that players play best responses to their own beliefs. A fortiori, all our results will also apply to the special case where beliefs are derivable from a joint probability distribution of types via a Bayesian Nash equilibrium.[36]

9 Do agents optimize or do they use simple heuristics?

In keeping with the traditional method in economics, we have followed a strict optimization approach (which here entails using backward induction in solving a two-period problem to find the dynamically optimal solution). Both the psychological (Proposition 2(a)) and the classical model (Proposition 4 (c)) predict that the first-period effort should be greater than the second-period effort in all treatments. 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 the predictions of Propositions 2(a), 4(c), but only qualitatively. For the reasons given in the discussion on Proposition 2 and Proposition 4, it is difficult to see how any strict optimizing framework can avoid the prediction that optimal first-period effort is greater than optimal second-period effort.

The main alternative to optimization is the *heuristics* and *biases* approach associated with Daniel Kahneman and Amos Tversky. What heuristics might our experimental subjects be using? Our respondents live in traditional rural communities in Pakistan. In such communities, social norms, often backed by sanctions for non-compliance, impart a powerful incentive to conform to social rules. The most relevant signal of the appropriate social norm, in our experiments, is the *normative* expectation, s, received by each agent in the public repayment treatments (*ILP* and *JLP*).[37] These expectations specify the socially appropriate effort level, as judged by one's peers.

Conformity with social norms (external pressure) is not the only factor in influencing effort in joint liability treatments. In particular, in the contract *JLP*, agent i also receives a private signal of the partner's expectation of effort, θ_i; this leads to a consideration of the emotions of guilt-aversion and surprise-seeking (internal pressure). In the *JLP* contract, where both internal and external pressures are present, how should agents balance the emotions of guilt-aversion/surprise-seeking, on the one hand, with shame-aversion/approval-seeking on the other? This is an unresolved question that has not received adequate attention in economic theory partly because it has not simultaneously formalized the microfoundations of these human motives.

The relative efficacy of shame-aversion/approval-seeking and guilt-aversion/surprise-seeking in influencing behavior may be culture-dependent (Enke, 2019; Fessler, 2004). Recently, Sznycer et al. (2018) have argued that the emotion of shame is universal and an elemental part of human

[36] For a similar argument and other solution concepts for psychological games see Battigalli et al. (2019).

[37] Recall that in our experiments, the empirical expectations are closely aligned with the normative expectations.

biology. Our data suggests that these emotions are context-dependent and in the presence of both motives, shame-aversion/approval-seeking takes precedence over guilt-aversion/surprise-seeking.

Consider *JLI*, where repayment is private, so no shame or approval motive is involved. In period 1, if agents are guilt-averse and perceive that the private signal, θ_i, of the partner's expectation of the effort level is not unreasonably high, then they are likely to choose an effort level that is close to the signal. In period 2, there are two possibilities. If agents engage in strict economic calculus, then they should realize that their contract is effectively identical to an *ILI* contract in period 2 and an end game effect should kick-in. Alternatively, subjects might use the *anchoring heuristic* in solving a cognitively challenging game.[38] In the context of our game, the signal of their partner in the first period, θ_i, may serve to anchor agents' efforts at θ_i in the second period.

Below, we conjecture that agents follow the following 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.

Thus, agents do not optimize in its strict sense, they simply set their effort level close, or equal, to the social norm to avoid shame or loss of social capital (see Example 3 in the introduction).

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 second period, there is no guilt-aversion/surprise-seeking, just shame-aversion and approval-seeking motives. So, agent i sets effort level close, or equal, to the social norm, s. However, in the first period, both guilt-aversion/surprise-seeking and shame-aversion/approval-seeking motive are present. Moreover, the agent receives two, possibly conflicting, signals (θ_i and s). In this case, due to precedence of social norm compliance, the evidence above is consistent with agent i ignoring θ_i, and setting $\widetilde{e}_{i1}^{JLP} \simeq s$.

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.

Thus, in the first period, agent i simply sets effort level close, or equal, to θ_i (provided θ_i is not unreasonably high) to avoid guilt with respect to the partner. In the second period, there is no guilt-aversion/surprise-seeking, 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.*

[38] There is much evidence that subjects are highly influenced by anchors, even informationally useless ones, in making decisions, see Dhami (2016, Section 19.6).

Another implication of H1, H2, H3 is that as the normative expectations, encapsulated in the signal s, increase, agent i increases his/her effort level. By contrast, under psychological utility and best response to beliefs, the effort is increasing in s if agent i is myopic, otherwise the relevant derivative cannot be signed (see Appendix-B).[39] Our empirical results have highlighted that effort is increasing in s (e.g., the contrast between treatments *ILI* and *ILP*). Also shame-aversion trumps guilt-aversion (contrast between *JLI* and *JLP*) which gives the corollary that effort follows s and so must be increasing in s. The only way to explain this empirical result is either subjects (1) exhibit myopia and play psychological best responses, or (2) they follow heuristics of the form mentioned above.

This leaves out the contract *ILI.* There are no signals, s or θ_i, in *ILI* contracts, and our Conjectures H1-H3 do not apply. So, what heuristics are agents using in this case? This, clearly, requires further research.

10 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 precisely defines peer pressure (or internal pressure) and social capital (or external pressure) in an empirically testable manner. Our experimental results confirm the importance of these motivations under different contracts.

The psychological model formulates guilt-aversion/surprise-seeking as the internal pressure, and shame-aversion/approval-seeking determine the external pressure that borrowers face in a typical microfinance environment. There should be no presumption that these two motives are weighted equally in the preferences of borrowers. Experimental results show that while guilt and surprise are identified as the main determinants of effort in joint liability contracts under private repayment (*JLI*), these motivations subside under public repayment of loans. In public repayment, subjects appear to be more keen to avoid *shame* due to low effort, as compared to avoiding *guilt* from falling behind their partner's expectations. This result provides a compelling explanation for the move from joint liability to individual liability contracts (as in the move from Grameen-I to II), provided that repayment of loans is in public. 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 public repayment, irrespective of the liability structure.

Average effort levels in both periods are significantly higher in all our four treatments relative to the predictions of the classical model. In the second period, the psychological model makes the same prediction under private repayment as the classical model. Both rely on an end-game effect in a two-period model that is not supported by the evidence. We argue that the lack

[39] Much empirical evidence suggests the presence of myopia, for instance, in loss aversion behavior (Dhami, 2016, Section 3.4).

of an end game effect may be consistent with heuristics-based choices, such as those that rely on the anchoring heuristic. Under public repayment, the prediction of norm compliance in the psychological model is verified by data.

Overall our results highlight the importance of behavioral motivations in economic decision making in the microfinance environment. 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 better understanding of human behavior.

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Appendix A (Proofs)

Proof of Proposition 1

In Definition 2, F_i^1 enters $U(e_{i1}, e_{i2}, \mathbf{p}_i)$ through $\overline{b}_i^1$ (recall (2.23)), F_i^2 enters $U(e_{i1}, e_{i2}, \mathbf{p}_i)$ through ϕ_i (recall (2.14)) and G_i^2 enters $U(e_{i1}, e_{i2}, \mathbf{p}_i)$ through $\overline{\phi}_i$ (recall (2.16)). Since $U(e_{i1}, e_{i2}, \mathbf{p}_i)$ is a continuous function on the compact set, $(e_{i1}, e_{i2}) \in [0,1] \times [0,1]$, a psychological best response (Definition 2) does exist.

To prove uniqueness, we first derive some intermediate results. Using integration by parts, (2.16) can be written in the equivalent form:

$$\overline{\phi}_i(e_{it}, s) = \overline{\alpha}_i \int_{e'_{it}=0}^{e_{it}} G_i^2(e'_{it} \mid s)\, de'_{it} + \overline{\beta}_i \int_{e'_{it}=e_{it}}^{1} G_i^2(e'_{it} \mid s)\, de'_{it} - \overline{\beta}_i (1 - e_{it}). \tag{A.1}$$

Differentiating (A.1) gives

$$\frac{\partial \overline{\phi}_i(e_{it}, s)}{\partial \overline{\beta}_i} = \int_{e'_{it}=e_{it}}^{1} G_i^2(e'_{it} \mid s)\, de'_{it} - (e_{it} - 1). \tag{A.2}$$

Using the inequality

$$\int_{e'_{it}=e_{it}}^{1} G_i^2(e'_{it} \mid s)\, de'_{it} < (1 - e_{it})\, G_i^2(1 \mid s) = 1 - e_{it}, \tag{A.3}$$

we get, from (A.2),

$$\frac{\partial \overline{\phi}_i(e_{it}, s)}{\partial \overline{\beta}_i} < 0. \tag{A.4}$$

Now, recall that (2.19) takes the form: $U(e_{i1}, e_{i2}, \mathbf{p}) = \Psi(e_{i1}) + \psi(e_{i1}) V(e_{i2}, \mathbf{p})$, where $\psi(e_{i1})$ and $\Psi(e_{i1})$ are functions of e_{i1} but not e_{i2}, $\psi(e_{i1}) > 0$ and $V(e_{i2}, \mathbf{p})$ is a function of e_{i2} but not e_{i1}. Hence, maximizing $U(e_{i1}, e_{i2}, \mathbf{p})$ with respect to e_{i2} reduces to maximizing $V(e_{i2}, \mathbf{p})$ with respect to e_{i2}.

From (2.8), (A.2) and (2.22), we get:

$$\frac{\partial}{\partial e_{i2}} V(e_{i2}, \mathbf{p}) = \frac{1}{2}[Y - L(1+r)] - c'(e_{i2}) + (T_{ILP} + T_{JLP})\, \overline{\mu}_i \left[\overline{\beta}_i - \left(\overline{\beta}_i - \overline{\alpha}_i\right) G_i^2(e_{i2} \mid s)\right], \tag{A.5}$$

$$\frac{\partial^2}{\partial e_{i2}^2} V(e_{i2}, \mathbf{p}) = -c''(e_{i2}) - (T_{ILP} + T_{JLP})\, \overline{\mu}_i \left(\overline{\beta}_i - \overline{\alpha}_i\right) g_i^2(e_{i2} \mid s). \tag{A.6}$$

From (2.9), (2.17), (A.6) and the fact that $\overline{\mu}_i \geq 0$, we get that $\frac{\partial^2}{\partial e_{i2}^2} V(e_{i2}, \mathbf{p}) < 0$. Hence, $V(e_{i2}, \mathbf{p})$ is strictly concave in e_{i2} and, hence, the optimum, e_{i2}^k, is unique (where k refers to the contract under operation).

Having determined e_{i2}^k optimally, the optimal value for e_{i1} can be found by maximizing $U\left(e_{i1}, e_{i2}^k, \mathbf{p}\right)$ with respect to e_{i1}, given e_{i2}^k. From (2.1), (2.15), (2.17) and (2.19), we get

$$\begin{aligned}\frac{\partial^2 U\left(e_{i1}, e_{i2}, \mathbf{p}\right)}{\partial e_{i1}^2} &= -c''\left(e_{i1}\right) - \left(T_{JLI} + T_{JLP}\right)\mu_i\left(\beta_i - \alpha_i\right) f_i^2\left(e_{i1} \mid \theta_i\right) \\ &\quad - \left(T_{ILP} + T_{JLP}\right)\overline{\mu}_i\left(\overline{\beta}_i - \overline{\alpha}_i\right) g_i^2\left(e_{i1} \mid s\right) < 0,\end{aligned} \tag{A.7}$$

hence, $U\left(e_{i1}, e_{i2}, \mathbf{p}\right)$ is strictly concave in e_{i1} and, hence, the optimum, e_{i1}^k, is unique. ■

Proof of Proposition 2

We first derive some intermediate results:

Using integration by parts, (2.14) can be written in the equivalent form:

$$\phi_i\left(e_{i1}, \theta_i\right) = \alpha_i \int_{e'_{i1}=0}^{e_{i1}} F_i^2\left(e'_{i1} \mid \theta_i\right) de'_{i1} + \beta_i \int_{e'_{i1}=e_{i1}}^{1} F_i^2\left(e'_{i1} \mid \theta_i\right) de'_{i1} - \beta_i\left(1 - e_{i1}\right) \tag{A.8}$$

Differentiating (A.8) gives

$$\frac{\partial \phi_i\left(e_{i1}, \theta_i\right)}{\partial \beta_i} = \int_{e'_{i1}=e_{i1}}^{1} F_i^2\left(e'_{i1} \mid \theta_i\right) de'_{i1} - \left(1 - e_{i1}\right) \tag{A.9}$$

Using the inequality

$$\int_{e'_{i1}=e_{i1}}^{1} F_i^2\left(e'_{i1} \mid \theta_i\right) de'_{i1} < \left(1 - e_{i1}\right) F_i^2\left(1 \mid \theta_i\right) = 1 - e_{i1} \tag{A.10}$$

we get, from (A.9),

$$\frac{\partial \phi_i\left(e_{i1}, \theta_i\right)}{\partial \beta_i} < 0 \tag{A.11}$$

Now, note that the second period is identical whether we have *ILI* or *JLI* contracts. Hence, since the optimum is unique (Section 3), $e_{i2}^{ILI} = e_{i2}^{JLI}$. Similarly, the second period is identical whether we have *ILP* or *JLP* contracts and the optimum is unique. Hence, $e_{i2}^{ILP} = e_{i2}^{JLP}$.

We give the rest of the proof in two stages. First we prove (a) $e_{i2}^k < e_{i1}^k$, i.e., for all contracts k, optimal first period effort is higher than optimal second-period effort. Then we prove (b) $e_{i2}^{ILI,\,JLI} < e_{i2}^{ILP,\,JLP}$, i.e., optimal second period effort under public repayment is higher than optimal second-period effort under individual repayment.

(a) From (2.19) we get

$$\begin{aligned}&\frac{\partial}{\partial e_{i1}} U\left(e_{i1}, e_{i2}, \mathbf{p}_i\right) \\ &= \frac{\partial}{\partial e_{i1}} EM\left(e_{i1}\right) + \left(T_{JLI} + T_{JLP}\right)\mu_i \frac{\partial}{\partial e_{i1}}\phi_i\left(e_{i1}, \theta_i\right) + \left(T_{ILP} + T_{JLP}\right)\overline{\mu}_i \frac{\partial}{\partial e_{i1}}\overline{\phi}_i\left(e_{i1}, s\right) \\ &+ \frac{\partial}{\partial e_{i1}} p\left(e_{i1}\right)\left[T_{ILI} + T_{ILP} + \left(T_{JLI} + T_{JLP}\right) p\left(\overline{b}_i^1\right)\right]\left[EM\left(e_{i2}\right) + \left(T_{ILP} + T_{JLP}\right)\overline{\mu}_i \overline{\phi}_i\left(e_{i2}, s\right)\right], \\ &\mu_i \geq 0,\ \overline{\mu}_i \geq 0.\end{aligned} \tag{A.12}$$

From (2.3), (2.8), (A.9), (A.2) and (A.12),

$$\frac{\partial}{\partial e_{i1}}U\left(e_{i1},e_{i2},\mathbf{p}_i\right)=\frac{1}{2}\left[Y-L\left(1+r\right)\right]-c'\left(e_{it}\right)$$
$$+\left(T_{JLI}+T_{JLP}\right)\mu_i\left[\beta_i+\left(\alpha_i-\beta_i\right)F_i^2\left(e_{i1}\mid\theta_i\right)\right]$$
$$+\left(T_{ILP}+T_{JLP}\right)\overline{\mu}_i\left[\overline{\beta}_i+\left(\overline{\alpha}_i-\overline{\beta}_i\right)G_i^2\left(e_{it},s\right)\right]$$
$$+\frac{1}{2}\left[T_{ILI}+T_{ILP}+\left(T_{JLI}+T_{JLP}\right)p\left(\overline{b}_i^1\right)\right]\left[EM\left(e_{i2}\right)+\left(T_{ILP}+T_{JLP}\right)\overline{\mu}_i\overline{\phi}_i\left(e_{i2},s\right)\right]. \quad \text{(A.13)}$$

Since $EM\left(e_{i2}^k\right)+\left(T_{ILP}+T_{JLP}\right)\overline{\mu}_i\overline{\phi}_i\left(e_{i2}^k,s\right)>0$, we get from (A.13):

$$\frac{\partial}{\partial e_{i1}}U\left(e_{i1},e_{i2}^k,\mathbf{p}_i\right)>\frac{1}{2}\left[Y-L\left(1+r\right)\right]-c'\left(e_{i1}\right)$$
$$+\left(T_{JLI}+T_{JLP}\right)\mu_i\left[\beta_i-\left(\beta_i-\alpha_i\right)F_i^2\left(e_{i1}\mid\theta_i\right)\right]$$
$$+\left(T_{ILP}+T_{JLP}\right)\overline{\mu}_i\left[\overline{\beta}_i-\left(\overline{\beta}_i-\overline{\alpha}_i\right)G_i^2\left(e_{i1}\mid s\right)\right], \quad \text{(A.14)}$$

Since $\left(T_{JLI}+T_{JLP}\right)\mu_i\left[\beta_i-\left(\beta_i-\alpha_i\right)F_i^2\left(e_{i1}\mid\theta_i\right)\right]\geq 0$, we get from (A.14):

$$\frac{\partial}{\partial e_{i1}}U\left(e_{i1},e_{i2}^k,\mathbf{p}_i\right)>\frac{1}{2}\left[Y-L\left(1+r\right)\right]-c'\left(e_{i1}\right)$$
$$+\left(T_{ILP}+T_{JLP}\right)\overline{\mu}_i\left[\overline{\beta}_i-\left(\overline{\beta}_i-\overline{\alpha}_i\right)G_i^2\left(e_{i1}\mid s\right)\right], \quad \text{(A.15)}$$

Since $e_{i1}^k\in(0,1)$, we get $\frac{\partial}{\partial e_{i1}}U\left(e_{i1}^k,e_{i2}^k,\mathbf{p}_i\right)=0$. Hence, from (A.15) we get

$$\frac{1}{2}\left[Y-L\left(1+r\right)\right]-c'\left(e_{i1}^k\right)$$
$$+\left(T_{ILP}+T_{JLP}\right)\overline{\mu}_i\left[\overline{\beta}_i-\left(\overline{\beta}_i-\overline{\alpha}_i\right)G_i^2\left(e_{i1}^k\mid s\right)\right]<0 \quad \text{(A.16)}$$

Assuming $e_{i2}^k\in(0,1)$, we get $\frac{\partial}{\partial e_{i2}}V\left(e_{i2}^k,\mathbf{p}_i\right)=0$. Hence, from (A.5) we get

$$\frac{1}{2}\left[Y-L\left(1+r\right)\right]-c'\left(e_{i2}^k\right)+\left(T_{ILP}+T_{JLP}\right)\overline{\mu}_i\left[\overline{\beta}_i-\left(\overline{\beta}_i-\overline{\alpha}_i\right)G_i^2\left(e_{i2}^k\mid s\right)\right]=0, \quad \text{(A.17)}$$

and, hence,

$$\frac{1}{2}\left[Y-L\left(1+r\right)\right]=c'\left(e_{i2}^k\right)-\left(T_{ILP}+T_{JLP}\right)\overline{\mu}_i\left[\overline{\beta}_i-\left(\overline{\beta}_i-\overline{\alpha}_i\right)G_i^2\left(e_{i2}^k\mid s\right)\right]. \quad \text{(A.18)}$$

Substitute for $\frac{1}{2}\left[Y-L\left(1+r\right)\right]$ from (A.18) into (A.16), to get

$$c'\left(e_{i2}^k\right)-\left(T_{ILP}+T_{JLP}\right)\overline{\mu}_i\left[\overline{\beta}_i-\left(\overline{\beta}_i-\overline{\alpha}_i\right)G_i^2\left(e_{i2}^k\mid s\right)\right]-c'\left(e_{i1}^k\right)$$
$$+\left(T_{ILP}+T_{JLP}\right)\overline{\mu}_i\left[\overline{\beta}_i-\left(\overline{\beta}_i-\overline{\alpha}_i\right)G_i^2\left(e_{i1}^k\mid s\right)\right]<0, \quad \text{(A.19)}$$

From (A.19), we get

$$\begin{aligned} & c'\left(e_{i2}^{k}\right) + \left(T_{ILP} + T_{JLP}\right)\overline{\mu}_i\left(\overline{\beta}_i - \overline{\alpha}_i\right)G_i^2\left(e_{i2}^{k} \mid s\right) \\ & < c'\left(e_{i1}^{k}\right) + \left(T_{ILP} + T_{JLP}\right)\overline{\mu}_i\left(\overline{\beta}_i - \overline{\alpha}_i\right)G_i^2\left(e_{i1}^{k} \mid s\right), \end{aligned} \tag{A.20}$$

But $c'(e)$ is a strictly increasing function of e and $\left(T_{ILP} + T_{JLP}\right)\overline{\mu}_i\left(\overline{\beta}_i - \overline{\alpha}_i\right)G_i^2(e \mid s)$ is a non-decreasing function of e. Hence, from (A.20), we get $e_{i2}^{k} < e_{i1}^{k}$. This completes stage (a) of the proof.

(b) We have

$$EM'\left(e_{i2}^{ILI,JLI}\right) = 0 \Leftrightarrow \frac{1}{2}\left[Y - L(1+r)\right] - c'\left(e_{i2}^{ILI,JLI}\right) = 0$$

$$\frac{\partial}{\partial e_{i2}}V\left(e_{i2}^{ILP,JLP}, \mathbf{p}_i\right) = 0 \Leftrightarrow$$

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

$$\frac{1}{2}\left[Y - L(1+r)\right] = c'\left(e_{i2}^{ILI,JLI}\right) \tag{A.21}$$

$$\frac{1}{2}\left[Y - L(1+r)\right] - c'\left(e_{i2}^{ILP,JLP}\right) + \left(T_{ILP} + T_{JLP}\right)\overline{\mu}_i\left[\overline{\beta}_i - \left(\overline{\beta}_i - \overline{\alpha}_i\right)G_i^2\left(e_{i2}^{ILP,JLP} \mid s\right)\right] = 0 \tag{A.22}$$

From (A.21) and (A.22):

$$c'\left(e_{i2}^{ILI,JLI}\right) - c'\left(e_{i2}^{ILP,JLP}\right) + \left(T_{ILP} + T_{JLP}\right)\overline{\mu}_i\left[\overline{\beta}_i - \left(\overline{\beta}_i - \overline{\alpha}_i\right)G_i^2\left(e_{i2}^{ILP,JLP} \mid s\right)\right] = 0,$$

$$\begin{aligned} c'\left(e_{i2}^{ILP,JLP}\right) - c'\left(e_{i2}^{ILI,JLI}\right) &= \left(T_{ILP} + T_{JLP}\right)\overline{\mu}_i\left[\overline{\beta}_i - \left(\overline{\beta}_i - \overline{\alpha}_i\right)G_i^2\left(e_{i2}^{ILP,JLP} \mid s\right)\right] \geq 0, \\ & \text{and } > 0, \text{ if } \overline{\mu}_i > 0. \end{aligned} \tag{A.23}$$

Hence, $c'\left(e_{i2}^{ILP,JLP}\right) > c'\left(e_{i2}^{ILI,JLI}\right)$, so $e_{i2}^{ILP,JLP} > e_{i2}^{ILI,JLI}$. This completes stage (b) of the proof. Combining the results of stages (a) and (b), we get $e_{i2}^{ILI,\ JLI} < e_{i2}^{ILP,\ JLP} < e_{i1}^{k}$. ■

Proof of Proposition: 4

(a) When agent i chooses her optimal second-period effort level, she maximizes $EM(e_{i2})$ with respect to e_{i2}. From (2.3) and (2.6), recall that $EM(e_{i2}) = \frac{1+e_{i2}}{2}\left[Y - L(1+r)\right] - c(e_{i2})$, which is the same for all agents, under all contracts, is independent of e_{i1}, e_{j1}, e_{i2} and has a unique maximum, e_{i2}^{k}. Hence, e_{i2}^{k} must be the same for both agents and for all four contracts.

(b) Consider one of the independent liability contracts, *ILI* or *ILP*. Having chosen e_{i2}^k optimally, agent i then chooses e_{i1} so as to maximize $U\left(e_{i1}, e_{i2}^k, \mathbf{p}_i\right)$, given by (5.4). Since e_{i2}^k is the same for both agents and all contracts (part (a)), since $U\left(e_{i1}, e_{i2}^k, \mathbf{p}_i\right)$ is the same objective function for both agents under both *ILI* and *ILP*, since $U\left(e_{i1}, e_{i2}^k, \mathbf{p}_i\right)$ is independent of e_{j1}, and since $U\left(e_{i1}, e_{i2}^k, \mathbf{p}_i\right)$ has a unique maximum e_{i1}^{IL}, it follow that e_{i1}^{IL} must be the same for both agents and both independent liability contracts.

(c) Here, we are concerned with the joint liability contracts. Hence, $T_{ILI} = T_{ILP} = 0$ and either $T_{JLI} = 1, T_{JLP} = 0$ or $T_{JLI} = 0, T_{JLP} = 1$. From (2.3), (5.4) and (5.5) we get, for $i, j \in \{1, 2\}$, $i \neq j$:

$$\frac{\partial U\left(e_{i1}^{IL}, e_{i2}^{IL}, \mathbf{p}_i\right)}{\partial e_{i1}} = EM'\left(e_{i1}^{IL}\right) + \frac{1}{2}EM\left(e_{i2}^{IL}\right), \tag{A.24}$$

$$\frac{\partial U\left(e_{i1}^{JL}, e_{i2}^{JL}, \mathbf{p}_i\right)}{\partial e_{i1}} = EM'\left(e_{i1}^{JL}\right) + \frac{1}{2}p\left(\overline{b}_i^1\right)EM\left(e_{i2}^{JL}\right). \tag{A.25}$$

(i) Since e_{11}^{JL} is an interior maximum we must have $\frac{\partial U\left(e_{11}^{JL}, e_{12}^{JL}, \mathbf{p}_i\right)}{\partial e_{11}} = 0$. Thus, from (A.25), we get $EM'(e_{11}^{JL}) = -\frac{1}{2}p\left(\overline{b}_1^1\right)EM\left(e_{12}^{JL}\right)$. However, e_{12}^{JL} is the optimal second-period effort, hence, from (2.7), we must have $EM\left(e_{12}^{JL}\right) > 0$. Thus, $EM'(e_{11}^{JL}) < 0$. Since e_{12}^{JL} is an interior optimum, we must have $EM'\left(e_{12}^{JL}\right) = 0$. Hence, $EM'(e_{11}^{JL}) < EM'\left(e_{12}^{JL}\right)$. However, from (2.9), we have $EM'' < 0$. Hence, $e_{12}^{JL} < e_{11}^{JL}$.

(ii) Since e_{11}^{IL} is an interior optimum, we must have $\frac{\partial U\left(e_{11}^{IL}, e_{12}^{IL}, \mathbf{p}_i\right)}{\partial e_1} = 0$. Hence, from (A.24), we get $EM'\left(e_{11}^{IL}\right) + \frac{1}{2}EM\left(e_{12}^{IL}\right) = 0$. But, from part (a), we have $e_{12}^{IL} = e_{12}^{JL}$. Hence, $EM\left(e_{12}^{JL}\right) = -2EM'\left(e_{11}^{IL}\right)$. We have already established (under (i), above) that $EM'(e_{11}^{JL}) = -\frac{1}{2}p\left(\overline{b}_1^1\right)EM\left(e_{12}^{JL}\right)$. Hence, $EM'(e_{11}^{JL}) = p\left(\overline{b}_1^1\right)EM'\left(e_{11}^{IL}\right)$. In part (i), above, we also established that $EM'(e_{11}^{JL}) < 0$. From (2.24), $0 < p\left(\overline{b}_1^1\right) < 1$. Hence $EM'(e_{11}^{JL}) > EM'\left(e_{11}^{IL}\right)$. Since $EM'' < 0$ (from (2.9)), it follows that $e_{11}^{JL} < e_{11}^{IL}$.

(iii) From (i) and (ii) it follows that $e_{12}^{JL} < e_{11}^{JL} < e_{11}^{IL}$. Similarly, it can be shown that $e_{22}^{JL} < e_{21}^{JL} < e_{21}^{IL}$. Thus, $e_{i2}^{JL} < e_{i1}^{JL} < e_{i1}^{IL}$. But from part (a), $e_{i2}^{JL} = e_{i2}^k$, for all contracts, k. This completes the proof of part (c).

(d) By taking $p\left(\overline{b}_i^1\right) = p\left(e_{j1}^{JL}\right)$, recall (5.8), we can see that (d) is a special case of (c). ■

Appendix-B (Complete comparative static results)

For the case $e_{i2}^k \in (0, 1)$ we have:

$$\left[\frac{\partial}{\partial e_{i2}}V\left(e_{i2}, \mathbf{p}_i\right)\right]_{e_{i2}=e_{i2}^k} = 0. \tag{A.26}$$

Since V is a function of e_{i2} but not of e_{i1}, we have:

$$\begin{aligned}
\frac{\partial e_{i2}^k}{\partial p} &= -\left[\frac{\partial^2 V\left(e_{i2}, \mathbf{p}_i\right)}{\partial e_{i2} \partial p}\right]_{e_{i2}=e_{i2}^k} \div \left[\frac{\partial^2 V\left(e_{i2}, \mathbf{p}_i\right)}{\partial e_{i2}^2}\right]_{e_{i2}=e_{i2}^k}, \\
p &\in \left\{\theta_i, s, \mu_i, \overline{\mu}_i, \alpha_i, \beta_i, \overline{\alpha}_i, \overline{\beta}_i, \overline{b}_i^1, Y, L, r\right\}, \\
k &\in \{ILI, ILP, JLI, JLP\}. \qquad \text{(A.27)}
\end{aligned}$$

Since $\frac{\partial^2 V(e_{i2}, \mathbf{p}_i)}{\partial e_{i2}^2} < 0$, $\frac{\partial e_{i2}^k}{\partial p}$ has the same sign as $\left[\frac{\partial^2 V(e_{i2}, \mathbf{p}_i)}{\partial e_{i2} \partial p}\right]_{e_{i2}=e_{i2}^k}$.

Similarly, for the case $e_{i1}^k \in (0,1)$ we have:

$$\left[\frac{\partial}{\partial e_{i1}} U\left(e_{i1}, e_{i2}^k, \mathbf{p}_i\right)\right]_{e_{i1}=e_{i1}^k} = 0. \qquad \text{(A.28)}$$

Since e_{i2}^k is unique, and is given independently of e_{i1}, we get:

$$\begin{aligned}
\frac{\partial e_{i1}^k}{\partial p} &= -\left[\frac{\partial^2 U\left(e_{i1}, e_{i2}^k, \mathbf{p}_i\right)}{\partial e_{i1} \partial p}\right]_{e_{i1}=e_{i1}^k} \div \left[\frac{\partial^2 U\left(e_{i1}, e_{i2}^k, \mathbf{p}_i\right)}{\partial e_{i1}^2}\right]_{e_{i2}=e_{i2}^k}, \\
p &\in \left\{\theta_i, s, \mu_i, \overline{\mu}_i, \alpha_i, \beta_i, \overline{\alpha}_i, \overline{\beta}_i, \overline{b}_i^1, Y, L, r\right\}, \\
k &\in \{ILI, ILP, JLI, JLP\}. \qquad \text{(A.29)}
\end{aligned}$$

Since $\frac{\partial^2 U\left(e_{i1}, e_{i2}^k, \mathbf{p}_i\right)}{\partial e_{i1}^2} < 0$, $\frac{\partial e_{i1}^k}{\partial p}$ has the same sign as $\left[\frac{\partial^2 U\left(e_{i1}, e_{i2}^k, \mathbf{p}_i\right)}{\partial e_{i1} \partial p}\right]_{e_{i1}=e_{i1}^k}$. It is straightforward, though tedious, to obtain and sign all the first and second partial derivatives of U and V (recall our derivations of (A.11) and (A.4)). When this is done, we get the following results.

For all contracts, k, for $i, t \in 1, 2$:

$$\frac{\partial e_{it}^k}{\partial Y} > 0,\ \frac{\partial e_{it}^k}{\partial L} < 0,\ \frac{\partial e_{it}^k}{\partial r} < 0. \qquad \text{(A.30)}$$

$$\frac{\partial e_{it}^{ILP,\ JLP}}{\partial \overline{\mu}_i} > 0,\ i, t \in \{1, 2\}. \qquad \text{(A.31)}$$

$$\frac{\partial e_{i1}^{JLI,\ JLP}}{\partial \overline{b}_i^1} > 0,\ \frac{\partial e_{i1}^{JLI,\ JLP}}{\partial \mu_i} > 0, i \in \{1, 2\}. \qquad \text{(A.32)}$$

$$\text{If } \mu_i = 0, \text{ then } \frac{\partial e_{i1}^{JLI,\ JLP}}{\partial \alpha_i} = \frac{\partial e_{i1}^{ILP,\ JLI,\ JLP}}{\partial \beta_i} = \frac{\partial e_{i1}^{JLI,\ JLP}}{\partial \theta_i} = 0,\ i \in \{1, 2\}, \qquad \text{(A.33)}$$

$$\text{if } \mu_i > 0, \text{ then } \frac{\partial e_{i1}^{JLI,\ JLP}}{\partial \alpha_i} > 0,\ \frac{\partial e_{i1}^{JLI,\ JLP}}{\partial \beta_i} > 0,\ \frac{\partial e_{i1}^{JLI,\ JLP}}{\partial \theta_i} > 0,\ i \in \{1, 2\}. \qquad \text{(A.34)}$$

$$\text{If } \overline{\mu}_i = 0, \text{ then } \frac{\partial e_{it}^{ILP,\, JLP}}{\partial \overline{\alpha}_i} = \frac{\partial e_{it}^{ILP,\, JLP}}{\partial \overline{\beta}_i} = \frac{\partial e_{it}^{ILP,\, JLP}}{\partial s} = 0,\, i, t \in \{1, 2\}\,, \tag{A.35}$$

$$\text{if } \overline{\mu}_i > 0, \text{ then } \frac{\partial e_{it}^{ILP,\, JLP}}{\partial \overline{\alpha}_i} > 0,\ \frac{\partial e_{i2}^{ILP,\, JLP}}{\partial \overline{\beta}_i} > 0,\ \frac{\partial e_{i2}^{ILP,\, JLP}}{\partial s} > 0,\, i, t \in \{1, 2\}\,. \tag{A.36}$$

The signs of $\frac{\partial e_{i1}^{ILP,\, JLP}}{\partial s}$ and $\frac{\partial e_{i1}^{ILP,\, JLP}}{\partial \overline{\beta}_i}$: We are unable to determine the signs of the partial derivatives $\frac{\partial e_{i1}^{ILP,\, JLP}}{\partial s}$ and $\frac{\partial e_{i1}^{ILP,\, JLP}}{\partial \overline{\beta}_i}$. To see why, consider first $\frac{\partial e_{i1}^{ILP,\, JLP}}{\partial s}$. $\frac{\partial e_{i1}^{ILP,\, JLP}}{\partial s}$ will have the same sign as $\left[\frac{\partial^2 U\left(e_{i1}, e_{i2}^{ILP,\, JLP}, \mathbf{p}_i\right)}{\partial e_{i1} \partial s}\right]_{e_{i1} = e_{i1}^{ILP,\, JLP}}$. From (2.19) we get

$$\frac{\partial^2 U\left(e_{i1}, e_{i2}, \mathbf{p}_i\right)}{\partial e_{i1} \partial s} = \frac{\partial^2 \Psi\left(e_{i1}\right)}{\partial e_{i1} \partial s} + \frac{\partial \psi\left(e_{i1}\right)}{\partial e_{i1}} \frac{\partial V\left(e_{i2}, \mathbf{p}_i\right)}{\partial s}. \tag{A.37}$$

Consider one of the contracts with public repayment, either contract *ILP* or *JLP*. Assume that $\overline{\mu}_i > 0$. From (2.3), (2.6), (2.13), (A.8), (2.17), (A.1) and (2.20), we get that

$$\frac{\partial^2 \Psi\left(e_{i1}\right)}{\partial e_{i1} \partial s} = \left(T_{ILP} + T_{JLP}\right) \overline{\mu}_i \left(\overline{\alpha}_i - \overline{\beta}_i\right) \frac{\partial G_i^2\left(e_{i1}, s\right)}{\partial s} > 0. \tag{A.38}$$

Recall, from Section 2.7, that $\Psi\left(e_{i1}\right)$ is first-period psychological utility of agent i. Hence, from (A.38), we see that an increase in the public signal, s, will *increase* the first-period effort level, e_{i1}, of agent i, if agent i is myopic, i.e., when choosing e_{i1} agent i is only concerned with first-period psychological utility. However, agent i is not myopic and is also interested in second-period psychological utility, $V\left(e_{i2}, \mathbf{p}_i\right)$. From (2.3) and (2.21) we see that $\frac{\partial \psi(e_{i1})}{\partial e_{i1}} > 0$ and, from (2.6), (2.13), (2.17), (A.1) and (2.22), we see that $\frac{\partial V(e_{i2}, \mathbf{p}_i)}{\partial s} < 0$. Hence,

$$\frac{\partial \psi\left(e_{i1}\right)}{\partial e_{i1}} \frac{\partial V\left(e_{i2}, \mathbf{p}_i\right)}{\partial s} < 0. \tag{A.39}$$

Thus, the total contribution of an increase in the public signal, s, to a change in the first-period effort level, e_{i1}, of agent i, is the sum of two terms, one positive and the other negative. Hence, the total effect depends on the precise parameter values.

Similarly, the total contribution of an increase in $\overline{\beta}_i$ to a change in the first-period effort level, e_{i1}, of agent i, is the sum of two terms, one positive and the other negative.[40] Hence, the total effect depends on the precise parameter values.

[40] Here, we need to use (A.4).

Appendix-C (The parameterized model)

We set the following parameter values and the cost of effort function to derive predictions from the classical model:

$$Y = 75,\ L = 50,\ r = 0.3,$$
$$c\left(e_{it}\right) = 12.5e_{it}^{2} \quad i,t \in \{1,2\}. \tag{A.40}$$

Note that here we use $e_{it} \in [0,1]$, so we multiply the cost function in Table 2 with 100. From (2.3), (2.6) and (A.40), we get the following single-period expected material utility function:

$$EM\left(e_{it}\right) = 5\left(1+e_{it}\right) - 12.5e_{it}^{2}. \tag{A.41}$$

The classical model (no psychological motives)

We consider the two types of contracts, independent liability, *IL*, and joint liability, *JL* (recall that, here, the *ILI* and *ILP* contracts are identical, so are the contracts *JLI* and *JLP*). Setting $\mu_i = \overline{\mu}_i = 0$ in (2.19)-(2.23), and using (A.41), we get second and first-period utility functions, V and U (recall Sections 6-5):

$$V\left(e_{i2}, \mathbf{p}_i\right) = 5\left(1+e_{i2}\right) - 12.5e_{i2}^{2}. \tag{A.42}$$

$$U\left(e_{i1}, e_{i2}, \mathbf{p}_i\right) = 5\left(1+e_{i1}\right) - 12.5e_{i1}^{2}$$
$$+\frac{1+e_{i1}}{2}\left[T_{ILI} + T_{ILP} + \left(T_{JLI} + T_{JLP}\right)\frac{1+\overline{b}_i^{1}}{2}\right]\left[5\left(1+e_{i2}\right) - 12.5e_{i2}^{2}\right]. \tag{A.43}$$

Individual liability contracts In particular, for independent liability contracts (*ILI* and *ILP*), we get, from (A.42) and (A.43):

$$V\left(e_{i2}, \mathbf{p}_i\right) = 5\left(1+e_{i2}\right) - 12.5e_{i2}^{2}. \tag{A.44}$$

$$U\left(e_{i1}, e_{i2}, \mathbf{p}_i\right) = 5\left(1+e_{i1}\right) - 12.5e_{i1}^{2} + \frac{1+e_{i1}}{2}\left[5\left(1+e_{i2}\right) - 12.5e_{i2}^{2}\right]. \tag{A.45}$$

Maximize (A.44) with respect to e_{i2} to get e_{i2}^{IL}, where $e_{i2}^{ILI} = e_{i2}^{ILP} = e_{i2}^{IL}$, then substitute in (A.45). Finally, maximize $U\left(e_{i1}, e_{i2}^{IL}, \mathbf{p}_i\right)$ with respect to e_{i1} to get e_{i1}^{IL}. Below are the results.

$$e_{i1}^{IL} = 0.31,\ e_{i2}^{IL} = 0.2. \tag{A.46}$$

As predicted by Propositions 2 and 4, $e_{i1}^{IL} > e_{i2}^{IL}$.

Joint liability contracts Setting $T_{ILI} = T_{ILP} = 0$ and $T_{JLI} = 1$ (and $T_{JLP} = 0$) or $T_{JLP} = 1$ (and $T_{JLI} = 0$), in (A.42), (A.43), gives:

$$V(e_{i2}, \mathbf{p}_i) = 5(1 + e_{i2}) - 12.5e_{i2}^2. \tag{A.47}$$

$$U(e_{i1}, e_{i2}, \mathbf{p}_i) = 5(1 + e_{i1}) - 12.5e_{i1}^2 + \frac{(1 + e_{i1})\left(1 + \overline{b}_i^1\right)}{4}\left[5(1 + e_{i2}) - 12.5e_{i2}^2\right]. \tag{A.48}$$

Maximize (A.47) with respect to e_{i2}, then (A.48) with respect to e_{i1}, to get:

$$e_{i1}^{JL} = 0.2 + 0.055\left(1 + \overline{b}_i^1\right); e_{i2}^{JL} = 0.2, \tag{A.49}$$

where $e_{i1}^{JLI} = e_{i1}^{JLP} = e_{i1}^{JL}$.

For $\overline{b}_i^1 < 1$, we get:

$$e_{i1}^{JL} < 0.31 = e_{i1}^{IL},$$

in agreement with Propositions 4.

The Nash equilibrium under joint liability contracts

As explained in Section 5, we can obtain the Nash equilibrium in our framework by taking $\overline{b}_i^1 = e_{j1}^{JL}$, $i, j \in \{1, 2\}$, $i \neq j$, $e_{j1}^{JLI} = e_{j1}^{JLP} = e_{j1}^{JL}$. Substituting in (A.49), we get the two equations:

$$e_{11}^{JL} = 0.2 + 0.055\left(1 + e_{21}^{JL}\right). \tag{A.50}$$

$$e_{21}^{JL} = 0.2 + 0.055\left(1 + e_{11}^{JL}\right). \tag{A.51}$$

Solving (A.50) and (A.51) simultaneously gives

$$e_{11}^{JL} = e_{21}^{JL} = 0.269\,84. \tag{A.52}$$

Hence, the subgame perfect equilibrium for our example is

$$e_{11}^{JL} = e_{21}^{JL} = 0.269\,84, \; e_{12}^{JL} = e_{22}^{JL} = 0.2, \tag{A.53}$$

in agreement with Propositions 4.

The profit of the bank

The bank loans L at the interest rate r. If the project is successful, then the agent repays the loan with interest: $(1 + r)L$. In this case, the bank's profit is rL. If the project is unsuccessful, then the agent pays the bank nothing and, therefore, the bank makes a loss of L. If the agent exerts an effort e_{it}, then the project is successful with probability $p\left(e_{it}\right)=\frac{1+e_{it}}{2}$. The bank's expected profit is, therefore, $E\pi_t=\frac{1+e_{it}}{2}rL-\left(1-\frac{1+e_{it}}{2}\right)L$, i.e.,

$$E\pi_t=\left[r+\left(1+r\right)e_{it}-1\right]\frac{L}{2}, \tag{A.54}$$

or, for $L=50$ and $r=0.3$,

$$E\pi_t=\left(32.5\right)\left(e_{it}-\frac{7}{13}\right). \tag{A.55}$$

Hence, the bank breaks even if, and only if, the effort level, e_{it}, satisfies

$$e_{it}\geq\frac{7}{13}\simeq 0.538\,46 \tag{A.56}$$

Appendix-D (Experimental Instructions)

Below we provide instructions are for joint liability microfinance games (*JLI* and *JLP*). Detailed instructions for other treatments are available on request.

Instructions for *JLI*

Welcome to the experiment. You are now participating in an economics experiment. You can earn money, depending on the decisions you take during the experiment. From now on, please do not communicate with any other participant in the experiment. Please pay careful attention to the instructions. If you have any questions, then please raise your hand, and we will come and address them.

There are 10 participants in this room. You are divided into 5 groups of two by randomly pairing each one of you with another participant in the room. The identity of each participant in the group is kept secret. Hence, the choices you make in the experiment are anonymous.

The experiment consists of two periods. Everyone will participate in the first period. Conditional on the outcomes in the first period, you may also be able to participate in the second period. Your earnings from the experiment are the sum of your earnings over the two periods. If you are not able to participate in the second period, then you earn no money in the second period. In addition to this sum of money, you will receive a fixed amount of 500 Rupees as your participation fee in the experiment. If you make any losses during the experiment, then losses will be deducted from your participation fee. You will be paid privately at the end of the experiment. Your choices and decisions during the experiment and information about your payoffs will be kept strictly confidential. To keep your decisions private, please do not reveal your choices to any other participant.

During the experiment, we will express your payoff in units of an experimental currency, EC. At the end of the experiment, the experimental currency will be converted into Pakistani rupees by multiplying it with 10. So, for instance, if you earn 9 units of experimental currency in the experiment, then at the end of the experiment, your income will be $9 \times 10 = 90$ Pakistani rupees. Details of how you will make decisions and receive payments are provided below.

Period 1

In the first period of the experiment, a bank offers each one of the two partners in a group, a loan of 50 units of EC. Each participant has an independent project. The bank charges an interest rate of 30% to each borrower. The loan can ONLY be used to invest in the project. The project is risky in the following sense. There are two possible outcomes of the project: success and failure. The chances of success depend on effort provision, as we explain in detail below.

Outcomes from the project

1. If your project is successful, it generates a revenue of 75 EC. At the end of the first period, you must repay your loan of 50 EC and the interest payment, 30% of 50 EC; a total interest inclusive loan repayment of 50(1+ 30%) = 65 EC. The loan repayment will automatically be deducted from your revenue of 75. Hence, after repayment, your net revenue will be 10 EC.

2. If your project fails, it generates zero revenue, and the loan repayment cannot be made. Your net revenue will be 0. You are not personally liable for the loss arising from non-repayment.

Choice of effort level

The outcome of your project (success or failure) depends on the effort level you choose. You can choose any effort level on the scale 1 to 10, where 1 represents the lowest effort and 10 the highest effort. Exerting a higher effort level is costlier and the cost is expressed in terms of EC; this can be seen in Table A1 below. You incur the cost of effort regardless of the outcome of your project (success or failure). The cost of your effort will be deducted from your revenue. If your net revenue is zero (in case of failure), then the cost of effort will be deducted from your participation fee.

Chances of success of the project

If you put in the lowest effort level 1, the chance of success of the project is 55%. You can improve the chance of success by choosing a higher effort level. In particular, for every additional effort level, starting from 1, the probability of success increases by 5%. Table A1 below presents the probability of success and the cost of effort for every effort level that you can choose.

Table A1

Effort Level	1	2	3	4	5	6	7	8	9	10
Prob of Success	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Cost of Effort in EC	0.125	0.5	1.125	2.0	3.125	4.5	6.125	8.0	10.125	12.5
Cost of Effort in PKR	1.25	5	11.25	20	31.25	45	61.25	80	101.25	125

Once you have chosen the effort level, the outcome of the project is determined according to the chance of success given in Table A1. After the outcome of the project is revealed, you will be informed about:

a) Your and your partner's chosen effort level.

b) The outcome of your and your partner's project.

If BOTH you and your partner were successful, then BOTH of you will proceed to the second-period game. If, however, ANY member of a group (you or your partner) failed in the project, then BOTH of you will NOT be able to proceed to the second period and your participation in the experiment will end. Hence, the chance that you will receive the second-period loan not only depends on your choices but also the choices of your partner in your group.

If your project is successful, but not your partner's, then the cost of your effort and the loan repayment will be deducted from your payoff. In this case, you are not liable for the failure of your partner's project (i.e., you pay neither for his/her cost of effort nor for his/her loan repayment). Similarly, if your project failed while your partner's project succeeded, then the cost of your effort will be deducted from your participation fee, but your partner is not liable for your loan repayment or the cost of effort.

Period 2

If you and your partner are successful in period 1, then in the second period both of you receive a new loan of 50 EC each for new independent projects. The second-period project is identical to the first-period project. The second period is the final period of the game. Thus, your and your partner's choices/actions have no consequences for each other for the future. If you play the game in the second period, then you will again choose an effort level on the scale 1 to 10, and the outcome will be determined by the probability of success given in Table A1. Once the outcome is determined, you will be informed about it. The cost of effort is deducted from your payoff, irrespective of the outcome of the project (success or failure).

How is your payoff calculated?

Your payoff in a period in which you have participated is determined as follows:

Outcome of your project: Success	Outcome of your project: Failure
Revenue from your project = 75 EC	Revenue from your project = 0 EC
Loan repayment = $50(1 + 30\%) = 65$ EC	Loan repayment to lender = 0 EC
After repayment payoff = $75 - 65 = 10$ EC	After repayment payoff = $0 - 0 = 0$ EC
Net payoff = $10 -$ cost of effort	Net payoff = $0 -$ cost of effort

How are your earnings calculated?

The income of all participants will be calculated in the same way. Your income consists of two parts:

a) Your participation fee of 500 Rupees.

b) The income you generate during the experiment.

Your income from the experiment will be calculated by the following formula: (Net Payoff in period 1 + Net Payoff in period 2) x 10.

Your total income will be calculated as follows: 500 + (Net Payoff in period 1 + Net Payoff in period 2) x 10.

Income Calculation Examples:

(1) Suppose that in period 1, you choose an effort level of 5. From Table A1, there is a 75% chance that your project will succeed and the cost of your effort is 3.125. Suppose that your project succeeds and the project of your partner is also successful. This ensures two things:

a) You and your partner will receive a second-period loan of 50 EC each.

b) After repayment of loan, your first-period net payoff will be $10 - 3.125 = 6.875$ EC.

Now let us consider the second period. Suppose that once again, you choose effort level 5. From Table A1, there is a 75% chance that your project will succeed and the cost of your effort is 3.125. Suppose that the outcome of your effort choice is that the project succeeds. Thus, your second-period net payoff is $10 - 3.125 = 6.875$ EC.

Your earnings from the experiment (over both periods) are $(6.875 + 6.875) \times 10 = 137.5$ Rupees.

Your total earnings at the end of experiment, inclusive of your participation fee, are $500 + (6.875 + 6.875) \times 10 = 637.5$ Rupees.

(2) Suppose that in period 1, you choose an effort level of 5, that would imply that there is a 75% chance that your project will succeed and the cost of your effort is 3.125. Now suppose that your project fails. This has two implications:

a) You and your partner will NOT receive a second-period loan.

b) Your first-period payoff will be $0 - 3.125 = -3.125$ EC.

Your earnings from the experiment are $(-3.125) \times 10 = -31.25$ Rupees.

Your total earnings at the end of the experiment, inclusive of your participation fee, are $500 - 31.25 = 468.75$ Rupees.

(3) Suppose that in period 1, you choose an effort level of 5, that would imply that there is a 75% chance that your project will succeed and the cost of your effort is 3.125. Suppose that your project succeeds but your partner's project fails. This has two implications:

a) You and your partner will NOT receive a second-period loan.

b) After repayment of loan, your first-period net payoff will be $10 - 3.125 = 6.875$ EC.

Your earnings from the experiment are $(6.875) \times 10 = 68.75$ Rupees.

Your total earnings at the end of the experiment, inclusive of your participation fee are $500 + 68.75 = 568.75$ Rupees.

(4) Suppose that in period 1, you choose an effort level of 1. From Table A1, there is a 55% chance that your project will succeed and the cost of your effort is 0.125. Suppose that your project fails, but your partner's project succeeds. This has two implications:

a) You and your partner will NOT receive a second-period loan.

b) Your first-period net payoff will be $0 - 0.125 = -0.125$ EC.

Your earning from the experiment is $(-0.125) \times 10 = -1.25$ Rupees.

Your total earnings at the end of the experiment, inclusive of your participation fee, are $500 - 1.25 = 498.75$ Rupees.

Practice Questions:

The following questions enhance your understanding of the experiment.

If you choose effort level 1 in the first period:

a) What is the cost of your effort?

b) What is the chance of success of your project?

c) What is the chance of failure of your project?

d) If your project fails, then what is your first-period payoff?

e) If either your or your partner's project fails in the first period, then will you receive a second-period loan? (Y/N)

f) If your project fails in the first period, then what is your total income from the experiment?

g) If you succeed in the first period, but your partner's project fails, then what is your first-period payoff?

h) If both of you succeed, then will you receive a second-period loan? (Y/N)

i) Suppose that your and your partner's projects succeed in the first period. If you again choose effort level 1 in the second period and succeed, then what is your total income?

Instructions for *JLP*

Instructions for the *JLP* treatment are identical to the *JLI* treatment except that the subjects received following additional information.

a) Before subjects could choose their effort level, they were informed about the empirical and normative expectations of participants from a similar earlier experiment. Subjects received the following two 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.

b) All participants in the *JLP* treatment were informed that at the end of each period in which they participate, the experimenter will publicly announce each participant's effort level and the outcome of the project to other participants in the room. All other participants in the room will then be able to express their individual-specific approval for the chosen level of effort by showing a green card or disapproval by showing a red card. This announcement was made in front of all subjects.

Guess Sheet for *JLI* & *JLP*

ID Number: __________ Session: __________

Before you choose your effort level, please answer the following question. You can earn extra money if you answer the question correctly.

What effort level do you expect your partner to choose in this game: __________. You will win additional 50 Rupees, if your guess matches with your partner's actual chosen effort level.[41]

[41] Once subjects reported their expectations, then they were privately asked if they would like to transmit their guess to the partner.

Decision Sheet (*JLI*)

ID Number: ___________ Session: ___________

You are informed that your partner expects you to choose the effort level ___________.

Note: If you have permitted to transmit your expectations to your partner, then your partner is informed about your expectation of his/her effort level. Your partner is also informed that you know his/her expectation before you choose your effort level.

Period 1

Please chose an effort level from the table below:

Decision Table

Effort Level	1	2	3	4	5	6	7	8	9	10
Prob of Success	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Cost of Effort in EC	0.125	0.5	1.125	2.0	3.125	4.5	6.125	8.0	10.125	12.5
Cost of Effort in PKR	1.25	5	11.25	20	31.25	45	61.25	80	101.25	125

Outcome of the project is revealed by the experimenter: ___________

If the outcome is Failure, then you take no further part in the experiment. You now leave the session in progress and collect your income outside the room.
If the outcome of your AND your partner's projects in the first period is Success, you may proceed to period 2.

Period 2

Please chose an effort level from the table below:

Decision Table

Effort Level	1	2	3	4	5	6	7	8	9	10
Prob of Success	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Cost of Effort in EC	0.125	0.5	1.125	2.0	3.125	4.5	6.125	8.0	10.125	12.5
Cost of Effort in PKR	1.25	5	11.25	20	31.25	45	61.25	80	101.25	125

Outcome of the project is revealed by the experimenter: ___________

Decision Sheet (*JLP*)

ID Number: __________ Session: __________

You are informed that your partner expects you to choose the effort level __________.

Note: If you have permitted to transmit your expectations to your partner, then your partner is informed about your expectation of his/her effort level. Your partner is also informed that you know his/her expectation before you choose your effort level.

Period 1

Please chose an effort level from the table below:

Decision Table

Effort Level	1	2	3	4	5	6	7	8	9	10
Prob of Success	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Cost of Effort in EC	0.125	0.5	1.125	2.0	3.125	4.5	6.125	8.0	10.125	12.5
Cost of Effort in PKR	1.25	5	11.25	20	31.25	45	61.25	80	101.25	125

Outcome of the project is revealed by the experimenter: __________

If the outcome is Failure, then you take no further part in the experiment. You now leave the session in progress and collect your income outside the room.
If the outcome of your AND your partner's projects in the first period is Success, you may proceed to period 2.

Approval and Disproval:
Number of Green Cards (noted by the experimenter): __________
Number of Red Cards (noted by the experimenter): __________

Period 2

Please chose an effort level from the table below:

Decision Table

Effort Level	1	2	3	4	5	6	7	8	9	10
Prob of Success	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Cost of Effort in EC	0.125	0.5	1.125	2.0	3.125	4.5	6.125	8.0	10.125	12.5
Cost of Effort in PKR	1.25	5	11.25	20	31.25	45	61.25	80	101.25	125

Outcome of the project is revealed by the experimenter: ____________

Approval and Disproval:

Number of Green Cards (noted by the experimenter): ____________

Number of Red Cards (noted by the experimenter): ____________