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THE DYNAMICS OF COOPERATION IN GROUP LENDING - A MICROFINANCE EXPERIMENT

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Abstract

We investigate the dynamics of borrower behavior in a microfinance experiment in which subjects are jointly responsible for credit repayment. Although cooperation levels are generally high, moral hazard problems persist among borrowers. Moreover, the path dependency of decisions mitigates the insurance effect of joint liability.

We compare two conversion mechanisms from joint to individual liability. First, an active choice of the joint liability contract does not systematically increase cooperation. Second, conversion based on repayment success tends to have a detrimental impact on cooperation among the remaining joint liability borrowers.

Keywords: Microfinance, group lending, individual lending, social preferences
JEL Classification: O16, G21, C92, H41

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1 Introduction

Microfinance programs have been a very successful instrument for poverty alleviation since the 1970s. Nowadays they are widespread in developing countries and have already been established in the western world. From the numerous non-standard credit contracts implemented in practice, joint liability lending is probably the most prevalent. Here, the responsibility for credit repayment is borne by a group of several borrowers. If one person is not able to repay her credit, other group members have to bail her out.

Joint liability contracts offer a 'social' collateral for borrowers and at the same time mitigate moral hazard and adverse selection problems between micro banks and clients.[1] Yet, this contract scheme also has potential shortcomings. In this study, we focus on the moral hazard problems created among borrowers.[2] If borrowers can rely on the group, they have the incentive to free-ride by shifting the repayment burden or investment risks to the group members. Monitoring and social pressure can mitigate this problem; however, if social ties between group members are loose or non-existent or if social sanctions are not enforceable, joint liability schemes may not function properly as an insurance against involuntary default.[3]

In practice, several microfinance banks have started to offer individual liability contracts to their clients. However, there is little empirical evidence that helps to evaluate which contract scheme is preferable under what circumstances. In the description of a large-scale field experiment, Giné and Karlan (2009) state that "*the basic empirical question of the relative merits of group versus individual liability has remained unanswered for many reasons of endogeneity. Merely comparing performance of one product versus another, within or across lenders, fails to establish a causal relationship between the contract terms and outcomes such as repayment, selection, or welfare, due to countless unobserved characteristics that drive individual selection into one contract or the other, as well as institutional choices on what to offer, and how.*"

[1] Stiglitz (1990), Banerjee et al. (1994) and Armendàriz de Aghion (1999) show how monitoring and sanctioning among agents in a borrower group can mitigate moral hazard problems. Furthermore, the selection of borrowers into credit groups helps to overcome adverse selection problems (see Armendàriz de Aghion and Gollier, 2000, Ghatak, 1999 and van Tassel, 1999). Finally, peer pressure within borrower groups reduces strategic defaults (see Besley and Coate, 1995). For an overview of the theoretical literature see Morduch (1999).

[2] Other problematic factors of joint liability contracts are decreased attractiveness for good risks and low flexibility concerning heterogeneous credit demands, see Giné and Karlan (2009) for a discussion.

[3] Armendàriz de Aghion and Morduch (2005) mention kinship among villagers or anonymous credit programs in cities as examples for situations in which social interaction within borrower groups might not be effective.

The goal of the present study is to complement existing empirical work by investigating behavioral impacts of joint and individual liability in a controlled laboratory environment. In particular, the focus is on behavioral dynamics, as the interaction between borrowers might crucially influence the functioning of group lending contracts. Moreover, the study compares the performance of different conversion mechanisms in mitigating moral hazard problems.

We let experimental subjects play a microfinance game up to 12 periods under joint liability (Run 1) before some of them are converted into individual liability (Run 2). Our decision variable is the level of effort put into a risky project. Under joint liability, borrowers face a social dilemma. While providing the highest feasible effort maximizes joint payoffs, the subgame perfect Nash equilibrium consists of choosing the lowest effort level in each period. Moreover, in line with common microfinance practice, we introduce dynamic incentives. Credit provision is contingent on successful repayment in the previous period.[4]

We consider two conversion mechanisms from joint to individual liability. In a first treatment, subjects choose between an individual and a joint liability contract after the first run. In a second treatment, borrower groups with above-average repayment performance are offered individual contracts for Run 2 while the other subjects continue under joint liability contracts. Behavior in both treatments is compared to a reference setup in which subjects remain under joint liability for the entire game.

We observe high average effort levels in all experimental treatments. Nevertheless, within-group moral hazard can be observed, as subjects increase their efforts significantly after being converted into individual liability. Moreover, the path-dependency of behavior has a detrimental effect for the functioning of joint liability programs from a dynamic perspective. Effort decisions are positively related to partner effort and negatively related to the frequency of partner repayments. With respect to conversion mechanisms, we find no systematic effort increase in our treatment where subjects can select into credit contract schemes. Here, contract choice is largely driven by individual experiences with partners. By contrast, moral hazard problems among joint liability borrowers tend to become stronger after performance based conversion.

In the following, we briefly review the related empirical and experimental literature on microfinance contracts (section 2). In the next step, we introduce our experimental decision situation (section 3), describe the design details and formulate hypotheses (section 4). We present aggregate and individual results in section 5 and conclude in section 6.

[4] Armendàriz de Aghion and Morduch (2000 and 2005) show that the threat of not receiving follow-up loans may prevent strategic default of borrowers.

2 Related Literature

The experimental and empirical literature on the effects of microfinance contracts yields mixed results. There are several studies comparing repayment performance of joint and individual liability contracts. Gomez and Santor (2003) found superior repayment performance of group lending schemes due to both selection effects and decreasing within-group moral hazard problems in a Canadian sample. In a laboratory experiment, Abbink et al. (2006) observed that, although subjects had the option to default strategically, repayment performance increased under joint liability relative to individual contracts. Cason et al. (2009) conducted a microfinance experiment in which lending activities and repayment rates were increased by group lending contracts in case of low monitoring costs among borrowers.

However, other studies come to different conclusions. In a controlled long-term field experiment by Giné and Karlan (2009), a random sample of joint liability borrowers from a Philippine microfinance institution was converted into individual contracts while the remaining borrowers continued under group liability. After three years, the samples did not differ with respect to loan repayments.[5] Moreover, in a comparison study of more than 300 microfinance institutions, Cull et al. (2009) found no correlation between loan portfolio quality and the implemented lending method.

Regarding the behavioral implications of contract schemes there is some evidence for incentives problems created by group liability contracts. Kono (2006) carried out microfinance experiments in Vietnam showing that strategic default increased if subjects were jointly responsible for repayment. A survey study by Karlan (2007) highlighted the importance of peer monitoring and social sanctioning, as repayment performance of borrower groups increased with stronger social ties between their members. Finally, Giné et al. (forthcoming) conducted experiments in urban Peru with a large sample of owners and employees of micro-enterprizes and found a higher propensity to choose risky investment projects under joint liability. This pattern was, however, mitigated with the introduction of dynamic incentives.

As we model moral hazard among borrowers as a social dilemma, our experimental design is related to a standard public goods game. Results from numerous replications of this experimental game show that positive cooperation levels are established despite clear economic incentives to free-ride (see Ledyard, 1995, for an extensive survey of the literature). There are two kinds of design

[5] However, the study confirmed some inherent problems of joint liability lending, as individual liability programs were more likely to attract new customers.

variations that are especially relevant in our context. First, selection processes or orientation on out-of-equilibrium payoffs influence the degree of subjects' cooperativeness (see Bohnet and Kübler, 2005; Page et al., 2005; Gürerk et al., 2006; Grimm and Mengel, 2009) and might therefore have an impact on the performance of conversion mechanisms in our setting. Second, there is convincing evidence that a substantial share of players condition their contributions on the contributions of other players (see, for example, Fischbacher et al., 2001; Gunnthorsdottir et al., 2007; Ambrus and Pathak, 2009; Fischbacher and Gächter, forthcoming). Conditional cooperation can be expected to affect the degree of effort exertion within borrower groups and the functioning of group lending from a dynamic perspective (we will come back to this point in section 4).

3 Decision Situation and Experimental Parameters

In our experimental setting we model the effort decisions of borrowers after being granted a credit amount of I by a micro bank. The credit is used for a risky investment project that pays revenue $R > 0$ in case of success and 0 in case of failure. Every borrower chooses her effort level e from the interval $[e_0, e_{max}]$ that influences project success according to the probability function $p(e)$ with $p'(e) > 0$ and $p''(e) = 0$. Associated effort costs are captured by the cost function $c(e)$ with $c'(e) > 0$ and $c''(e) = 0$ and have to be incurred irrespective of the project outcome.

Project payoffs are randomly determined after effort levels have been chosen. Under joint liability, players are informed about payoffs and effort levels of their partners. In case of sufficient funds, loan repayments L for each credit are automatically deducted from borrowers' payoffs. If the credit sum is fully repaid, new credits are provided in the next period and borrowers decide again about their efforts. In case of default, borrowers receive no further credit in the subsequent periods of the experimental run.

We set a number of additional restrictions on the experimental variables: first, as we assume that $R \geq 2L$, a borrower is able to repay two loans in case of success under joint liability.[6] Next, there is an exogenous success probability $p_0 > 0$ regardless of effort provision so that total success probability p is determined by $p = p_0 + p(e)$. Finally, we assume that providing the maximum feasible effort still bears a risk of project failure, as $p(e_0) + p(e_{max}) < 1$, in order to capture the insurance effect of joint liability contracts compared to individual loans.

[6] By this assumption we avoid non-linearities of profit functions under joint liability contracts.

Under individual liability a borrower's expected payoff in the one-shot game is

$$E[\pi_i(e_i)] = [p_0 + p_i(e_i)] \cdot (R - L) - c(e_i) \tag{1}$$

The first-order-condition for optimal effort yields $p'(e) \cdot (R - L) = c'(e)$. As marginal gains and costs of effort are constant per assumption, the optimum in the one-shot game is a corner solution: it is either optimal to choose the maximum effort level e_{max} or the minimum e_0.

For joint liability contracts we consider the case that two persons form a borrower pair. Assuming that project payoffs are independent, the payoff function of borrower i is:

$$\begin{aligned} E[\pi_i(e_i, e_j)] = [p_0 + p_i(e_i)] \cdot [p_0 + p_j(e_j)] \cdot (R - L) + \\ [p_0 + p_i(e_i)] \cdot [1 - p_0 - p_j(e_j)] \cdot (R - 2L) - c(e_i) \end{aligned} \tag{2}$$

With probability $[p_0 + p_i(e)] \cdot [p_0 + p_j(e)]$ both partners succeed and repay their own loans. However, with probability $[p_0 + p_i(e)] \cdot [1 - p_0 - p_j(e_j)]$ borrower i's project succeeds while partner j's project fails. Then borrower i's payoff is reduced also by j's obligation. The optimal effort choice by borrower i in the one-shot game is determined by $p'(e) \cdot [p_0 + p_j(e_j)] \cdot (R - L) + p'(e) \cdot [1 - p_0 - p_j(e_j)] \cdot (R - 2L) = c'(e)$. Replacing $p'(e) = \bar{p}$ and $c'(e) = \bar{c}$ and assuming that borrower j also chooses the profit-maximizing effort level yields $\bar{p} \cdot [R - L - (1 - p_0 - p_j(e_j^*)) \cdot L] \gtrless \bar{c}$.

The moral hazard problem among borrowers becomes clear if we compare first-order conditions under both contracts. As the term $1 - p_0 - p_j(e_j^*)$ is greater than zero per assumption, a provision of e_{max} becomes less likely under group lending. The risk that the partner's loan has to be repaid lowers marginal gains from effort exertion.

Abstracting from discounting, the payoff function for individual borrowers in period t of the repeated setting is

$$E[\pi_i(e_{i,t})] = [p_0 + p_i(e_{i,t})] \cdot (R - L + \sum_{k=t+1}^{T} E[\pi_{i,k}(e_{i,k}^*)]) - c(e_{i,t}) \tag{3}$$

The term $\sum_{k=t+1}^{T} E[\pi_{i,k}(e_{i,k}^*)]$ displays expected payoffs from optimal effort decisions in latter periods of the game. Equation (3) shows that dynamic incentives increase the attractiveness of effort exertion in period t, because payoffs

from credits in latter rounds are lost after a default. Under a joint liability contract, player i's payoff function in t is

$$
\begin{aligned}
&E[\pi_i(e_{i,t}, e_{j,t})] = \\
&[p_0 + p_{i,t}(e_{i,t})] \cdot [p_0 + p_{j,t}(e_{j,t})] \cdot (R - L + \sum_{k=t+1}^{T} E[\pi_{i,k}(e^*_{i,k}, e^*_{j,k})]) + \\
&[p_0 + p_{i,t}(e_{i,t})] \cdot [1 - p_0 - p_{j,t}(e_{j,t})] \cdot (R - 2L + \sum_{k=t+1}^{T} E[\pi_{i,k}(e^*_{i,k}, e^*_{j,k})]) + \\
&[1 - p_0 - p_{i,t}(e_{i,t})] \cdot [p_0 + p_{j,t}(e_{j,t})] \cdot \sum_{k=t+1}^{T} E[\pi_{i,k}(e^*_{i,k}, e^*_{j,k})]) - c(e_i) \quad (4)
\end{aligned}
$$

Compared to the one-shot joint liability game, the payoff function is extended by a third revenue term indicating the insurance effect of group lending from borrower i's perspective. Even if she fails to repay her credit in period t, there is a positive probability that the partner bails her out and she receives payoffs from further credits.

The path of optimal effort decisions in this game can be determined by backwards induction and depends on the precise set of parameters. In the experiment, we use the parametrization listed in Table 1.

TABLE 1
SET OF PARAMETERS

Variable	Parameter Value
R	200
L	100
I	50
e_0	0
e_{max}	8
p_0	0.5
$p(e)$	$0.05 \cdot e$
$c(e)$	$6 \cdot e$
T	12

To model the decision situation in the desired way, parameters have to meet several requirements. The first requirement is related to individual liability contracts and the functioning of dynamic incentives: the threat of not receiving follow-up loans must provide a disciplining effect on agents' effort choices. Therefore, full effort exertion should be optimal for the individual borrower i in the repeated setting. With our parameters, equilibrium effort for a single

borrower is $e^*_{i,t} = 8$ in $t = 1, ..., 11$ and $e^*_{i,t} = 0$ in $t = 12$. The expected payoff for the 12-period game is $E[\pi_i(e^*_i)] = 301.38$.

Furthermore, we want to create a social dilemma among borrowers under joint liability. It can be easily shown that with the present parameters, the symmetric equilibrium effort under group lending for borrowers i and j is $e^*_{i,t} = e^*_{j,t} = 0$ for $t = 1, ..., 12$, yielding expected payoffs of $E[\pi_i(e^*_i, e^*_j)] = E[\pi_j(e^*_j, e^*_i)] = 96.84$. The maximum sum of payoffs is reached, however, if both borrowers choose the maximum feasible level $e_{i,t} = e_{j,t} = 8$ for $t = 1, ..., 12$. In this case, expected payoffs are $E[\pi_i] = E[\pi_j] = 374.88$.[7]

Finally, please note that the parameters display the insurance effect of joint liability lending. First, expected payoffs from the full effort strategy under group lending exceed equilibrium payoffs under individual contracts. Second, individual contracts yield higher payoffs in equilibrium than group contracts, as borrowers should be worse off under joint responsibility if low cooperation is established.

4 Experimental Design and Hypotheses

We conducted 8 experimental sessions in which altogether 256 subjects took part (32 subjects per session), most of them with a major in Economics, Business Administration or related fields. In each session participants were divided into matching groups of 8 persons (subjects were not aware of this procedure). The experiment consisted of two runs of up to 12 rounds of the described decision situation.

All subjects played Run 1 under joint liability. Before the experiment began, two anonymous partners were matched to form a borrower pair for the entire first run. As long as the sum of loan repayments was covered in a given period, the borrower pair received two new loans and decided simultaneously about effort levels in the next period. After each decision, subjects were informed about effort levels and project revenues of both group members.

The treatment variation consisted of different conversion mechanisms from joint to individual liability after Run 1 was completed. These treatments – denoted with SELECT and PERFORM in the remainder of the paper – display two possible options of micro banks with respect to contract offers.

First, treatment SELECT refers to the option of offering potential borrowers unrestricted access to contract schemes. Here, subjects could opt either for an

[7] With the present parametrization, the threat of denied credit in subsequent periods is not severe enough to make full effort exertion the optimal choice. This is due to the relatively high exogenous success probability – even if both borrowers choose $e = e_0 = 0$, the probability of receiving a follow-up loan is still 75% – and the small number of repetitions.

individual or a joint liability contract to be applied for the next 12 periods. Subjects who had chosen joint liability contracts were then paired with a new anonymous partner from their experimental matching group.[8]

Second, treatment PERFORM depicts the common practice of offering individual contracts to clients with good credit histories. Borrower pairs were converted to individual liability on the basis of their repayment performance in Run 1. In our experiment, the two pairs per matching group with the highest number of successfully repaid loans were subsequently offered individual contracts, while the other two pairs remained under joint liability and were rematched with a new partner.[9] In the base specification of this treatment (referred to as NOINFO), information about the conversion was provided at the same time as in the other treatments, namely after Run 1 was completed. In addition, to control for a possible effect of ex-ante information about the possibility of conversion, we conducted specification INFO that was identical to NOINFO except that subjects were informed about the conversion mechanism already before the experiment started.

Finally, we implemented a benchmark treatment (BASE) to distinguish between the effects of the conversion mechanisms on effort exertion and the effects of repeated interaction in borrower groups. Here, subjects played the game under joint liability in both runs. Similar to the other treatments, partners were rematched after the first run.

Over the periods in which they received loans, subjects accumulated experimental payoffs. If period losses occurred, for example if a project failed and the subject had exerted positive effort levels, the losses were subtracted from accumulated payoffs. After the experiment, one run was randomly determined by the role of a die. Accumulated payoffs of this run were subsequently converted with an exchange rate of 30 experimental currency units per Euro and paid out to the participants.

The focus of our study is on the dynamics of moral hazard among borrowers. Orientation on strict payoff maximization implies the choice of minimum effort in each period. However, given the evidence from public goods games, we expect generally positive average effort levels. Yet, due to the incentives to free-ride, we expect that subjects exert less effort under joint liability than under individual contracts (Hypothesis 1).

[8] In case an uneven number of subjects per matching group had opted for joint liability, one person was randomly chosen and converted into individual liability.

[9] If two or more pairs had the same repayment performance and this was relevant for the assignment to contract schemes in the second run, one pair was randomly chosen for conversion.

With respect to conversion mechanisms, we hypothesize that both selection based and performance based conversion have behavioral implications on subjects' general cooperativeness under group lending. First, in line with the evidence from studies about selection in dilemma games, we hypothesize that the choice of joint liability contracts induces higher effort levels in Run 2 relative to the baseline treatment (Hypothesis 2). Second, for a similar reason, we expect lower relative effort levels under joint liability after performance based conversion in Run 2. Provided that there is a sufficiently strong correlation between effort and repayment success, remaining under group lending is a signal for low cooperativeness in the first run. In this case, we expect subjects' willingness to exert effort to be lower than in the reference treatment (Hypothesis 3).[10]

With respect to individual behavior, we hypothesize that efforts in both runs are path-dependent. Similar to conditional cooperation in public goods games, we expect decisions to be positively correlated with partner decisions (Hypothesis 4). This would imply that group lending contracts become increasingly vulnerable against default over time if at least one partner chooses lower-than-maximum effort levels.

The experimental sessions took place in the period from April 2008 to February 2009 in the Cologne Laboratory for Economic Research. Subjects were recruited using Greiner's Online Recruitment System ORSEE (Greiner, 2004). The experiment was computerized using the z-Tree software (Fischbacher, 2007). After subjects arrived and were randomly assigned to a cubicle, instructions were distributed.[11] After the experiment, subjects answered survey questions about demographical data and the underlying motivations for their decisions. Earnings for the selected run were privately paid out. The average payoff was 14.79 Euros (including an increased show-up fee of 5.00 Euros to cover potential losses in the course of the game). Each session lasted approximately one and a half hours.

[10] Please note that ex-ante information about performance related conversion might influence behavior already in the first run of the experiment (specification INFO in the PERFORM treatment). This specification gives rise to a large number of equilibria in which positive effort levels are provided by at least some of the joint liability pairs. Hence, ex-ante information could play a disciplining role for effort exertion in Run 1. On a behavioral level, however, presenting both individual and group liability schemes may lead to a higher saliency of incentive problems among borrowers and subsequently to lower efforts so that the net effect is unclear.

[11] Instructions translated from German can be found in the Appendix.

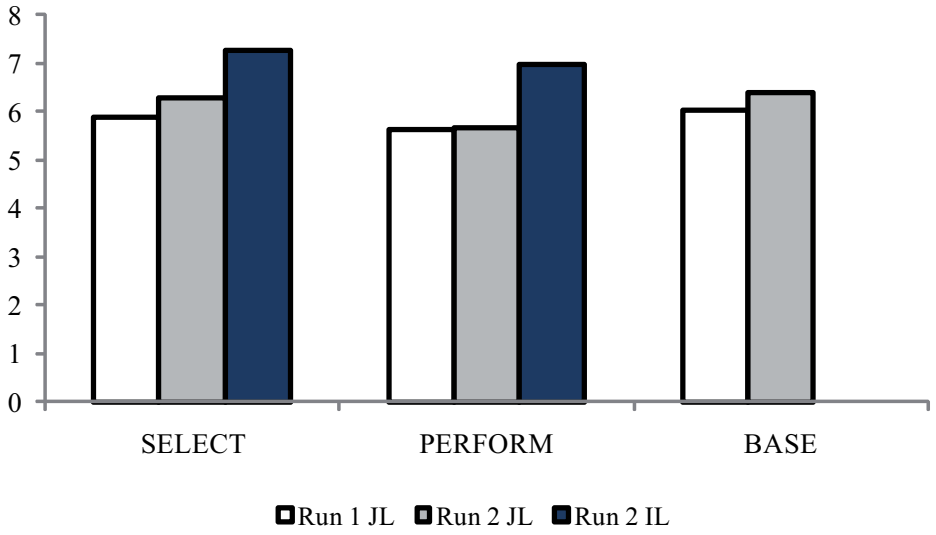
5 Experimental Results

In the following, we will present results on the aggregate level and compare our experimental treatments with respect to effort exertion and repayment performance. Next, we will analyze influence factors on individual effort decisions and finally investigate motivations for contract choices in the SELECT treatment.

5.1 Aggregate Results

Figure 1 displays average effort levels calculated over all active borrowers in both runs for each experimental treatment. The abbreviations JL and IL refer to subjects under joint liability and individual liability, respectively.

FIGURE 1
Average Effort Levels per Treatment



High effort levels are achieved in both runs, with averages reaching some 70% to 90% of the maximum feasible effort. In the first run, average effort levels account for 5.89 in treatment SELECT, 5.62 in treatment PERFORM and 6.04 in treatment BASE. Comparing the treatments with two-sided Mann-Whitney-U (MWU) tests reveals no significant differences on conventional levels ($p > .1$).[12]

[12]For our analysis, we pool the data of the NOINFO and INFO specifications in treatment PERFORM, because they do not differ with respect to effort levels. Average efforts for specifications NOINFO (INFO) are 5.70 (5.53) under joint liability in Run 1, 6.00 (5.30) under joint liability in Run 2 and 7.09 (6.82) under individual liability in Run 2. The corresponding p-values of two-sided Mann-Whitney-U (MWU) tests for effort comparisons between the specifications yield $p = .721$, $p = .368$ and $p = .458$, respectively.

In line with incentives, subjects converted to individual liability converge to full effort exertion in Run 2. Here, average effort levels for the second run increase to 6.96 (PERFORM) and 7.27 (SELECT). Two-sided Wilcoxon Matched Pairs Signed Rank (WMPSR) tests confirm that this difference is significant ($p = .016$ for SELECT and $p < .001$ for PERFORM). This supports our Hypothesis 1 that moral hazard among borrowers exists under group lending.

Among the remaining borrower pairs in Run 2, we observe a small increase of average effort irrespective of the treatment: the corresponding values are 6.28 in treatment SELECT, 5.68 in treatment PERFORM and 6.37 in treatment BASE. However, this difference is weakly significant only in BASE ($p = .078$ for BASE, $p = .844$ for SELECT and $p = .706$ for PERFORM, respectively, two-sided WMPSR tests).

With respect to the impact of conversion mechanisms, we find no evidence in line with Hypothesis 2 that selection into group contracts systematically increases cooperation among borrower pairs. There is no significant difference between the effort levels in BASE and SELECT ($p = .574$, two-sided MWU test). A reason for this result could lie in the motivations behind subjects' contract choices (we will discuss this issue in subsection 5.3).

In Run 2, subjects in treatment PERFORM put (weakly) significantly lower efforts into their projects than their counterparts in the BASE treatment ($p = .068$, two-sided MWU test). This observation provides some evidence for Hypothesis 3 about the dampening effect of performance based conversion on cooperation of the remaining borrower pairs. The prospect of being matched with a borrower having a weak repayment performance decreases subjects' willingness to exert high effort levels.[13]

Finally, we compare the repayment performance of the treatments using relative repayment rates which we define as the percentage share of loans repaid at total feasible loans in all 12 periods per run. Table 2 lists the averages of all treatments for both runs.

There are no significant treatment differences concerning credit repayments per contract (pairwise MWU tests yield $p > .1$ in all cases). Relative repayment rates decrease on average in Run 2, but only significantly so among subjects under individual liability ($p = .008$ for SELECT and $p < .001$ for PERFORM, two-sided WMPSR tests). Here, the relative effort increase of the subjects cannot offset their higher vulnerability against unintentional defaults. Due to

[13]Our experimental data confirms that in the PERFORM treatment, repayment success is a valid signal for exerted effort on average. Calculated over Run 1, the correlation between the number of successful repayments and average effort levels is positive and significant (Spearman's $\rho = .253$, $p = .001$).

TABLE 2
AVERAGE RELATIVE REPAYMENT RATES PER TREATMENT IN %

Treatment	Run 1	Run 2	
	Joint Liability	Individual Liability	Joint Liability
SELECT	83.3	47.8	77.9
PERFORM	81.3	45.1	71.6
BASE	78.1	–	71.4

generally high effort levels under group lending, the insurance effect of joint liability contracts dominates the moral hazard effect in our setting.

5.2 Individual Decisions

To identify the drivers of individual behavior under joint liability, we calculate regression models with random effects on the level of experimental subjects.[14] Our dependent variable is the individual effort choice in a given period. Table 3 displays the regression results.

In the first specification (Model 1) for Run 1, we include the variables *Period* (number of period) and $e_{j,t-1}$ (partner's effort level in the last period). The coefficient for *Period* is negative and significant indicating a downward trend of effort over time. More importantly, we find evidence for the responsiveness of subjects concerning partner effort, as the sign of $e_{j,t-1}$ is positive and highly significant. This is in line with Hypothesis 4 and emphasizes the path-dependency of cooperation in the group lending scheme: The lower the partner's effort has been in the previous period, the lower the subsequent effort choice of a subject is.

In addition, we include the variable $TimesPaid_{t-1}$ in Model 2 indicating the accumulated number of periods in which a subject had to repay the loan of her partner in the period before the effort choice. Due to its correlation with effort $e_{j,t-1}$, we also include the interaction term $e_{j,t-1}\ X\ TimesPaid_{t-1}$.[15] Model 2 shows that – controlling for the partner's effort level – a subject's willingness to exert effort declines significantly with the number of partner repayments. As the interaction term is positive and significant, the negative effect of $TimesPaid_{t-1}$ becomes smaller with higher levels of partner effort. Yet, its estimated net effect remains negative if calculated at the mean value of $e_{j,t-1} \approx 5.35$ in Run 1. All in all, these results suggest that the insurance effect of group lending is dampened

[14] Please note that our results remain similar if we use linear models with fixed effects or simple OLS models with clustered standard errors.

[15] Spearman ρ-values for the correlation between $TimesPaid_{t-1}$ and $e_{j,t-1}$ calculated over all treatments are $\rho = -.188$ in Run 1 ($p < .001$) and $\rho = -.186$ in Run 2 ($p < .001$).

TABLE 3
INDIVIDUAL EFFORT DECISIONS UNDER JOINT LIABILITY

Model	1	2	3	4	5
Dependent Variable	$e_{i,t}$	$e_{i,t}$	$e_{i,t}$	$e_{i,t}$	$e_{i,t}$
Run	1	1	2	1	2
Period	-0.152***	-0.046***	-0.080***	-0.038**	-0.096***
	[0.010]	[0.014]	[0.019]	[0.016]	[0.021]
$e_{j,t-1}$	0.209***	0.336***	0.138***	0.373***	0.156***
	[0.014]	[0.028]	[0.040]	[0.036]	[0.050]
$TimesPaid_{t-1}$		-0.577***	-0.742***	-0.582***	-0.865***
		[0.099]	[0.138]	[0.141]	[0.201]
$e_{j,t-1}$ *X* $TimesPaid_{t-1}$		0.055***	0.083***	0.057***	0.114***
		[0.016]	[0.023]	[0.021]	[0.031]
SELECT			-0.267		-0.192
			[0.336]		[0.392]
PERFORM			-0.519*		-0.139
			[0.285]		[0.310]
Risk Preference				-0.095**	-0.145**
				[0.037]	[0.069]
Constant	5.483***	4.231***	6.878***	4.635***	7.735***
	[0.110]	[0.197]	[0.464]	[0.318]	[0.629]
Observations	2594	2338	1336	1440	968
Subjects	256	252	160	156	112
Wald-χ^2	347.6	581.1	171.5	385	148.1

Random effects are calculated on the level of experimental subjects. Standard errors are given in brackets. ***, ** and * denote significance levels of $p < 0.01$, $p < 0.05$ and $p < 0.1$, respectively.

over time, as the willingness to exert effort declines after agents had to stand in for each other.[16]

Our conclusions remain robust for joint liability borrowers in Run 2 (Model 3). Here, we include also the dummy variables SELECT and PERFORM for the respective treatments. In line with results from non-parametric tests, the treatment dummy for PERFORM has a negative sign and is (weakly) significant while the dummy for the SELECT treatment is not significant. Moreover, the signs and significance levels of the variables capturing the interaction within borrower pairs are comparable to Run 1.

Please note that an important influence factor in our setting might be risk aversion. The threat of receiving no further credit after a default might induce higher effort exertion regardless of partner choices. Therefore, as a robustness check, we collected a survey measure for risk aversion in 5 of 8 experimental sessions, namely the answer to the question "Are you generally willing to take

[16]Conclusions are the same if we include a dummy for the repayment of the partner's loan in the preceding period instead of accumulated repayments.

risks, or do you try to avoid risks?" taken from the German Socio-Economic Panel (SOEP).[17] People could answer on a scale from 0 (risk averse) to 10 (fully prepared to take risks). We rerun regression Models 2 and 3 including the variable for risk preferences (see Models 4 and 5). In both specifications the coefficient has the expected negative sign and is significant. The more risk averse a person is – indicated by lower values for the risk preference variable –, the higher her estimated effort is. Hence, the possibility of exclusion from further credits has a disciplinary effect among borrower pairs. However, the impact of the variables concerning partner interaction ($e_{j,t-1}$ and $TimesPaid_{t-1}$) remains equally robust if we control for risk aversion.[18]

5.3 Selection into Contracts

In the SELECTION treatment, 25 out of 64 subjects (39.1%) opted for the individual contract. To investigate possible motivations behind contract choices and to explain why self-selection does not systematically increase effort levels, we calculate several measures for Run 1 separately for subjects choosing individual and joint liability (see Table 4). Averages are compared on the level of experimental matching groups using two-sided WMPSR tests.

TABLE 4
Influence Factors for Contract Choices

Contract Choice	Individual Liability	Joint Liability	p-value
Own Effort	5.54	6.10	.383
Partner Effort	5.28	6.25	.039
Paid for Partner (Share of Periods)	0.21	0.12	.016
Partner paid (Share of Periods)	0.14	0.17	.375
Risk Preference*	4.00	4.53	.375

Mean values are compared using two-sided WPMSR tests.
*Measure was collected for 32 out of 64 subjects in the SELECT treatment.

The first variable of interest is own average effort. Following Hypothesis 2, one could expect that the more cooperative subjects select into the joint liability contract. However, although average efforts among joint liability subjects are somewhat higher (6.10 compared to 5.54 of subjects choosing individual liability), the difference is not significant. In contrast, partner behavior seems to be more important for the contract choice, as the average effort exerted by partners of subjects opting for individual contracts is significantly lower (5.28 versus

[17]For a description of the SOEP see Wagner et al. (2007).

[18]Due to the lower number of observations, the dummy variable for the PERFORM treatment is not significant in Model 5.

6.25, $p = .034$, WMPSR). Moreover, similar to individual effort decisions, the frequency of partner repayments influences contract selection. Individual liability subjects had to repay their partners' loans significantly more often in Run 1 than subjects choosing joint liability (in 21% of all active periods compared to 12%, $p = .016$, WMPSR). In contrast, the share of periods in which subjects relied on their partners are roughly the same (14% for individual contracts and 17% for joint liability contracts). Finally, subjects do not differ with respect to risk preferences ($p = .375$, two-sided WMPSR test).

To sum up, our results suggest that contract choices are predominantly directed by experiences with the partner: The lower a partner's average effort and the higher the frequency of partner repayments in Run 1 are, the more likely a person is to prefer the individual credit contract for Run 2.

6 Conclusions

We have conducted a microfinance experiment in which subjects decided about the effort put into risky investment projects under joint and individual credit contracts. Under the joint liability contract, borrowers face a social dilemma. While it would be collectively optimal to exert the highest possible effort, it is individually rational to choose the minimum effort level.

In the first run of the experiment, all participants receive group lending contracts. In the second run, participants are converted to individual contracts on the basis of self-selection or repayment success. Both treatments are compared to a reference setting in which subjects interact under joint liability for both runs.

Subjects exert high average effort levels under group lending in all treatments and both runs. It follows that in our setting, joint liability contracts are superior to individual contracts in terms of repayment performance. Yet, within-group moral hazard still persists for two reasons. First, subjects choose significantly higher efforts under individual contracts than under joint liability contracts. Second, effort decisions are highly path-dependent, as borrowers condition their efforts on partner behavior. In addition, realized outcomes of investment projects also have an impact on effort choices. The more often a subject had to repay the partner's loan, the lower her estimated effort is in subsequent periods.

A comparison of conversion mechanisms shows that removing the groups with a high repayment performance may have a negative impact on the remaining borrowers. The latter subjects tend to exert lower efforts than their counterparts in the reference treatment. In contrast, self-selection into con-

tracts does not systematically change average efforts in Run 2. There is also no sign for a systematic selection of cooperative players into the joint liability scheme. Instead, partner efforts and the frequency of double repayments are more important drivers for the contract choice.

To sum up, while our controlled laboratory experiment captures only few of the aspects that determine the success of microfinance programs in the field, it points out the necessity to monitor within-group dynamics. Because micro banks in practice often establish lasting relationships with their customers, the dynamic interaction within borrower groups might crucially influence the functioning of joint liability.

Finally, our study provides a first test of the effects of alternative conversion mechanisms on cooperation avoiding sample-selection problems that may emerge with field data. To connect field studies and laboratory experiments might be a promising approach for further research in the microfinance context.

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Appendix

A Instructions

Below we show the instructions for the first and second run in treatment SELECT. Instructions for the other groups and treatments were formulated in a similar way.

Instructions: General Information

Welcome to the experiment! In this experiment you can earn money. How much depends on your decisions and the decisions of other participants.
From now on, please do not communicate with other participants. If you have a question concerning the experiment, please raise your hand! We will come to you and answer your question. If you violate these rules, we have to exclude you from the experiment and all payoffs.
In the experiment, ECU is used as the currency. At the end of the experiment, your payoff in ECU is converted into Euro and paid out in cash. The exchange rate is 30 ECU = 1 Euro. In the experiment, all ECU amounts are rounded to whole numbers.
The experiment consists of two runs. After the experiment, one of the two runs is randomly selected. The sum of period payoffs of this run is paid out. In addition, you receive an amount of 5.00 Euros for your participation in the experiment, which is paid out at the end regardless of the decisions. If you make a loss in the course of the experiment, it will be set off against the amount of 5.00 Euros.

Instructions: First Run

The following instructions refer to the first run. After the first run you will receive new instructions.
The first run consists of 12 periods. Previous to the first run, pairs of two participants are formed randomly. These pairs interact with each other during the whole first run. The identity of the other participant is secret, and no other participant will be informed about your identity. Thus, your decisions are anonymous.
The following explanations apply to you and to the other participant. The other participant faces exactly the same decision situation as you.

In the first period of the experiment, you and the other participant receive a credit of 50 ECU each. The credit amounts automatically fund a risky investment project. Each participant has a personal investment project into which her credit is invested.
Possible payoffs of the investment project are as follows:

- In case of success, each investment project achieves a payoff of 200 ECU.
- In case of failure, each investment project achieves a payoff of 0 ECU.

The payoff of your investment project and the payoff of the other participant's investment project are independent of each other.
The success probability of your project is influenced by your level of effort. You can choose every integer between $A = 0$ (lowest effort) and $A = 8$ (highest effort) as effort level (abbreviated with A in the following).

- If you choose $A = 0$, the success probability of your project is 50%.
- For every unit of effort, the success probability of your project increases by 5%.
- Examples:
  - If you choose $A = 1$, the success probability of your project is 55%.
  - In case of $A = 2$, the success probability of your project is 60%.
  - ...
  - In case of the highest effort level $A = 8$, the success probability of your project is 90%.

For every unit of effort that you choose, you have costs of 6 ECU. (Example: If you choose $A = 4$, the costs of effort are $4 \cdot 6$ ECU = 24 ECU.) The costs for your chosen effort level incur regardless of the project success.
You find an overview of possible effort levels and the associated costs in the following table.

Effort level chosen	0	1	2	3	4	5	6	7	8
Success probability of the project in %	50%	55%	60%	65%	70%	75%	80%	85%	90%
Effort costs	0	6	12	18	24	30	36	42	48

After you and the other participant have chosen effort levels, payoffs of both investment projects are randomly determined. You are informed about:

- the payoff of your project (either 200 ECU or 0 ECU).
- the payoff of the other participant's project (either 200 ECU or 0 ECU).
- your chosen effort level and effort costs.
- the other participant's effort level and her effort costs.
- your period payoff and the sum of period payoffs in this run.
- the other participant's period payoff and the sum of her period payoffs in this run.

The repayment amount for your credit is 100 ECU, the repayment amount for the other participant's credit is also 100 ECU. After payoffs of the investment projects are determined, credits have to be repaid. You and the other participant are jointly responsible for the sum of both repayment amounts (100 ECU + 100 ECU = 200 ECU).
If your project was successful (your payoff = 200 ECU), the repayment for your credit (= 100 ECU) is deducted automatically from your payoff. If at the same time the other participant's project was not successful (payoff = 0 ECU), she is not able to repay her credit. In that case the other participant's repayment is also deducted automatically from your payoff.
If your project was not successful (your payoff = 0 ECU), you are not able to repay your credit. If at the same time the project of the other participant was successful (payoff = 200 ECU), your repayment is deducted automatically from the payoff of the other participant.
It is not possible to use payoffs from previous periods for credit repayments.

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

+	Payoffs of your project
-	Credit repayment
-	Effort costs
=	Period payoff

If the sum of both repayment amounts (= 200 ECU) is repaid, you and the other participant receive a new credit of 50 ECU in the next period and the decision situation proceeds again as described.
If less than the sum of both repayments (= 200 ECU) is repaid in one period, the first run is over for you and the other participant. You and the other participant will not receive a new credit for the rest of this run and will not make any decisions.

Instructions: Second Run

Welcome to the second run of the experiment! The second run of the experiment consists of 12 periods. For this run, all participants are divided into two groups, group 1 and group 2. Before the experiment starts, you can choose the group you want to belong to. If you have chosen one group, your choice is valid for the entire second run.
Participants choosing group 1 are responsible only for the repayment of their own credit during the entire second run. Otherwise the decision situation is identical to the decision situation in the first run. If a participant of group 1 is not able to repay her credit (= 100 ECU) in one period, the second run is over for her. In that case, the participant will not receive a new credit for the rest of the run and will not make any decisions.
Participants choosing group 2 are again – together with another participant – responsible for the sum of repayments of both credits in the second run. Analogous to the first run, pairs of two participants are formed randomly previous to run 2. These pairs will interact with each other during the whole second run.
The decision situation is identical to the decision situation in the first run of the experiment. If a pair of participants repays less than the sum of both repayment amounts (= 200 ECU) in one period, the second run is over for both participants. In that case, both participants will not receive a new credit for the rest of this run and will not make any decisions.

With respect to the assignment of participants to group 2, it is guaranteed that no participants interact with each other that were matched in the first run of the experiment. The exception is that two participants that were matched in the first run are the only participants in group 2. If an odd number of participants chooses group 2, one participant is randomly selected and assigned to group 1.