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# Credit Reporting, Relationship Banking, and Loan Repayment

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# Credit Reporting, Relationship Banking, and Loan Repayment\*

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## Abstract

This paper examines the impact of credit reporting on the repayment behavior of borrowers. We implement an experimental credit market in which loan repayment is not third-party enforceable. We then compare market outcome with a public credit registry to that without a credit registry. This experiment is conducted for two market environments: first, a market in which repeat interaction between borrowers and lenders is not feasible and, second, a market in which borrowers and lenders can choose to trade repeatedly with each other. In the market without repeat interaction the credit market collapses without a credit registry, as lenders rightly fear that borrowers will default. The introduction of a registry in this environment significantly raises repayment rates and the credit volume extended by lenders. When repeat transactions are possible a credit registry is not necessary to sustain high market performance as relationship banking enforces repayment even when lenders cannot share information. In this environment credit reporting has little impact on market efficiency, it does however affect trading structure and distribution. The presence of a credit registry leads to fewer banking relationships and reduces the ability of lenders to extract rents from such relationships.

Keywords: Credit Market, Information Sharing, Relationship Banking

JEL: G21, G28, D82

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# 1 Introduction

In credit markets, borrowers typically have more information about their investment opportunities, their own character and their prior indebtedness than lenders. This asymmetry of information gives rise to selection problems for lenders and potential moral hazard of borrowers, which may lead to a rationing of credit (Stiglitz and Weiss, 1981). In many countries problems of asymmetric information are aggravated by the fact that loan contracts are costly to enforce (Levine, 1998; Jappelli et al., 2005).

One response to asymmetric information and costly enforcement in the credit market is information sharing between lenders, i.e. credit reporting through private credit bureaus or public credit registries. Theoretical models suggest that credit reporting can reduce adverse selection in markets where borrowers approach different lenders sequentially (Pagano and Jappelli, 1993). Moreover, credit reporting can also have a strong disciplining effect on borrowers. Diamond (1989) shows that a public credit registry can motivate borrowers to choose agreed projects. Further models show that information sharing can discipline borrowers into exerting high effort in projects (Vercammen, 1995; Padilla and Pagano, 2000) and repaying loans (Klein, 1992).

A recent survey by the World Bank (World Bank, 2005) shows that credit bureaus or credit registries now exist in over 100 countries worldwide. In the USA, where credit reporting is most prevalent, over 3 million credit reports are issued every day (Hunt, 2005). In recent years, many developing and transition economies have also introduced credit registries or fostered credit bureaus in the hope of boosting credit growth (Miller, 2003). Giving the strong growth of credit reporting worldwide and the high hopes which policy makers place in such institutions, there is a need for empirical evidence which examines how credit reporting affects the performance of the financial sector.

In this paper we use experimental methods to examine how a public credit registry affects loan repayment and credit market performance. We examine an experimental credit market in which loan repayment is not third-party enforceable. We first implement a market in which there is no opportunity for information sharing between lenders. We then implement an identical market, but with a public credit registry which collects and disburses credit information to lenders. By comparing repayment behavior and credit volumes between the two markets we can identify the impact of a credit registry on credit market performance.

We contribute to the empirical literature on credit reporting in two ways. First,

this is the only study we know of which examines the impact of information sharing on borrower behavior. Several authors have shown that credit reports do reduce the selection costs of lenders by allowing them to more accurately predict loan defaults (Kallberg and Udell, 2003; Barron and Staaten, 2003; Powell et al., 2004). The disciplining effect of information sharing on borrower behavior has, however, not yet been studied.<sup>1</sup> This is by no means surprising, given that with field data it is difficult to identify whether an individual borrower has behaved differently than he would have done without the presence of a credit registry. Indeed, if borrower behavior were observable in the field, it would be contractible so that there would be no moral hazard on the account of asymmetric information.

The second contribution of our paper is that, in contrast to existing studies, we can directly identify how the introduction of a credit registry affects credit market performance. Current evidence on the impact of information sharing on credit market performance relies on cross-country comparisons. Jappelli and Pagano (2002) and Djankov et al. (2005) show that aggregate bank credit to the private sector is higher in countries where information sharing is more developed. Analyses of firm-level survey data (Galindo and Miller, 2001; Love and Mylenko, 2003) further show that access to bank credit is easier in countries where credit bureaus or registries exist. However, given the cross-sectional nature of their data, these studies cannot identify the direction of causality between credit reporting and credit volume. After all, theory suggests that credit bureaus will emerge where lenders benefit more from them (Pagano and Jappelli, 1993) and this is certainly the case where the credit volume is higher. Thus a positive correlation between credit reporting and credit market performance may arise simply because credit bureaus are more likely to be set up in countries where lending is vibrant. By applying experimental methods, our study allows us to circumvent this endogeneity issue and identify how the exogenous introduction of a credit registry affects credit market performance.

The impact of a credit registry on repayment behavior may depend strongly on the nature of credit transactions. In particular, the extent to which lending relationships are feasible may affect the benefits of information sharing between lenders. In a credit market dominated by short-term interaction (for example due to high mobility of borrowers) borrowers cannot be disciplined to repay loans in the absence of an information sharing mechanism. In contrast, in credit markets dominated by repeated interactions (e.g. working capital loans), information sharing may not be

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<sup>1</sup>Jappelli and Pagano (2002) show that loan defaults, measured by country risk indicators, are lower in countries where credit registries and bureaus are more developed. However, this result can obviously result from better selection of borrowers rather than from actually disciplining them to repay.

required to discipline borrowers. In such markets, theoretical models suggest that self-enforcing implicit contracts between lenders and borrowers, (i.e. banking relationships), can motivate high effort and timely repayments (Bull, 1987; Boot and Thakor, 1994). Empirical studies confirm that some credit market segments (in particular small business lending) are pervaded by relationship-banking and that these relationships improve the access of potential borrowers to credit (Petersen and Rajan, 1994, Elsas and Krahnert, 1998). Experimental studies (Brown et al., 2004; Fehr and Zehnder, 2005) also confirm that long-term relationships are a powerful disciplinary device.

In this paper we examine how the impact of a credit registry depends on the feasibility of relationship banking. We conduct our experiment for two credit market environments. In one environment information conditions prevent repeated interaction between particular borrowers and lenders so that all lending transactions are inherently one-off. In the second environment, information conditions are such that lenders can choose to trade with the same borrower repeatedly and banking relationships can emerge endogenously.

Our results indicate that the impact of a credit registry on market performance is highly dependent on the nature of credit transactions. When relationship banking is not feasible the credit market essentially collapses in the absence of a credit registry. As repayments are not third-party enforceable, many borrowers default and lenders cannot profitably offer credit contracts. The introduction of a credit registry in this environment greatly enhances the performance of the credit market. The availability of information on past repayment behavior allows lenders to condition their offers on the borrowers' reputation. As borrowers with a good track record get better credit offers, all borrowers have a strong incentive to sustain their reputation by repaying their debt. As a consequence a well functioning credit market is established in which a large percentage of the available gains from trade is realized.

When repeated interaction between borrowers and lenders is possible, the presence of a credit registry has no such effect on market performance. In this environment, the market participants solve the moral hazard problem even in the absence of a credit registry. By repeatedly interacting with the same borrower, lenders establish long-term relationships which enable them to condition their credit terms on the past repayments of their incumbent borrower. As only a good reputation leads to attractive credit offers from the incumbent lender, borrowers have strong incentives to repay. The disciplining effect of these banking relationships is sufficiently strong so that the introduction of a credit registry only slightly improves credit market performance. Nevertheless, even when relationship banking is feasible, a credit

registry does affect market outcome. First, the credit market is less dominated by specific borrower-lender relations, as these are no longer necessary to enforce repayment. Second, by improving the information available to “outside” lenders, a credit registry reduces the ability of lenders to extract rents from relationships.

From the policy perspective, our results have two consequences for the design of credit registries and credit bureaus. First, theory suggests that the optimal amount of information to be shared between lenders depends on the potential disciplining effect of credit reporting, vis-a-vis its screening effect. When the disciplining effect is negligible, it is optimal to share as much information as is available on borrowers. In contrast, when the disciplining effect is potentially important, it may be optimal to limit the type of information shared (Padilla and Pagano, 2000) and the length of credit histories (Vercammen, 1995). The intuition behind this result is that full disclosure of information on borrowers allow lenders to identify the type of borrowers and thus reduces adverse selection. However, full disclosure also eliminates any incentives of “bad” borrowers to imitate the behavior of good borrowers in order to hide their type. Our results suggest that a limiting of information exchange may be optimal in markets where relationship banking is rare and the disciplining of borrowers relies on credit reporting. Second, when the disciplining effect of information sharing is potentially strong, lenders should make sure that the existence of credit bureaus and credit registries is well-known to borrowers. Rather than share information secretly, as is the current practice in some countries (Luoto et al., 1994), lenders should make sure that borrowers are aware that their repayment behavior will be recorded and could affect their future access to credit.

The plan of the paper is as follows: Part 2 presents our experimental design and part 3 the corresponding predictions. Part 4 presents our results. Part 5 concludes.

## 2 Experimental Design

Experimental studies have proven highly valuable in testing theoretical conjectures which are difficult to identify using field data. In financial markets experiments have, for example, been used to study the emergence of bubbles (Smith et al., 1988; Lei et al., 2001), the dissemination of information (Sunder, 1992), herd behavior (Celan and Kariv, 2004), and more recently the emergence of banking relationships (Fehr and Zehnder, 2005). Our objective is to study how the repayment behavior of borrowers is affected by information sharing among lenders. We therefore implement an experimental credit market in which loan repayment is not third-party enforceable.

Our experimental credit market involves 17 participants. These participants are randomly assigned to the role of a borrower or a lender at the beginning of a session. Ten subjects are in the role of lenders and seven subjects are in the role of borrowers. Each session lasts for 20 periods and roles of subjects are fixed for the whole session.

At the beginning of every period each lender is endowed with 50 capital units ( $\bar{k}$ ). A lender has two opportunities to make use of his endowment. He can either invest the endowment in an endowment-storing technology or he can use the endowment to extend credit to a borrower. The first stage of each period is a continuous one-sided auction, in which lenders and borrowers can seal credit contracts. The lenders are the contract makers, i.e. they alone can make credit offers to the borrowers, who themselves can not apply for credit. When making a credit offer the lender has to specify four items: the size of the loan ( $k$ ), the requested repayment ( $\tilde{r}$ ), the set of market participants who can observe the offer and finally, which borrowers are authorized to accept the offer. Lenders can freely decide how they want to split their endowment between the endowment-storing technology and a credit offer, i.e. the loan size  $k$  can be picked from the set  $\{5, 10, 15, \dots, 50\}$ . The set for the requested repayment  $\tilde{r}$  is given by  $\{5, 10, 15, \dots, 100\}$ . There are two types of credit offers: Public credit offers and private credit offers. A private credit offer is only addressed to one specific borrower. It cannot be seen or accepted by other borrowers and is also not visible to other lenders. A public offer is always shown to all borrowers and all other lenders. However, even with public offers the lender must specify which borrowers are authorized to accept the offer. Hereby the lender can choose, or exclude as many borrowers as he wants.<sup>2</sup> During the auction a lender can make as many public and private offers as he wants. However, each lender can only conclude one credit contract per period. As soon as a borrower accepts an offer of a given lender a contract is concluded and all other outstanding offers made by this lender disappear from the market and can no longer be accepted by other borrowers. Each borrower can accept at most one contract per period so that our credit market implements an excess supply of credit.

Borrowers are endowed with 5 capital units in each period. At the second stage of a period borrowers automatically earn an investment income which is twice the size of this endowment and their borrowed capital,  $2(5 + k)$ . At the third stage of a period, borrowers who received a loan decide whether they want to make the repayment requested by the lender ( $r = \tilde{r}$ ) or not repay at all ( $r = 0$ ). Partial

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<sup>2</sup>This implementation of public offers is designed to capture public announcements of credit conditions by banks who can always choose not to extend credit to some clients on these terms.



repayments are not possible.<sup>3</sup>

At the end of each period, each lender is informed about his borrower's repayment decision, profits are calculated and all market participants get to know their own and their partner's payoffs for the period. Payoff functions, the number of lenders and borrowers and the number of trading periods are common knowledge. The monetary payoffs of the market participants per period are calculated as follows:

$$\begin{aligned} \text{Payoff of lender:} & \quad \pi = 50 - k + r \\ \text{Payoff of borrower:} & \quad v = 2(5 + k) - r \end{aligned}$$

Our goal is to study how the presence of a credit registry affects borrowers' repayment choices and credit market performance. In order to do so we first implement our credit market without any opportunity for information sharing between lenders. We then implement the credit market with a public credit registry which collects and disburses credit information to lenders. In the treatments with a credit registry all lenders get a credit report at the beginning of every period. The credit report is free and lists, for each borrower and all past periods, whether the borrower received a loan and whether he repaid it. The report thus contains complete information on the past repayment behavior of all borrowers. However, information on loan sizes and requested repayments is not provided. In these treatments all borrowers and lenders are aware that the credit registry automatically collects and disburses information on repayment behavior in each period. Table 1 provides an overview of our experimental treatments. Treatments with a credit registry are called "CR" treatments, while those without a credit registry are called "NO" treatments (for no credit registry).

We expect that the impact of credit reporting on borrowers' repayment behavior may depend on the feasibility of an alternative disciplining mechanism in the credit market: relationship banking. In reality, the feasibility of relationship banking in a credit market varies, depending on how mobile borrowers are and how diverse their funding needs are, compared to the product and geographical specialization of lenders. If borrowers are highly mobile and lenders are geographically specialized, banking relationships will be difficult to maintain. On the other hand, if mobility of borrowers is low or lenders are universal banks with country-wide coverage relationships are simple to maintain. We examine the impact of credit reporting for market conditions with varying feasibility of relationship banking. In order to study

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<sup>3</sup>In reality some borrowers obviously become delinquent without fully defaulting. However due to the deterministic nature of investment earnings in our design we exclude partial repayments.

the range of the impact which a credit registry could have on borrower behavior we implement our CR-NO comparison for two border cases: in one market condition relations are not feasible at all, while in the other condition borrowers and lenders can always continue relationships if they want to.

Table 1: Experimental Treatments

		Relationship Banking	
		Not Possible (Random ID)	Possible (Fixed ID)
Credit Registry	Yes	R-CR	F-CR
	No	R-NO	F-NO

Our first condition makes it impossible for lenders to interact repeatedly with a particular borrower by randomly assigning identification numbers (IDs) to borrowers and lenders in each new period (henceforth treatments in this environment are called R treatments). This procedure guarantees that no market participant can identify his former trading partners at the beginning of a period and therefore intentional repeated offers by lenders to borrowers are ruled out.

Our second environment involves a market in which lenders and borrowers have the opportunity to engage in long-term relationships. Repeated interaction with the same trading partner is possible because subjects have fixed IDs for the entire experimental session (henceforth treatments in this environment are called F treatments). Consequently, lenders can offer credit to the same borrower (i.e., to the same ID number) in consecutive periods and, if the borrower accepts these offers, a long-term relationship is established.

In total we conducted 20 experimental sessions, five for each of our four treatments. We had 17 subjects in each session, which makes a total of 340 participants. All experimental subjects were volunteers. They were all participating for the first time in such an experiment, and each participant could only participate in one session (i.e., each subject experienced only one of the treatments). All participants were students at the University of Zurich or the Swiss Federal Institute of Technology Zurich (ETH). The computerized experiment was programmed and conducted

with the experimental software z-Tree (Fischbacher, 1999). A session lasted approximately ninety minutes. Subjects received a show-up fee of 10 Swiss francs (CHF) and 1 additional franc for every 20 points earned during the experiment. On average subjects earned 55 Swiss francs (1.3 CHF  $\approx$  1 US\$ in January 2006).

To make sure that all participants fully understand the decision process and the payment structure of the game, each subject had to read a detailed set of instructions before a session was started. After reading the instructions participants had to pass a test with control questions. No session started before all subjects had correctly answered all control questions. Additionally there were two practice periods before an actual session was started in order to make the participants familiar with the bidding procedures. In both practice periods, subjects only went through the offering stage of a period, i.e. there were no repayment choices and subjects could not earn money in the practice periods.

### 3 Predictions

Under the assumption of common knowledge of rationality and selfishness of all market participants, the prediction for all four treatments is straightforward: Since credit repayments are not enforceable, the borrowers' best response in the stage game is to never repay their debt. Lenders, anticipating this behavior, will never offer credit so that the credit market collapses in the stage game equilibrium. As our experiment lasts for a finite number of periods, a simple backward induction argument ensures that the stage game equilibrium is played in every period of the game. The different treatment conditions do not affect this prediction. If lenders are certain that all borrowers are selfish, neither public information on past repayment behavior of borrowers nor the possibility to establish long-term relationships can overcome this inefficient outcome.

However, empirical evidences suggests that not all people simply maximize monetary payoffs. It has been shown that, in a wide range of economic settings, the behavior of some people is also driven by social motives (for an overview see, e.g., Fehr and Schmidt, 2002 and Camerer, 2003). Especially important for our purposes is the experimental evidence on the "investment game" (also called "trust game"). In this simple two-player experiment the first mover ("investor") gets an endowment  $X$ , which he can keep or invest. If the investor invests  $i \leq X$ , his investments is trebled and transferred to the second mover ("trustee"). The trustee must then decide how much to send back to the investor. A large number of studies show that many investors decide to invest and a considerable fraction of trustees are willing

to pay back a positive amount. It appears that many trustees feel a moral obligation to repay. Or, put differently, they are willing to reciprocate the investor’s risky action which benefits them (for an extensive summary see Camerer, 2003). Recent research by Karlan (2005) shows, moreover, that the second mover behavior in investment games can be used to predict real-life financial decisions.

The evidence from the investment game suggests that, in our experiment social motives could lead some borrowers to repay loans because they would otherwise suffer from a bad conscience or because they would like to reciprocate “fair” financing conditions provided by lenders. In the following we therefore examine our credit market treatments under the assumption that a fraction  $p$  of the borrowers are “conditionally honest”. We assume that these borrowers are willing to meet their repayment obligations ( $r = \tilde{r}$ ) on a voluntary basis, as long as the repayment requested by the lender does not exceed a certain threshold value  $\tilde{r}(k) \leq \phi k$ , where  $\phi > 1$  (this implies that an honest borrower is prepared to repay a loan which demands some positive interest rate). Guided by existing experimental evidence (see e.g. Fehr and Schmidt, 2002), we assume that honest borrowers only repay if they get at least an equal share of gains from trade, i.e.  $(2 - \phi)k \geq \phi k - k$  or  $\phi \leq 1.5$ . These considerations lead us therefore to assume a parameter range of  $\phi \in (1, 1.5]$ .

### 3.1 Predictions for the R Treatments

In the **R-NO treatment**, lenders have no information on the prior behavior of any particular borrower in the market. This treatment essentially implements a series of one-shot interactions so that each period can be analyzed as a one-period game. In such a game, selfish borrowers never repay their debt, while honest borrowers repay as long as they are offered a contract of the form  $[k, \tilde{r} \leq \phi k]$ . Consequently, under these conditions the provision of credit can only be profitable for lenders if the fraction of honest borrowers  $p$  is large enough. In Proposition A1 in the Appendix we formally show that lenders are only willing to extend credit if  $p \geq \frac{1}{\phi}$ . If there are fewer honest borrowers the credit market collapses and all lenders fully invest their capital into the endowment-storing technology. In light of our parameter assumptions, Proposition A1 suggests that a substantial share of honest borrowers are required to guarantee the existence of a functioning credit market. If the honest borrowers preferences are such that  $\phi \in (1, 1.5]$ , then the necessary fraction of honest borrowers to make credit offers profitable for lenders is  $p \geq 2/3$ . Experimental evidence suggests, however, that only 40 to 60 percent of subjects are motivated by social preferences (see e.g. Fehr and Schmidt, 2002). Accordingly, we would predict

that the credit market will collapse in our R-NO treatment. Empirically, however, a full collapse of the market would require that all lenders have an accurate initial belief about the fraction of honest borrowers. This is a relatively strong assumption. If some lenders start with excessively optimistic beliefs, there may be some trading in the early periods of the experiment. However, as soon as learning takes place and beliefs are updated, the credit market should break down.

In the **R-CR treatment**, lenders receive a credit report at the beginning of each period stating, for each borrower and each prior period, whether the borrower concluded a credit contract and whether he repaid his debt. In contrast to the R-NO treatment, lenders in the R-CR can therefore condition their credit offers on the borrowers' past repayment behavior. If selfish borrowers anticipate the conditional offering of lenders they have a strong incentive to hide their type and imitate the behavior of honest borrowers. Repaying a loan is the only way for selfish borrowers to build up a reputation as a honest type and to get access to profitable future credit offers of lenders. In Proposition A2 in the Appendix, we show that this mechanism can sustain an equilibrium in which a substantial credit volume is provided, even in cases where the share of honest borrowers  $p$  is such that the credit market would collapse in the R-NO treatment ( $p < \frac{1}{\phi}$ ).<sup>4</sup>

Proposition A2 describes the following equilibrium behavior of lenders and borrowers: In all periods lenders strictly condition their credit offers on the borrowers' past repayment behavior, i.e. they make only credit offers to borrowers who have never defaulted in the past. In a first phase of the R-CR treatment this motivates all selfish borrowers to repay loans out of reputational concerns and accordingly lenders extend the maximal credit volume. During this "pooling" phase selfish and honest borrowers behave identically and therefore no information about the borrowers' types is revealed. In later periods, reputational incentives decline and repayment rates fall as selfish borrowers begin to default with a positive probability. The partial defaulting of selfish borrowers allows lenders to update their beliefs about the borrowers' types and ensures that lending does not lead to losses for lenders. However, in this second phase, the aggregate credit volume begins to fall as those borrowers who defaulted in prior periods receive no further loans and those who repaid receive only loans with non-maximal credit sizes. Furthermore,

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<sup>4</sup>The assumption that there are two types of borrowers implies that we analyze a finitely repeated game with incomplete information. Such games are usually characterized by a large number of equilibria (see Fudenberg and Maskin, 1986). It is not our objective to provide a complete formal analysis of our experimental game in the Appendix. We rather prove that there are Perfect Bayesian Equilibria in which the reputation mechanisms intuitively described in this section ensure that a functioning credit market exists.

competition among lenders implies that credit offers are such that all gains from trade go to the borrowers and lenders make zero profits throughout the experiment.

In order to see that the equilibrium described above can indeed imply a substantial efficiency effect, consider the following numerical example: Assume that  $\phi = 1.2$  (honest borrowers are willing to repay 60 if they receive a loan of size 50) and that  $p = 0.5$  (50% of borrowers are honest). In this case the condition derived in Proposition A1 shows that the credit market collapses in the R-NO treatment:  $p = 0.5 < \frac{1}{\phi} = 0.83$ . Proposition A2, on the other hand, tells us that in the R-CR treatment all borrowers could get full credit provision ( $k_t^* = 50$ ) until period 17. In period 17, selfish borrowers start to default with a positive probability.<sup>5</sup> From period 18 on, those borrowers who no longer have a clean record do not get credit offers and the lenders begin to decrease the size of the loans extended.<sup>6</sup> Taken together this implies that the credit registry can have a significant positive effect on credit market efficiency. In our example the overall realized credit volume amounts to 89 percent of the potentially possible credit volume.

Based on these considerations we state the following hypotheses for our R treatments:

**Hypothesis R Treatments:** In the R-CR treatment the repayment rate of borrowers is significantly higher than in the R-NO treatment. In the R-NO treatment, the low repayment rate leads to a collapse of the credit market. In the R-CR treatment, credit volumes are significantly higher than in the R-NO, albeit with decreasing volumes towards the end of the experiment.

## 3.2 Predictions for the F Treatments

In the **F-NO treatment**, lenders do not have information on the behavior of all borrowers in all prior periods. However, due to the fixed identities, lenders do have information on past behavior of those borrowers with whom they themselves have traded in prior periods. Thus in contrast to the R-NO treatment, lenders have the possibility to offer attractive contract renewals to known borrowers with satisfactory past repayment behavior. If repayment guarantees access to profitable loans from incumbent lenders, selfish borrowers may also be motivated to repay. Proposition A3 in the Appendix shows that there is an equilibrium in the F-NO

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<sup>5</sup>The equilibrium repayment probabilities of selfish borrowers  $\gamma_t^*$  in periods 17 to 20 are:  $\gamma_{17}^* = 0.73$ ,  $\gamma_{18}^* = 0.60$ ,  $\gamma_{19}^* = 0.45$ ,  $\gamma_{20}^* = 0$ .

<sup>6</sup>The equilibrium size of loans  $k_t^*$  offered in periods 18 to 20 are:  $k_{18}^* = 29$ ,  $k_{19}^* = 17$ ,  $k_{20}^* = 10$ .

treatment in which endogenously formed banking relationships ensure the provision of a substantial credit volume even in the case where the fraction of honest borrowers is insufficient to guarantee the existence of a credit market in the R-NO treatment ( $p < \frac{1}{\phi}$ ) and no credit registry is present.

The equilibrium behavior of lenders and borrowers derived in Proposition A3 can be described as follows: In the first period all lenders make a competitive offer and try to conclude a contract with a borrower. Those lenders who succeed in concluding a contract with a borrower in the first period subsequently establish a long-term relationship with their incumbent borrower. As long as the incumbent borrower repays, they renew his contract in every period by making him a private offer. Lenders who could not conclude a contract in the first period invest their capital in the endowment-storing technology and remain outside the credit market. The reason that they do not try to enter the market by making competitive offers to borrowers in relationships with other lenders is that they believe that such contract offers would only attract selfish borrowers. As trading with selfish borrowers is not profitable, they prefer to stay away from the credit market.

As outside lenders do not contest the market, lenders who have established a relationship with a borrower can exert a certain market power. By making offers which just satisfy the conditions under which honest borrowers repay, they can skim off part of the gains from trade in their relationship. Of course, in the first period lenders anticipate that they will earn a rent if they manage to establish a relationship. Competition among lenders therefore implies that they are prepared to make losses in the first period in order to get access to the rents earned in a relationship. Within the relationships, the conditional contract renewals of incumbent borrowers, in combination with the fact outside lenders are not willing to offer credit, motivates selfish borrowers to perfectly imitate the repayment behavior of honest borrowers in a first phase of the game. As lenders make profits in these periods they maximize their income by extending maximal credit amounts. During this “pooling” phase of the experiment, no additional information about the types of borrowers is revealed and the lenders’ beliefs remain constant at the initial level  $p$ . When the end of the game draws near, however, lenders are only willing to renew their contracts if they get additional information on the borrowers’ types. Therefore, in this phase, selfish borrowers start defaulting with positive probabilities and therewith ensure that lenders can update their beliefs and remain willing to renew their contracts. However, as defaulting borrowers no longer get credit offers and as lenders start to lower the size of their loans, the extended credit volume decreases towards the end of the game.



In order to show that a substantial credit volume can be sustained in this “relationship equilibrium”, we apply the numerical example from above to this situation as well. As before, we start with the assumptions that  $\phi = 1.2$  and  $p = 0.5$ . Proposition A3 implies that the maximal credit provision ( $k_t^* = 50$ ) can be sustained until period 17. In period 17, selfish lenders begin to default with a positive probability.<sup>7</sup> In the subsequent periods not all borrowers get credit and lenders reduce the size of the extended loans such that the total credit volume decreases in the final periods of the game.<sup>8</sup> However, overall, 90 percent of the maximally possible credit volume is issued.

In the **F-CR treatment**, the presence of a credit registry implies that lenders have information not only on the behavior of their own prior borrowers, but on all borrowers in the game. As a consequence, the equilibrium derived for the R-CR treatment and described in detail in Proposition A2 of the Appendix also applies for the F-CR treatment. Lenders condition their offers strictly on borrowers’ credit records, inducing certain repayment by all borrowers initially and positive repayment probabilities for selfish borrowers, even in the end-game phase. Due to strong competition for borrowers, all (expected) gains from trade are reaped by borrowers in all periods. Note, however, that even in the presence of a credit registry, the relationship equilibrium described for the F-NO treatment in Proposition A3 in the Appendix can also be sustained in the F-CR treatment. In this equilibrium, inside lenders condition credit offers on their incumbent borrowers’ prior behavior, while outside lenders offer no credit at all. The reason for this is that, even if outside lenders have information on prior borrower behavior through the credit register, the belief that only selfish borrowers will switch will prevent them from making credit offers. As a consequence, selfish borrowers again have an incentive to repay with certainty in early periods of the experiment and with positive probability in the end-game phase.

Our numerical example shows that the “credit-record equilibrium” described by Proposition A2 and the relational equilibrium described by Proposition A3 yield identical repayment rates and practically identical credit volumes. Thus market performance in the F-CR should be similar to that in the F-NO treatment, independent of which equilibrium type arises. However, market structure and distribution of surplus will differ between the F-CR and F-NO treatments if the “credit-registry equilibrium” is played in the F-CR. As discussed above, long-term relationships

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<sup>7</sup>The equilibrium repayment probabilities of selfish borrowers  $\gamma_t^*$  in periods 17 to 20 are:  $\gamma_{17}^* = 0.73$ ,  $\gamma_{18}^* = 0.60$ ,  $\gamma_{19}^* = 0.45$ ,  $\gamma_{20}^* = 0$ .

<sup>8</sup>The equilibrium size of loans  $k_t^*$  offered in periods 18 to 20 are:  $k_{18}^* = 30$ ,  $k_{19}^* = 18$ ,  $k_{20}^* = 11$ .



are not necessary to sustain the “credit-registry equilibrium” and would therefore be observed less frequently than in the F-NO. Moreover, lenders who establish relationships earn quasi-rents in the F-NO treatment while in the “credit-registry equilibrium” all lenders earn zero profits in all periods. Expecting that the presence of a credit registry in the F-CR will encourage at least some more competition from outside lenders, we make the following hypothesis for our F treatments:

**Hypothesis F Treatments:** Repayment rates and credit volume are identical in the F-NO and F-CR treatments: Both display high repayment rates and credit volumes in an initial phase. Towards the final period, however, some borrowers start to default and credit volumes decrease. In the F-CR, the disciplining of borrowers is less reliant on relationship lending, so that long-term relationships may be less frequent. Moreover, the presence of a credit registry implies that in the F-CR it may be more difficult for lenders to extract profits from relationships than in the F-NO.

## 4 Results

### 4.1 No Relationship Banking

In this section we examine the impact of a credit registry when relationship banking is not possible, by comparing the outcome of the R-CR to that of the R-NO treatment. We begin by examining the repayment behavior of borrowers. Our predictions suggest that, in the R-NO treatment, honest borrowers repay loans which offer “fair” contract terms while selfish borrowers always default. In contrast, in the R-CR treatment, the credit registry should also motivate selfish borrowers to repay in order to maintain a clean credit record and have future access to credit. As a consequence, we expect a higher aggregate repayment rate in the R-CR than in the R-NO treatment.

Figure 1 presents the repayment rate of borrowers by period for both treatments. The figure shows that the repayment rate hovers around 30% throughout the R-NO treatment, resulting in a total repayment rate of 29%. As predicted, the presence of a credit registry leads to a substantially higher repayment rate in the R-CR treatment. There the aggregate repayment rate is 80%. A non-parametric test confirms that the difference in repayment rates between the two treatments is statistically significant.<sup>9</sup>

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<sup>9</sup>We conduct a Mann-Whitney Test using mean repayment rates per session as observations. The 5 sessions of the R-CR treatment display repayment rates of 87, 85, 81, 77 and 70 percent

Even if the credit registry in the R-CR treatment does discipline selfish borrowers to repay loans, we expect that the repayment rate will fall towards the end of the experiment. Remember that the value of a good credit record declines towards the end of our experiment, due to the finite horizon of 20 periods. We therefore expect that selfish borrowers who repay in earlier periods out of reputational concerns, will default in the final periods. Indeed, Figure 1 shows that, in the final periods of the R-CR treatment, loan repayments drop substantially. While 86% of all loans are repaid in period 1 through 15, this falls to less than 50% in the last five periods of the R-CR treatment. Moreover, as predicted, the repayment rate in the final period of the R-CR treatment falls to that of the R-NO treatment.

Figure 1: Repayment Rates in R Treatments

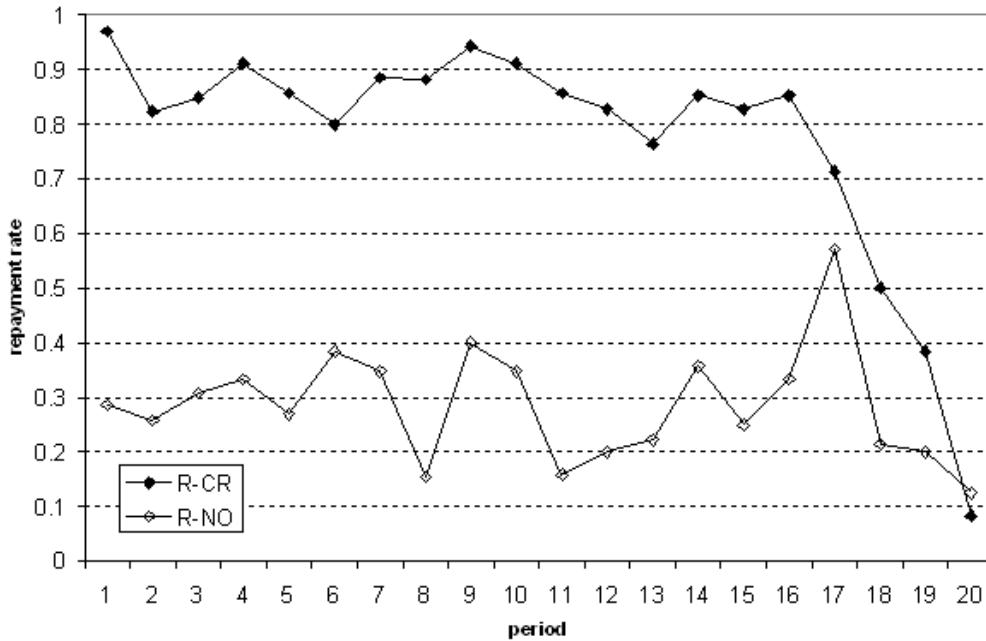


Figure 1 suggests that the presence of the credit registry in the R-CR treatment motivates loan repayments from selfish borrowers who would otherwise default. Note, however, that the higher repayment rate in the R-CR could also be explained by more favorable contract terms for borrowers in that treatment than in the R-NO. This would induce honest borrowers to repay more often in the R-CR than in the R-NO treatment. In order to control for differences in contract terms we conduct a repayment experiment respectively. In the R-NO treatment the five sessions have repayment rates of 39, 31, 29, 26 and 16 percent respectively. A one-sided test thus cannot reject the hypothesis that repayment is more frequent in the R-CR treatment ( $p = .004$ ).

multivariate analysis of repayment behavior.

Table 2 presents the results of a regression analysis of repayment decisions in which we pool all observations from the R-CR and R-NO treatment. Our dependant variable is a dummy variable which is 1 if a borrower repaid and 0 if he defaulted. We control for the size of loans and the desired repayment by including the variables “CreditSize” and “RepaymentSize”. Our main explanatory variable is the dummy variable “R-CR”, which is 1 for all observations in the R-CR treatment and 0 for all those in the R-NO treatment. If repayment rates are higher in the R-CR, ceteris paribus, we should see a positive coefficient for this variable. Our further explanatory variables are the dummy variable “FinalPeriods” and the interaction term “R-CR\*FinalPeriods”. The variable “FinalPeriods” takes on the value 1 if the decision was made in period 16 or later, and 0 for earlier periods. We do not expect any time effect on repayment in the R-NO treatment and therefore that “FinalPeriods” should be insignificant. However, as the disciplining effect of a credit registry on selfish borrowers declines in the final periods of the experiment, we expect a negative coefficient for the interaction term “R-CR\*FinalPeriods”.

Table 2: Repayment Behavior in the R-Treatments

Dependant Variable:	Prob. of Repayment
CreditSize	.03*** (.004)
RepaymentSize	-.02*** (.004)
FinalPeriods	-.04 (.090)
R-CR	.59*** (.074)
R-CR*FinalPeriods	-.23** (.090)
Constant	.32*** (.040)
N = 1067	
F(5,9) = 90.11	
Prob = .000	
$R^2 = .36$	

*Notes:* Linear regression with robust standard errors clustered on sessions. \*\*\* indicates significance at the 1% level, \*\*at the 5% level and \* at the 10% level.

The results presented in Table 2 show that an identical credit offer is more likely to be repaid in the R-CR treatment than in the R-NO treatment.<sup>10</sup> As predicted,

<sup>10</sup>Since observations within sessions may be dependent we report for all regressions in this paper robust standard errors with clustering on sessions. Given that our explanatory variable in Table

our main explanatory variable, “R-CR”, is significantly positive. Furthermore, the display coefficients show that the reputational effects are weaker towards the end of the experiment. The interaction term “R-CR\*FinalPeriods” is significantly negative, while the main effect on “Finalperiods” displays an insignificant coefficient. This confirms that there is a strong end-game effect in the R-CR which is not present in the R-NO treatment. These findings support our conjecture that the presence of a credit registry in the R-CR treatment has motivated selfish borrowers to repay loans more often than in the R-NO.

Table 3: Reputation and Credit Access in the R-CR treatment

	Share of Prior Loans Repaid			
	< .5	.5 – .75	> .75	Total
Credit Size (mean)	30.9	30.1	40.2	38.4
Interest Rate (mean)	0.43	0.38	0.32	0.33
Observations	23	101	576	700

We expect that borrowers in the R-CR treatment will repay loans more often than in the R-NO because they benefit from having a good record in the credit registry. We should therefore find that in the R-CR treatment the availability of credit is positively correlated with a borrower’s repayment record. Moreover, as all lenders have the same information and must compete for borrowers, we expect that those borrowers with good credit records will be offered lower costs of credit. Table 3 shows that this is the case. For each borrower we establish his reputation at the beginning of each period by calculating the share of prior loans which he has repaid. We classify the reputation of each borrower into three categories: low, if he has repaid less than 50% of prior loans; medium if he has repaid 50-75% of prior loans; and high if he has repaid more than 75% of prior loans. Table 3 shows that, in the R-CR treatment, borrowers with a better reputation get higher volumes of credit. The mean credit size of a borrower with a high reputation is 10 units larger than that of a borrower with a low or medium reputation. Furthermore, the table shows that the cost of credit for borrowers with high reputations is lower than for borrowers with medium or low reputations. We calculate the interest rate ( $[\text{repayment} - \text{credit size}]/\text{credit size}$ ) demanded by lenders for each realized loan contract. The table shows that, on average, lenders charge 10% less interest to

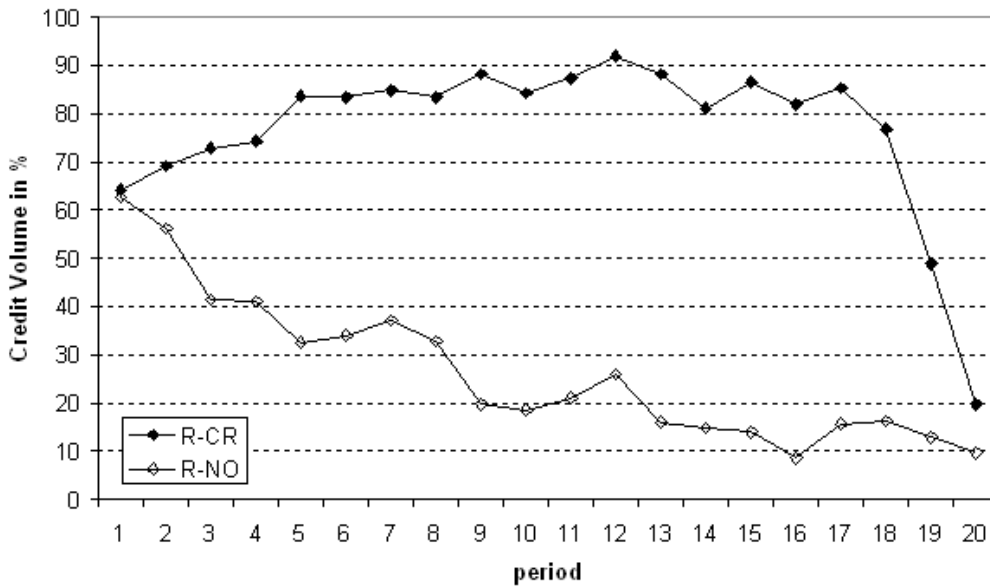
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2 is a dummy variable the probit method would be appropriate. However, as clustering is not feasible for probit regressions, we use the linear probability model (see also Moffitt, 1999).

high reputation borrowers than from low reputation borrowers. Linear regression analyses controlling for the period of interaction confirm that credit size is positively correlated with a borrowers reputation (coef.= 24.2,  $p = .02$ ), while the cost of credit is negatively correlated with this reputation (coef.=  $-1.18$ ,  $p = .01$ ).<sup>11</sup>

In the R-NO treatment the past repayment behavior of borrowers has no impact at all on their access to credit. Identical regression analyses for this treatment show that neither credit size (coef.=  $-.03$ ,  $p = .99$ ) nor the cost of credit (coef.=  $-.03$ ,  $p = .45$ ) is correlated with a borrower’s prior repayment record. This is by no means surprising, given that borrower identities are changed randomly in each period. As a consequence there is no incentive at all in the R-NO treatment for selfish borrowers to repay loans.

Figure 2: Credit Volume in R Treatments



If lenders anticipate the disciplining effect of the credit registry in the R-CR treatment, we would expect them to extend a higher volume of credit than they do in the R-NO treatment. Figure 2 shows that this is the case. The figure displays the realized credit volume per period as a percentage of the maximum credit volume across sessions for the R-CR and R-NO treatments.<sup>12</sup> In the R-CR treatment,

<sup>11</sup>We conduct the following linear regressions:  $CreditSize_{i,t} = \alpha + \beta_1 * PriorRepaymentShare_{i,t} + \beta_2 * Period_t + \varepsilon$ , and  $InterestRate_{i,t} = \alpha + \beta_1 * PriorRepaymentShare_{i,t} + \beta_2 * Period_t + \varepsilon$ . Estimates in both regressions are based on robust standard errors and control for dependencies within sessions by applying the clustering method.

<sup>12</sup>As the maximum loan size was 50 units and 7 loans were possible in each period, the maximum

almost the maximum number of loans are made from period 1 through to period 18. The average credit size is also constantly high in this treatment, with mean credit size rising from an initial level of 34 to over 45 in period 13. As a consequence, the total volume of credit rises from 64 percent in period 1 to 92% in period 12 and remains above 80% until period 17. Not surprisingly, credit volume then falls in the final periods of the R-CR treatment. We saw previously that the repayment rate of borrowers declines towards the end of the experiment in the R-CR treatment. Figure 2 shows that this is anticipated by lenders who extend lower credit volumes.

Figure 2 shows a completely different picture for the R-NO treatment. Surprisingly, this treatment also starts off with a substantial credit volume. In period 1 of the R-NO treatment, 7 loans are made in all sessions with an average loan size of 31. However, the number and size of loans then falls rapidly. From period 11 onwards fewer than 4 trades are made on average per period and this falls to less than 2 credits in the final periods. In addition, the mean credit size is lower than 20 from period 9 onwards. As a consequence, Figure 2 shows that total credit volume falls steadily in the R-NO treatment and is less than 20% from period 13 onwards. On aggregate, lenders in the R-CR treatment extended 77% of potential credit, while in the R-NO treatment aggregate credit was only 27% of its potential volume. A non-parametric test confirms that this difference in credit volume is significant.<sup>13</sup>

The presence of a credit registry thus increases credit volume substantially when relationship banking is not feasible. Who benefits from this increase in credit market performance? We predicted that strong competition for borrowers in our experiment would erode any profits among lenders. Indeed, it turns out that all gains from trade in the R-CR treatment are reaped by borrowers. Table 4 displays the mean payoff of lenders, depending on the amount of credit they have extended. Remember that in all treatments lenders who do not extend credit earn a payoff of 50. The table shows that, in the R-CR treatment, lenders earn payoffs close to this outside option independent of the volume of credit they extend. This is confirmed by a regression analysis of lenders' payoffs in the R-CR treatment, which shows that these are uncorrelated with credit size (coef.= .11,  $p = .27$ ).<sup>14</sup>

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credit volume per period in a session was 350 units.

<sup>13</sup>We conduct a one-sided Mann-Whitney test using total credit volume per session as observations ( $p = .004$ ). In the R-NO treatment the five sessions display a credit volume (measured in percentage of the total potential volume) of 36, 29, 29, 24 and 16 percent respectively. In the R-CR treatment, the credit volume per session was 84, 81, 78, 76 and 66 percent respectively.

<sup>14</sup>For the R-CR and R-NO data separately, we conduct the following linear regression:  $\text{LenderPayoff}_{i,t} = \alpha + \beta_1 * \text{CreditSize}_i + \beta_2 * \text{Period}_t + \varepsilon$ . Estimates in both regressions are based on robust standard errors and allow for dependencies within sessions by applying the clustering method.

Table 4: Loan Size and Lender Payoffs

	Credit Size						Total
	0	5-10	15-20	25-30	35-40	45-50	
R-CR	50.0	50.0	48.9	50.1	50.0	51.9	50.6
R-NO	50.0	44.0	38.5	35.4	18.7	17.3	44.0

In contrast to the R-CR treatment, lenders who do extend credit in the R-NO earn less than their outside option. Table 4 shows, indeed, that lenders who extend loans of more than 30 units earn on average less than half their outside option. A regression analysis of lenders' payoffs on credit size confirms that these are negatively correlated in the R-NO treatment (coef. =  $-.68$ ,  $p = .004$ ). Table 4 thus shows that the presence of a credit registry in the R-CR treatment makes it feasible to lend, while in the R-NO treatment lenders can only make losses. This explains our finding that the credit market is sustained in the presence of a credit registry while it collapses otherwise.

Our results in this section suggest that a credit registry can greatly enhance the performance of a credit market when relationship banking is not feasible. The exchange of information between lenders generates incentives for borrowers who would otherwise default to repay loans. This makes it feasible for lenders to extend high credit volumes, despite the fact that repayment is not third-party enforceable. Strong competition among lenders implies that all surplus generated through the presence of the credit registry is reaped by borrowers.

## 4.2 Credit Reporting and Relationship Banking

In this section we examine the impact of a credit registry in a market where banking relationships are feasible. We begin again by comparing the repayment behavior of borrowers in the F-CR and F-NO treatments. Our predictions suggest that, in both treatments, selfish borrowers will initially repay loans out of reputational concerns. In the F-CR treatment, selfish borrowers can build a public reputation for being honest because their behavior is communicated to all lenders through the credit registry. In the F-NO treatment, borrowers cannot build a public reputation for themselves as there is no credit registry. However, by repaying loans the borrower can build a reputation with a particular lender. Our predictions showed that such relationship banking is capable of enforcing the same repayment rates as a credit registry.

Figure 3 shows that the repayment behavior of borrowers is very similar in the two treatments. In the first four periods, repayment rates are slightly higher in the F-CR treatment than in the F-NO. This suggests that reputational incentives may be more obvious in a market where a credit registry is present. However, from period 5 onwards, repayment rates are identical in both treatments, hovering around 80% until period 17. The aggregate repayment rate in the F-CR treatment (79%) is slightly higher than that in the F-NO treatment (74%). However, a non-parametric test shows that repayment behavior does not differ significantly between the treatments.<sup>15</sup> As predicted, repayment rates fall towards the end of the experiment in both treatments. In period 19 and 20 repayment rates in both treatments are roughly 50%. This result suggests that high levels of repayment in earlier periods are due to the strategic behavior of selfish borrowers rather than an overwhelming presence of honest borrowers.

Figure 3: Repayment Rates in F Treatments

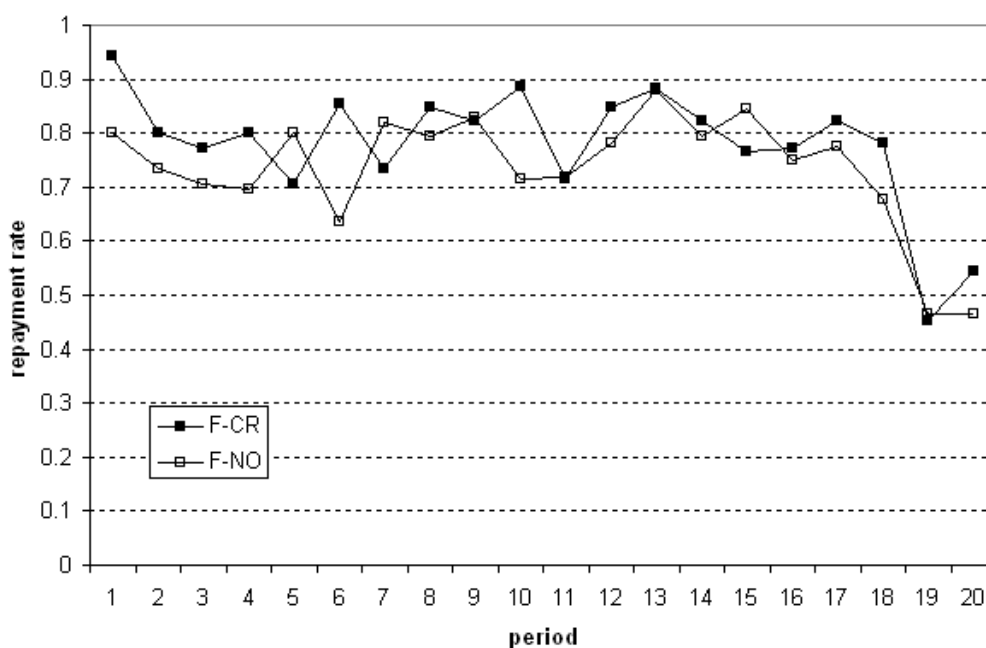


Figure 3 suggests that, in both the F-NO and F-CR treatments, borrowers had strong reputational incentives to repay loans. This is confirmed by looking at how

<sup>15</sup>In the five sessions of the F-CR treatment, repayment rates are 86, 82, 78, 76 and 72 percent respectively. In comparison, the five F-NO sessions show repayment rates of 79, 77, 76, 72 and 68 percent respectively. A two-sided Mann-Whitney test using these session averages as observations cannot reject the hypothesis that repayment rates are identical in the F-CR and the F-NO treatment ( $p = .22$ ).



loan size and the cost of credit for borrowers depends on their prior repayment record. As in the previous section, we establish the reputation of each borrower at the beginning of each period by calculating the share of prior loans which he has repaid. We then examine how the size of credit obtained by the borrower and the interest rate paid for credit depends on this reputation. Table 5 shows that, in both treatments, borrowers with better repayment records get larger loans and pay less interest. Linear regressions controlling for the period of interaction confirm that credit availability is positively correlated with a borrower’s reputation in the F-CR (coef.= 33.1,  $p = .001$ ) and the F-NO treatment (coef.= 33.4,  $p = .001$ ). Regression analyses also confirm that the cost of credit is negatively correlated with a borrower’s reputation in the F-CR (coef.=  $-.32$ ,  $p = .02$ ) and the F-NO treatment (coef.=  $-.24$ ,  $p = .04$ ).<sup>16</sup> In light of the results in our previous section, it is not surprising that credit access is conditioned on a borrower’s credit record in the F-CR treatment. The fact, however, that this is also the case in the F-NO treatment, where no credit registry exists, and prior behavior is only known to a borrower’s lender already suggests that relationship banking is important in this treatment.

Table 5: Reputation and Credit Access in the F- Treatments

		Share of Prior Loans Repaid			
		< .5	.5 – .75	> .75	Total
F-CR	Credit Size (mean)	25.7	31.6	42.9	39.6
	Interest Rate (mean)	0.39	0.37	0.27	0.29
	Observations	46	133	521	700
F-NO	Credit Size (mean)	18.5	34.4	42.0	36.9
	Interest Rate (mean)	0.37	0.30	0.22	0.26
	Observations	86	201	413	700

Figure 3 and Table 5 suggest that incentives for borrowers to repay loans are equally high in the F-CR and F-NO treatments, confirming our predictions that a credit registry is not necessary to enforce repayment when relationship banking is feasible. As a consequence, we should see that credit volume (and thus market performance) is similar in the two treatments. Figure 4 confirms that this is the case.

<sup>16</sup>We conduct the following linear regressions:  $\text{CreditSize}_{i,t} = \alpha + \beta_1 * \text{PriorRepaymentShare}_{i,t} + \beta_2 * \text{Period}_t + \varepsilon$ , and  $\text{InterestRate}_{i,t} = \alpha + \beta_1 * \text{PriorRepaymentShare}_{i,t} + \beta_2 * \text{Period}_t + \varepsilon$ . Estimates in both regressions are based on robust standard errors and control for dependencies within sessions by applying the clustering method.

The figure displays the credit volume extended in the F-CR and F-NO treatments by period (again as a percentage of total potential volume). We see that the high repayment rates encourage lenders to disburse large volumes of credit in both treatments. On aggregate, 94% of potential loans are made in the F-CR treatment and 91.6% in the F-NO treatment. Moreover, the average size of these loans is very high in both treatments. From an initial level of 35, average loan size climbs to above 40 during the first ten periods, and then remains between 40 and 45 for the rest of the experiment. As a consequence, total credit volume rises to more than 80% in both treatments. Not surprisingly, both treatments record a fall in credit volume in the final periods. Again lenders anticipate the fall in reputational incentives for selfish borrowers and decrease their lending activities. Aggregate market performance is slightly higher in the F-CR (79%) than in the F-NO (74%) treatment. However, a non-parametric test cannot reject the hypothesis that credit volume is identical in both treatments.<sup>17</sup>

Figure 4: Credit Volume in F Treatments

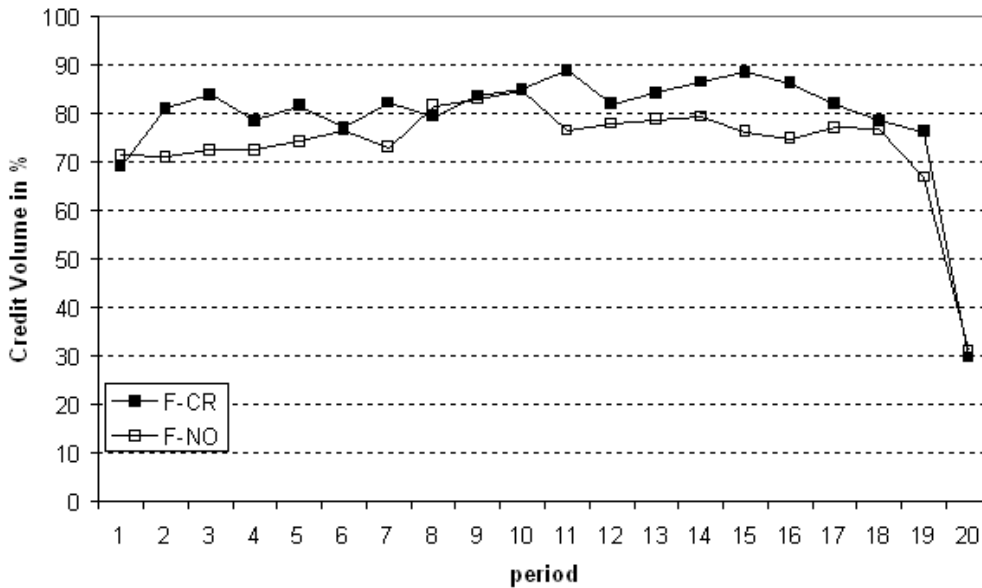


Figure 4 confirms our prediction that credit market performance does not depend on the existence of a credit registry when relationship banking is feasible. However, we also predict that market outcome may differ in terms of trading structure and

<sup>17</sup>In the five sessions of the F-CR treatment, credit volume was 82, 82, 80, 76 and 76 percent of potential credit volumes respectively. In comparison, the five F-NO sessions yielded 81, 78, 72, 69 and 69 percent respectively. A two-sided Mann-Whitney using session totals as observations yields  $p = .15$ .

distribution. For the F-NO treatment we predicted that the credit market would be pervaded by long-term relationships as quasi-rents in relationships are the key to disciplining borrowers. Moreover, given that relationships arise we predicted that lenders would also earn positive profits within these relationships. By contrast, the existence of a credit registry in the F-CR implies that long-term relationships between particular borrowers and lenders are not necessary to discipline borrowers. Moreover, as all lenders know the repayment history of all borrowers, competition for borrowers should reduce the ability of lenders to extract rents from relationships. We thus predict that there will be fewer relationships in the F-CR treatment than in the F-NO treatment. Moreover, we predict that lenders who establish relationships make less profits in the F-CR in the F-NO treatment

Table 6 shows that market outcome in the F-NO treatment is characterized by more relationships than in the F-CR. The table reports the share of renewed loans, i.e. the share of transactions which involved the same lender - borrower pair as in the previous period for different phases of both treatments. In the F-NO treatment the share of renewals climbs from just below 40% in the initial periods to over 50% in period 11 through 20. Aggregated over all periods, the share of renewed contracts in the F-NO treatment is 48%. Thus roughly half of all loans made in this treatment involve the same lender and borrower as in the previous period.

Table 6: Share of Renewed Loans

	Periods				Total
	2 - 5	6 - 10	11 - 15	16 - 20	
F-CR	0.24	0.39	0.39	0.54	0.39
F-NO	0.38	0.44	0.58	0.50	0.48

Table 6 shows that credit relationships are also quite common even when a credit registry exists. In the F-CR treatment the share of credit renewals is initially less than 25%, but rises steadily over the course of the experiment, also exceeding 50% in the final phase of the experiment. As predicted, the share of renewed credit in the F-CR treatment, at 39%, is lower than that in the F-NO. However, due to a strong variation across sessions, a non-parametric test indicates that this difference is not significant.<sup>18</sup>

<sup>18</sup>In the five sessions of the F-NO, average renewal rates are 53, 53, 52, 36 and 34 percent respectively. In comparison, the five F-CR sessions have renewal rates of 52, 41, 40, 30 and 21 percent respectively. A one-sided Mann-Whitney test using these session averages as observations

The data presented in Table 6 may seem surprising. Although lenders have access to a credit registry in the F-CR treatment it seems that they still rely strongly on credit relationships to motivate loan repayment. This finding is less surprising when we compare the information available within a relationship to that available from a credit registry. Within a long term relationship, lenders typically have much more information about a borrower than they could elicit from a credit report. In our experiment this was also the case. Our credit registry only provided information on whether a borrower repaid a loan or not. Within a relationship, however, the lender had additional information on contract terms (credit size, repayment size) which a lender had accepted and repaid. Table 6 suggests that this additional information encouraged lenders to maintain relationships with a particular borrower, although they could easily obtain the credit record of each borrower at no cost.

Given that relationships are prevalent in both treatments, how does this affect the distribution of surplus between lenders and borrowers? Do lenders manage to extract rents from relations in both treatments? Or does the existence of a credit registry in the F-CR treatment mean that lenders earn less rents because “outside” competitors are better informed about each borrower. Table 7 reports how the profits of a lender depend on the duration of relationship with a borrower. We establish the total duration of each relationship between a lender and a borrower by calculating the number of renewed interactions between the two. For each relationship we then calculate the mean profits per period for the lender.

Table 7: Relationships and Lender Profits

	Relationship Duration			
	1-2	3-10	11-20	Total
F-NO	40.0	57.3	56.5	47.7
F-CR	47.9	51.9	56.8	49.8

The table shows that, on aggregate, payoffs of lenders in both treatments are very close to their outside option of 50. This suggests that competition for borrowers has eroded expected profits among lenders. The table, however, also shows that the profits earned by lenders in both treatments depend on their ability to establish and maintain relationships. In the F-NO treatment, lenders who were engaged in short-term interactions (1-2 periods) made substantial losses. In con-

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rejects the hypothesis that credit relationships are more frequent in the F-NO than in the F-CR treatment ( $p = .15$ ).

trast, those lenders who established a relationship of more than 2 periods ended up earning a (small) rent. This confirms our prediction that lenders extract some quasi-rents from relationships in the F-NO due to their superior information about their incumbent borrower. A regression analysis of lender profits on relationship duration, controlling for the period of the experiment, confirms that profits increase with relationship duration (coef.= 1.33,  $p = .004$ ).<sup>19</sup>

With the presence of a credit registry in the R-CR treatment, lenders do not make such significant losses in short-term interactions as they do in the R-NO. It seems that the credit registry enables lenders to avoid interaction with would-be defaulters in the R-CR. Moreover, in medium-term relationships (3-10 periods), lenders do not earn any substantial rents. This suggests that, in comparison to the F-NO treatment, public information about the repayment history of a borrower in the F-CR prevented lenders from extracting rents from such relationships. We do find, however, that in very long-term relationships lenders did earn similar rents in the F-CR treatment to those earned in the F-NO. A regression analysis of lender profits shows that profits increase with relationship duration in the F-CR (coef.= 0.78,  $p = .008$ ). However, the coefficient of the regression also confirms our prediction that lenders benefit less from long-term relationships than in the F-NO treatment.<sup>20</sup> This finding confirms that the presence of a credit registry does reduce the potential of lenders to hold-up borrowers in relations.

## 5 Conclusions

In this paper we applied experimental methods to examine the impact of a public credit registry on the repayment behavior of borrowers in a competitive credit market. Our results suggest that the impact of a credit registry depends strongly on the nature of credit transactions. Credit reporting is highly valuable in markets where banking relationships are difficult to establish, for example, due to highly mobile borrowers. In such markets, the disciplining of borrowers to repay loans is strongly dependent on the existence of an information-sharing mechanism. By contrast, in markets where relationship banking is prevalent, these relationships

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<sup>19</sup>We conducted the following linear regression:  $\text{LenderProfit}_{i,t} = \alpha + \beta_1 * \text{Relationshipduration}_i + \beta_2 * \text{Period}_t + \varepsilon$ . Estimates are based on robust standard errors and control for dependencies within sessions by applying the clustering method.

<sup>20</sup>To confirm this we pooled the data from both treatments and conducted the following linear regression:  $\text{LenderProfit}_{i,t} = \alpha + \beta_1 * \text{Relationshipduration}_i + \beta_2 * \text{Period}_t + \beta_3 * \text{F-CR} + \beta_4 * \text{Relationshipduration}_i * \text{F-CR} + \varepsilon$ , again controlling for dependencies within sessions by applying the clustering method. In this regression the interaction effect F-CR\*Relationshipduration yielded a significant negative coefficient

may themselves motivate repayment, so that a credit registry has little impact on borrower behavior.

Our results suggest two consequences for the design of credit registries and credit bureaus. First, it may not always be optimal for lenders to share all available information on borrowers. In markets where relationship banking is prevalent, the potential disciplining effect of credit reporting is negligible so that it is optimal to share as much information as is available on borrowers. By contrast, when relationship banking is difficult to maintain, the disciplining effect is potentially important, so that it may be optimal to limit the type of information shared (as suggested by Padilla and Pagano, 2000) and the length of credit histories (as suggested by Vercammen, 1995).

Second, when relationship banking is difficult to maintain, lenders should make sure that the existence of credit bureaus and credit registries is well-known to borrowers. Rather than share information secretly, as is the current practice in some countries (Luoto et al., 1994), lenders should make sure that borrowers are aware that their repayment behavior will be recorded and could affect their future access to credit.

Our methodology and results suggest several avenues of future research. First, experimental methods could be applied to study the endogenous emergence of information sharing. Theoretical models (Klein, 1992; Jappelli and Pagano, 1993) suggest that private credit bureaus are more likely to emerge when they are most valuable to lenders. Experimental methods would make it possible to examine this hypothesis by studying the emergence of credit bureaus in a variety of market environments. Experimental methods could also be applied to study alternative designs of credit bureaus and credit registries. As suggested by theoretical work (Padilla and Pagano, 2000; Vercammen, 1995), the type of information recorded by a credit registry, the history of credit records provided, and also the incentive mechanisms related to providing and retrieving information may affect the functioning and impact of a credit registry. It would be valuable to study these effects in a controlled manner through carefully designed experiments.

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# A Appendix

## A.1 Model and Assumptions

There are  $m$  lenders and  $n < m$  borrowers in a game which lasts for  $T > 1$  periods. In each period  $t$  each lender has  $\bar{k}$  units of capital to lend. Capital has an opportunity cost of 1 (repayment plus interest) per unit. The lender can lend any part of this capital  $k_t \in [0, \bar{k}]$  in each period to any one borrower. In order to do so, the first stage of each period is such that all lenders can simultaneously submit a credit offer to any subset of borrowers.<sup>21</sup> A credit offer  $[k_t, \tilde{r}_t]$  consists of a loan size  $k_t$  and a desired repayment  $\tilde{r}_t$  (principal plus interest). At the second stage of each period borrowers choose in random order from the available offers. In each period borrowers are free to accept one of the available loans or not to borrow at all. The repayment of a loan cannot be enforced by the lender. At stage three of each period the borrower can choose to either make the requested repayment  $r_t = \tilde{r}_t$  or not repay at all  $r_t = 0$  (gradual repayments are not possible).

The period payoff of a lender  $\pi_t$  is calculated as follows:

$$\pi_t = \bar{k} - k_t + r_t$$

Each borrower has a fixed return  $a$  from self-financed projects in each period. Additionally, the borrower can invest any capital  $k_t$  borrowed in a safe project which yields a safe return of  $bk_t$ , where  $b > 1$ .

The period payoff of a borrower  $v_t$  is therefore given by:

$$v_t(k_t, r_t, \tilde{r}_t) = a + bk_t - r_t$$

There are 2 types of borrowers: A share  $p$  are honest types who suffer mental costs  $g(\tilde{r}_t, k_t)$  (bad conscience / inequity aversion) if they don't repay in cases where they perceive the financing conditions as "fair" (i.e., in cases where the desired repayment does not exceed a certain reference value  $\tilde{r}_t \leq \phi k$ ), the rest of the borrowers are purely selfish profit-maximizers. Thus, the period utility of borrower can be written as:

$$u_t(k_t, r_t, \tilde{r}_t) = v_t - g(\tilde{r}_t, k_t)$$

where the mental costs  $g(\tilde{r}_t, k_t)$  are defined as follows:

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<sup>21</sup>Since continuous auctions have defied a fully rigorous analysis so far we make this assumption on the trading mechanism for tractability reasons.

$$\begin{aligned}
g(\tilde{r}_t, k_t)^{\text{honest}} &= \begin{cases} \infty & \text{if } r_t < \tilde{r}_t \leq \phi k \\ 0 & \text{if } r_t \geq \tilde{r}_t \text{ or } \tilde{r}_t > \phi k \end{cases} \\
g(\tilde{r}_t, k_t)^{\text{selfish}} &= 0
\end{aligned}$$

As a consequence honest borrowers always repay their loans as long as they have received “fair” financing conditions in a given period. With respect to the reference repayment of honest borrowers, we assume that  $\phi \in (1, (b+1)/2]$ . This means that the reference repayment is somewhere in between the repayment where all the gains from trade go to the borrower and the repayment where the gains from trade are equally split between lender and borrower.

The total material surplus per trade is given by

$$\pi_t(k_t, r_t) - \bar{k} + u_t(k_t, r_t, \tilde{r}_t) - a = (b-1)k_t$$

Since we assume that  $b > 1$  it is value maximizing if the maximum credit volume  $\bar{k}$  is provided in each transaction period.

In the following we derive equilibria of this game for different credit market conditions. In section A.2 we analyze a credit market, in which lenders and borrowers interact only in one-off situations. In section A.3 we investigate a credit market where the market participants have the possibility to engage in repeat interactions. In each environment we examine both the case without information sharing between banks and the case of a public credit registry with mandatory reporting.

The incomplete information nature of the game (i.e. uncertainty about the players’ types) implies that it should be analyzed as reputation game analogous to the one described in Kreps et al. (1982). The equilibrium concept is perfect Bayesian Equilibrium. Such games are generally characterized by a large number of equilibria (see Fudenberg and Maskin (1986)). However, our aim is not to provide a complete formal analysis of the game, but rather to show, that there are equilibria in the R-CR, F-NO and F-CR treatments in which the reputational mechanisms intuitively described in section 3 ensure that a substantial credit volume can be sustained.

## A.2 Lending without Relationship Banking

In each period all market participants receive freshly assigned identification numbers. Lenders therefore cannot recognize any of the borrowers, even if they have financed them before.

### A.2.1 Lending without a Credit Registry

Lenders do not receive any information on the prior behavior of any borrower in the market. Each period  $t$  can therefore be viewed as a one-period game. In the following we consequently drop the time index  $t$  and analyze the one-period outcome. Proposition A1 establishes that in the one-off situation lenders are only willing to extend credit if the fraction of honest borrowers  $p$  is sufficiently large.

**Proposition A1:** If  $p \geq \frac{1}{\phi}$  there exists a perfect Bayesian equilibrium in which all borrowers receive maximum credit  $\bar{k}$ . If  $p < \frac{1}{\phi}$  no credit is extended in equilibrium.

**Proof of Proposition A1:** Lenders anticipate that honest borrowers will always repay a loan  $k$  only if  $\tilde{r}(k) \leq \phi k$ , while selfish borrowers will never repay a loan. The expected profit of a lender is thus:

$$E\pi(k, \tilde{r}(k)) = \begin{cases} \bar{k} - k + p\tilde{r}(k) & \text{if } \tilde{r}(k) \leq \phi k \\ \bar{k} - k & \text{if } \tilde{r}(k) > \phi k \end{cases}$$

Thus only if there exists a  $k > 0$  for which  $p\phi k > k$  will any lender offer any credit. Put differently this requires that  $p \geq \frac{1}{\phi}$ . If this condition is satisfied lenders can profitably extend credit. Due to competition among lenders these will earn zero profits so that  $pr^*(k) = k$ . Honest borrowers thus earn  $u(k^*, r^*) = a + bk - r^*(k) = a + (b - \frac{1}{p})k^*$ . Borrowers prefer the highest possible credit level as our parameter assumptions imply  $bp > 1$ . We have therefore established that in a one-period game the equilibrium contract offer of lenders will be

$$[k^*, r^*] = \begin{cases} [\bar{k}, \frac{\bar{k}}{p}] & \text{if } p \geq \frac{1}{\phi} \\ [0, 0] & \text{if } p < \frac{1}{\phi} \end{cases}$$

### A.2.2 Lending with a Credit Registry

At the end of each period lenders are exogenously forced (legal obligation) to submit information on the repayment behavior of their current borrower to a public credit registry. In return they receive a credit report which states for each borrower and each past period whether the borrower got a loan and whether he repaid his loan or not. The provision of information and access to the credit registry information has no cost for lenders.

Proposition A2 shows that even if the share of honest borrowers would lead to a market collapse in a one-shot transaction (i.e., if  $p < \frac{1}{\phi}$  (Proposition A1)), a public credit

registry can sustain substantial credit volumes. In the derived equilibrium reputational concerns motivate selfish borrowers to perfectly imitate the behavior of honest borrowers in the early periods of the game. However, this “pooling” of behavior across types cannot be optimal in all periods. The reason is the following: As long as selfish and honest borrowers behave identically lenders cannot get any additional information about the type of specific borrowers and therefore their belief remains at the initial level  $p < \frac{1}{\phi}$ . But since lenders anticipate that selfish borrowers never repay in the last period their belief must be at least  $\frac{1}{\phi}$  at the beginning of the last period, otherwise they are not willing to extend credit (see Proposition A1). Consequently, when the final period draws near selfish borrowers start to partly default allowing lenders to update their beliefs about the type of specific borrowers. Thus, it is the partial defaulting of selfish lenders that ensures that lenders strongly enough believe in the honesty of repaying borrowers in order to be willing to offer credit in periods near the end of the game. As a consequence of the “pooling” behavior in the early periods of the experiment the maximal credit volume can be sustained in these periods. In the later periods when selfish borrowers begin to default the credit volume decreases.

**Proposition A2:** Consider a credit market game of  $T \geq 2$  periods and suppose that  $\frac{1}{\phi^T} < p < \frac{1}{\phi}$ . With exogenous credit reporting the following strategies and beliefs form a perfect bayesian equilibrium.

- In all periods all lenders offer a contract  $[k_t^*, \tilde{r}_t^*]$  to all borrowers who always repaid in the past. No lender offers any credit to a borrower who defaulted in any previous period  $j < t$ . The credit size and the requested repayment in each period  $t$  are defined as follows:

$$[k_t^*, \tilde{r}_t^*] = \begin{cases} [\bar{k}, \bar{k}] & \text{if } t < T - s \\ [\bar{k}, \frac{\bar{k}}{p\phi^s}] & \text{if } t = T - s \\ [\frac{\bar{k}}{pb^l\phi^{s-l+1}}, \frac{\bar{k}}{pb^l\phi^{s-l}}] & \text{if } t = T - s + l \text{ for all } l \in \{1, 2, \dots, s\} \end{cases}$$

where  $s$  is the smallest integer that satisfies  $p \geq \frac{1}{\phi^{s+1}}$ .

- Honest borrowers accept the contract  $[k_t^*, \tilde{r}_t^*]$  in all periods  $t$  and repay the loan in each period.
- Selfish borrowers accept the contract  $[k_t^*, \tilde{r}_t^*]$  in all periods  $t$ . Their repayment probability  $\gamma_t^*$  is given by

$$\gamma_t^* = \begin{cases} 1 & \text{if } t < T - s \\ \frac{(\phi^s - 1)p}{1 - p} & \text{if } t = T - s \\ \frac{\phi^{s-l} - 1}{\phi^{s+1-l} - 1} & \text{if } t = T - s + l \text{ for all } l \in \{1, 2, \dots, s - 1\} \\ 0 & \text{if } t = T \end{cases}$$

- Lenders believe that any borrower who defaults on a loan in periods  $t < T - s$  is selfish.

**Proof of Proposition A2:** Proof is by construction and is established in 4 steps:

Step 1 (repayment by honest borrowers): Honest borrowers will repay in each period as long as their financing conditions are fair; i.e.  $\tilde{r}_t^* \leq \phi k_t^*$ . Given the strategies of lenders this condition is satisfied in every period.

Step 2 (repayment by selfish borrowers): In period  $T$  selfish borrowers will always default. In non-final periods  $t < T$  selfish borrowers will repay with a positive probability if their following incentive constraint is met:  $-r_t + V_{t+1}^R \geq V_{t+1}^D$ , where  $V_{t+1}^R$  and  $V_{t+1}^D$  represent the future expected utilities of a selfish borrower at the beginning of period  $t+1$  after repaying respectively defaulting in period  $t$ . We first consider a selfish borrower's incentives in the next to last period  $T - 1$ : Given the lenders' strategies above we have  $V_T^R = a + bk_T^* = a + \frac{\bar{k}}{pb^{s-1}\phi}$  and  $V_T^D = a$ . As  $\tilde{r}_{T-1}^* = \frac{\bar{k}}{pb^{s-1}\phi}$  the incentive constraint is met with equality in period  $T - 1$ . It is therefore a best strategy for the selfish borrower to repay with any probability  $\gamma_{T-1}^* \in [0, 1]$ . Concerning the decision in  $T - 2$  we have  $V_{T-1}^R = 2a + bk_{T-1}^* - \tilde{r}_{T-1}^* + bk_T^* = 2a + \frac{\bar{k}}{pb^{s-2}\phi^2}$  and  $V_{T-1}^D = 2a$ . As  $\tilde{r}_{T-2}^* = \frac{\bar{k}}{pb^{s-2}\phi^2}$  the incentive constraint is again met with equality in period  $T - 2$  and it is therefore a best strategy for the selfish borrower to repay with any probability  $\gamma_{T-2}^* \in [0, 1]$ . The same argument can be made for all periods  $t > T - s$ . In period  $T - s$  the lenders' strategies imply that  $V_{T-s+1}^R = sa + \sum_{l=1}^s bk_{T-s+l}^* - \sum_{l=1}^{s-1} \tilde{r}_{T-s+l}^* = sa + bk_{T-s+1}^* = sa + \frac{\bar{k}}{p\phi^s}$  and  $V_{T-s+1}^D = sa$ . Since  $\tilde{r}_{T-s}^* = \frac{\bar{k}}{p\phi^s}$  also the incentive constraint in period  $T - s$  is satisfied with equality such that any repayment probability  $\gamma_{T-s}^* \in [0, 1]$  is a best reply for a selfish borrower. In periods  $t < T - s$  all lenders offer the contract  $[k_t^*, \tilde{r}_t^*] = [\bar{k}, \bar{k}]$  with certainty. As  $\tilde{r}_t^* = \bar{k} < b\bar{k}$  the incentive constraint is met with inequality in these periods. It is therefore a best strategy for selfish borrowers to repay with probability  $\gamma_t^* = 1$  in all periods  $t < T - s$ .

Step 3 (beliefs of lenders): In equilibrium all borrowers of the same type play identical strategies. As all lenders have access to the credit registry they have identical

information concerning borrowers' types in each period. At the beginning of each period all lenders form a belief about the honesty of each borrower based on the information retrieved from the credit registry. In equilibrium the lenders' contract offers are such that honest borrowers always have an incentive to repay. In periods  $t < T - s$  also selfish borrowers repay with certainty in equilibrium. As defaulting is off the equilibrium path in these periods, Bayes' Rule does not apply and it must be specified how lenders update their beliefs in case of default: We assume that lenders have the out-of-equilibrium belief that any borrower without a clean record is selfish. In periods  $T - s \leq t \leq T$  only selfish borrowers default with a positive probability in equilibrium such that lenders rationally believe that not repaying borrowers are selfish. Bayesian updating implies that the belief about borrowers who have always repaid in the past is calculated as  $p_t^e = \frac{p_{t-1}^e}{p_{t-1}^e + (1 - p_{t-1}^e)\gamma_{t-1}^*}$ .

Step 4 (contract offers of lenders): The fact that in equilibrium all lenders have identical information concerning the borrowers' types implies a competitive market for clients and therefore lenders earn zero profits in each period. The desired repayment  $\tilde{r}_t^*$  yields zero profits if  $[p_t^e + (1 - p_t^e)\gamma_t^*] \tilde{r}_t^* = k_t^*$ . In the final period  $T$  selfish borrowers always default ( $\gamma_T^* = 0$ ). In equilibrium lenders' desired repayment in  $T$  is  $\tilde{r}_T^* = \phi k_T^*$ . Thus, lenders are only willing to extend credit to borrowers for which their belief is at least  $p_T^e = \frac{1}{\phi}$ . Selfish borrowers must therefore choose their repayment probability in period  $T - 1$  so that this necessary belief in  $T$  is achieved:  $\gamma_{T-1}^* = \frac{p_{T-1}^e(\bar{r}(\bar{k}) - \bar{k})}{k(1 - p_{T-1}^e)}$ . However, also in period  $T - 1$  lenders are only willing to extend credit if they earn at least zero-profits. This implies that the repayment probability of selfish borrowers  $\gamma_{T-1}^*$  must not be too small. This is only possible if the belief in period  $T - 1$  is already large enough:  $p_{T-1}^e \geq \frac{1}{\phi^2}$ . Exactly the same arguments apply for the preceding periods such that we can calculate the minimally necessary belief for each period  $T - j$  for all  $j \leq s$ :  $p_{T-j}^{min} = \frac{1}{\phi^{j+1}}$ . By definition the period  $T - s$  is the last period in which the initial population fraction of honest borrowers is above the minimal belief necessary for lenders to extend credit:  $\frac{1}{\phi^s} \geq p \geq \frac{1}{\phi^{s+1}}$ . It is therefore in this period that borrowers start to partly default, such that the minimal belief can be sustained in all subsequent periods. The equilibrium repayment probabilities of borrowers in all periods  $t \geq T - j$  for  $0 < j \leq s$  stated in Proposition A2 are obtained by solving the following equation for  $\gamma_t^*$ :  $\frac{p_t^e}{p_t^e + (1 - p_t^e)\gamma_t^*} = p_{t+1}^{min}$ , where  $p_{T-s}^e = p$  and  $p_{T-j}^e = p_{T-j}^{min}$ .

In the early periods of the game  $t < T - s$  all borrowers repay with probability  $\gamma_t^* = 1$ . Thus, competition drives repayment requests down to  $\tilde{r}_t^* = k_t^*$ . In period  $T - s$  the lenders' belief may be strictly higher than the minimally necessary belief:

$p > \frac{1}{\phi^{s+1}}$ . Competition implies that also in this case the requested repayment is set such that the zero-profit condition is satisfied with equality:  $\tilde{r}_{T-s}^* = \frac{k_{T-s}^*}{p\phi^s}$ . In all later periods  $T-s < t \leq T$  the lenders' belief is always exactly at the threshold and accordingly the zero-profit condition can only be satisfied if the desired repayments are set at the maximal possible level:  $\tilde{r}_t^* = \phi k_t^*$ . As each individual lender earns zero-profits in every period any credit size  $k_t \in [0, 1]$  is a best-response of a lender to the equilibrium strategies of borrowers and other lenders in every period.

### A.3 Lending with Relationship Banking

We now assume that borrowers have fixed ID numbers so that lenders can identify those borrowers whom they have traded with in the past.

#### A.3.1 Market without a Credit Registry

Proposition A3 shows that the possibility for relationship banking allows to sustain substantial credit volumes even in the case where there is no credit registry and the share of honest borrowers would lead to a market collapse in a one-shot transaction. The intuition behind this equilibrium is the following: In the first period lenders compete for borrowers. Those lenders who succeed in concluding a contract with a borrower in the first period subsequently establish a long-term relationship with this borrower by renewing the contract in each period as long as the borrower has never defaulted. Outside lenders who could not conclude a contract in the first period do not try to enter the credit market in later periods. The reason for this is their fear that offering a contract would only attract selfish switchers with whom trading is not profitable. As the incumbent lenders' relationships are not contested from the outside, they can skim part of the gains from trade and earn relational rents. As lenders anticipate the emergence of rents in relationships, competition implies that they are prepared to take losses in the first period in order to get the possibility to start a relationship. The conditional contract renewals of incumbent borrowers in combination with the fact the outside lenders are not willing to offer credit motivates selfish sellers to perfectly imitate the repayment behavior of honest borrowers in the early periods of the game. In order to maximize their rent lenders extend loans of the maximal size in these periods. During this "pooling" phase of the experiment no additional information about the types of borrowers is revealed and the lenders' beliefs remain constant at the initial level  $p$ . When the end of the game draws near, however, lenders are only willing to renew their contracts if they get access to additional information on the borrowers' types. Consequently, selfish borrowers start to default with a positive probability. Lenders can update their beliefs at the beginning of every period



and continue renewing their contracts. However, in this end-game periods lenders start to lower the size of their loans such that the extended credit volume decreases towards the end of the game.

**Proposition A3:** Consider a credit market game of  $T \geq 2$  periods and suppose that  $\frac{1}{\phi^T} < p < \frac{1}{\phi}$ . Without exogenous credit reporting the following strategies and beliefs form a perfect bayesian equilibrium.

- In period 1 all lenders offer the contract  $[k_t^*, \tilde{r}_t^*] = [\bar{k}, \max\{0, \bar{k} - \rho\}]$  to all borrowers, where  $\rho = (T - s - 2 + p\phi^s)(\phi - 1)\bar{k}$ .
- In all periods  $2 \leq t \leq T$  all lenders who concluded a contract in the previous period offer the contract  $[k_t^*, \tilde{r}_t^*]$  to their incumbent borrower if this borrower repaid in the previous period. If the incumbent borrower of a lender defaulted in the previous period or if the lender didn't conclude a contract in the previous period, the lender does not offer any credit at all. The credit size and the requested repayment in each period  $t$  are defined as follows:

$$[k_t^*, \tilde{r}_t^*] = \begin{cases} [\bar{k}, \phi\bar{k}] & \text{if } 2 \leq t \leq T - s \\ \left[ \left(\frac{\phi}{b}\right)^l \bar{k}, \phi \left(\frac{\phi}{b}\right)^l \bar{k} \right] & \text{if } t = T - s + l \text{ for all } l \in \{1, 2, \dots, s\} \end{cases}$$

where  $s$  is the smallest integer that satisfies  $p \geq \frac{1}{\phi^{s+1}}$ .

- Honest borrowers accept the contract  $[k_t^*, \tilde{r}_t^*]$  in all periods  $t$  and repay the loan in each period.
- Selfish borrowers accept the contract  $[k_t^*, \tilde{r}_t^*]$  in all periods  $t$ . Their repayment probability  $\gamma_t^*$  is given by

$$\gamma_t^* = \begin{cases} 1 & \text{if } t < T - s \\ \frac{(\phi^s - 1)p}{1 - p} & \text{if } t = T - s \\ \frac{\phi^{s-l} - 1}{\phi^{s+1-l} - 1} & \text{if } t = T - s + l \text{ for all } l \in \{1, 2, \dots, s - 1\} \\ 0 & \text{if } t = T \end{cases}$$

- All lenders believe that any borrower who defaults on a loan in any period is selfish. Furthermore, outside lenders believe that borrowers who switch lenders in any period  $t > 1$  are selfish.

**Proof of Proposition A3:** Proof is by construction and is established in 4 steps:

Step 1 (repayment by honest borrowers): Honest borrowers will repay in each period as long as their financing conditions are fair; i.e.  $\tilde{r}_t^* \leq \phi k_t^*$ . Given the strategies of lenders this condition is satisfied in every period.

Step 2 (repayment by selfish borrowers): The argumentation is very similar to the one in Step 2 of the Proof of Proposition A2. In period  $T$  selfish borrowers will always default. The incentive constraint for selfish borrowers in non-final periods  $t < T$  is again  $-r_t + V_{t+1}^R \geq V_{t+1}^D$ . A selfish borrower's incentives in the next to last period  $T - 1$  are as follows: The lenders' strategies above imply that  $V_T^R = a + bk_T^* = a + b\left(\frac{\phi}{b}\right)^s \bar{k} = a + \frac{\phi^s \bar{k}}{b^{s-1}}$  and  $V_T^D = a$ . As  $\tilde{r}_{T-1}^* = \frac{\phi^s \bar{k}}{b^{s-1}}$  the incentive constraint is met with equality in period  $T - 1$ . It is therefore a best strategy for the selfish borrower to repay with any probability  $\gamma_{T-1}^* \in [0, 1]$ . Similar to Step 2 of the Proof of Proposition A2 the same argument can be made for all periods  $t \geq T - s$ . In periods  $t < T - s$  all lenders offer the contract  $[k_t^*, \tilde{r}_t^*] = [\bar{k}, \phi \bar{k}]$  with certainty. As  $\tilde{r}_t^* = \phi \bar{k} < b \bar{k}$  the incentive constraint is met with inequality in these periods. It is therefore a best strategy for selfish borrowers to repay with probability  $\gamma_t^* = 1$  in all periods  $t < T - s$ .

Step 3 (beliefs of lenders): In equilibrium all borrowers of the same type play identical strategies. However, lenders only observe the repayment behavior of borrowers with whom they directly interact. The lenders strategies imply that they either form a bilateral relationship with a borrowers from period 1 on, or they do not enter the credit market at all. At the beginning of each period all lenders who are part of an ongoing relationship form a new belief about the honesty of their incumbent borrower based on his repayment behavior in the last period. In equilibrium the lenders' contract offers are such that honest borrowers always have an incentive to repay. In periods  $t < T - s$  also selfish borrowers repay with certainty in equilibrium. As defaulting is off the equilibrium path in these periods, Bayes' Rule does not apply and it must be specified how lenders update their beliefs in case of default: We assume that lenders have the out-of-equilibrium belief that any borrower without a clean record is selfish. In periods  $T - s \leq t \leq T$  only selfish borrowers default with a positive probability in equilibrium such that lenders rationally believe that not repaying borrowers are selfish. Bayesian updating implies that the belief about an incumbent borrower who has always repaid in the past is calculated as  $p_t^e = \frac{p_{t-1}^e}{p_{t-1}^e + (1 - p_{t-1}^e) \gamma_{t-1}^*}$ . Furthermore, we assume that lenders who are not in a relationship with a borrower believe that borrowers who switch lenders are selfish. In equilibrium borrowers do not switch lenders such that this is an out-of-equilibrium belief.

Step 4 (contracts of lenders): The derivation of the repayment behavior of the borrowers in periods  $T - s \leq t \leq T$  and the best-response offers of lenders in periods  $T - s < t \leq T$  is identical as in the Proof of Proposition A2 and therefore omitted here.

Since the end-game situation for lenders is identical as in Proposition A2 lenders make zero profits in all periods  $T - s < t \leq T$ . However, in periods  $2 \leq t \leq T - s$  those lenders who are in a relationship with a borrower earn rents. The reason is that outside lenders have the out-of-equilibrium belief that switching borrowers are selfish and consequently do not make any credit offers. In these periods all borrowers repay with certainty and as lenders do not have to fear competition from other lenders they extend the maximal credit volume  $k_t^* = \bar{k}$  and ask for the highest possible repayment  $\tilde{r}_t^* = \phi k_t^*$ . As a consequence the lenders make positive profits. In period 1 in contrast all lenders anticipate that only lenders who conclude a contract in the first period succeed in establishing a relationship. Thus, the excess supply of lenders implies that lenders compete for borrowers in the first period. The rent from periods  $2 \leq t \leq T - s$  for lenders who establish a relationship is equal to  $\rho = (T - s - 2 + p\phi^s)(\phi - 1)\bar{k}$ . Competition implies that lenders are willing to make losses in the first period as long as these losses are not larger than the rent from a relationship. Thus, lenders offer contracts of the following form in the first period:  $[k_t^*, \tilde{r}_t^*] = [\bar{k}, \max\{0, \bar{k} - \rho\}]$ .

### A.3.2 Market with a Credit Registry

In the situation where both the credit registry and the opportunity for relationship banking are present Proposition A2 and Proposition A3 are sustainable.

#### **Note: Applicability of Propositions A2 and A3 to Experiment**

In our experiment lenders could only choose credit sizes from the set  $\{0, 5, 10, \dots, 50\}$ . The limited number of possible credit sizes may render it impossible that lenders choose the credit size such that borrowers are always indifferent in the end-game. However, alternatively we could also write down equilibria in which lenders do not lower the credit size in the end-game but instead offer the maximal credit only with a certain probability to borrowers who have always repaid in the past (or a combination of randomization and decreasing credit volumes). As probabilities can always be chosen continuously the discrete set of repayments would no longer be a problem. However, as we believe that the reduction of credit volumes is more realistic and the qualitative predictions of the equilibria remain the same we decided to present these more intuitive equilibria.

## Experimental Instructions

### "Credit Reporting, Relationship Banking, and Loan Repayment"

by Martin Brown and Christian Zehnder

The following instructions are a translation of our original German instructions for the **F-CR treatment**. They include instructions and documentation sheets for lenders and entrepreneurs. The original instructions for all four treatments, as well as the z-tree codes are available (in German) from the authors.

The instructions for the F-NO, R-CR, and R-NO treatments are exactly identical to those below except for the following changes:

- In the instructions for the **F-NO treatment** all references to the "information centre" are omitted:
  - Part (4) of the "Overview of Experimental Procedures" (lenders and entrepreneurs)
  - Section (4) of the "Detailed Experimental Procedures" (lenders and entrepreneurs)
  - Section 1.11 of the lenders instructions.
- The instructions for the **R-CR and R-NO treatments** correspond to those of the F-CR and F-NO respectively, except for the following change: All sections of the F- instructions where we mention that ID numbers are fixed for the whole duration of the experiment are changed, and explicitly state that ID numbers are randomly assigned in each period. This applies to the following sections:
  - Last paragraph of the cover page (lenders and entrepreneurs)
  - Section 1.4 (lenders and borrowers)
  - Section 4.2 in R-CR (lenders and borrowers): Here we state that the repayment history of an entrepreneur is reported under his current ID number.
  - The documentation sheet does not bear an ID number (lenders and borrowers)

## Instructions for Lenders

You are now taking part in an economic experiment. Please read the following instructions carefully. Everything that you need to know to participate in this experiment is explained below. Should you have any difficulties in understanding these instructions, please notify us. We will answer your questions at your cubicle.

At the beginning of the experiment you will receive an **initial sum of 10 Swiss Francs**. During the course of the experiment you can earn a further amount of money by gaining points.

The experiment is divided into periods. In each period you have to make decisions which you will enter in a computer. There are 20 periods in all. The amount of points that you gain during each period depends on your decisions and the decisions of other participants. All points that you gain during the course of the experiment will be exchanged into Swiss Francs at the end of the experiment. The exchange rate will be:

**20 Points = 1 Swiss Franc**

At the end of the experiment you will receive the sum of money that you earned during the experiment in addition to your 10 Francs initial sum.

Please note that communication between participants is strictly prohibited during the experiment. In addition we would like to point out that you may only use the computer functions which are required for the experiment. Communication between participants and unnecessary interference with computers will lead to exclusion from the experiment. In case you have any questions we shall be glad to assist you.

Prior to the experiment the 17 participants were divided into 2 groups: lenders and entrepreneurs. There are 10 lenders and 7 entrepreneurs. **You shall be a lender for the entire duration of the experiment.**

**All participants have received an identification number which they will keep for the entire duration of the experiment.** Your identification number is stated on the documentation sheet in front of you.

## Overview of the Experimental Procedures

At the beginning of each period all lenders receive a capital endowment. A lender can use this capital in two ways. He can use the capital to earn a certain income. Alternatively, he can use it to extend credit to an entrepreneur. If an entrepreneur receives credit he earns an investment return. The entrepreneur then decides whether to make a repayment to the lender or not.

The experiment last for a total of 20 periods. In each period the procedures are as follows:

**1) Trading Phase:** In each period there is a trading phase which lasts 2 minutes. During this phase the lenders can make credit offers, which can be accepted by the entrepreneurs. If you, as a lender, want to make a credit offer you must state the following:

- The credit amount
- The desired repayment
- And finally, which entrepreneurs may accept the offer.

As a lender you can make as many credit offers in each period as you want. A credit offer can be accept at any time during the trading phase. Each lender and each entrepreneur can only enter one credit agreement per period. As there are 10 lenders and 7 entrepreneurs, some lenders will not extend credit in any given period.

**2) Investment Return and Repayment:** If an entrepreneur enters a credit agreement during the trading phase, the credit amount is automatically invested. Hereby, he earns an investment return which is double the size of his credit amount. Following this, the entrepreneur decides whether to make the desired repayment to the lender. He can decide to make the desired repayment or to make no repayment at all.

**3) Income Calculation:** As soon as all entrepreneurs have decided whether to make the repayment to their lender, all earnings have been determined. At the end of the experiment your income from all 20 periods will be summed up, exchanged into Swiss Francs and paid to you together with your initial sum of 10 Swiss Francs.

**4) Information Centre:** At the end of each period the repayment decisions of all entrepreneurs are automatically saved in an "Information Centre". This information can be accessed by all lenders in all following periods free of charge and at any time.

## Detailed Experimental Procedures

There are 10 lenders and 7 entrepreneurs in this experiment. **You are an entrepreneur for the entire duration of the experiment.** During the experiment you will enter your decisions in a computer. In the following we describe in detail how you can make your decisions in each period.

### 1. The Trading Phase

(1.1) At the start of each period you as a lender receive a capital endowment of **50 Points**. You can use this capital in two ways. You can use your capital to extend credit to entrepreneurs. Alternatively, you can use your capital to earn a certain income. You can freely decide which share of your capital to extend credit and which share to use to earn a certain income.

(1.2) If you want to extend credit in a period you can make credit offers to the entrepreneurs. For this purpose, the following input screen will appear during the trading phase:

Public offers			Your private offers			Your identification number 1							
Lender	Credit amount	Desired repayment	Credit amount	Desired repayment	to entrepreneur								
						<p>Information Centre</p> <p>Here you make your offers</p> <p>Type of offer <input type="radio"/> public <input type="radio"/> private</p> <p>Credit amount <input type="text"/></p> <p>Desired repayment <input type="text"/></p> <p>The offer goes to the following entrepreneurs</p> <p><input type="checkbox"/> All</p> <p><input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7</p> <p><input type="button" value="No offer"/> <input type="button" value="OK"/></p>							
Here you are informed if one of your offers has been accepted						<table border="1"> <thead> <tr> <th>Your entrepr.</th> <th>Credit amount</th> <th>Des. repaym.</th> </tr> </thead> <tbody> <tr> <td colspan="3" style="height: 20px;"></td> </tr> </tbody> </table>		Your entrepr.	Credit amount	Des. repaym.			
Your entrepr.	Credit amount	Des. repaym.											

(1.3) In the top left corner you see in which period of the experiment you are. In the top right corner you see the remaining time left in the trading phase (in seconds). Each trading phase lasts for 2 minutes (120 seconds) in each period.

(1.4) Directly underneath the time display you see your identification number. **You keep this identification number for the entire duration of the experiment, i.e. for all 20 periods.** This also applies for all other participants in the experiment, i.e. all lenders and entrepreneurs have a constant identification number for all 20 periods.

(1.5) Once you see the above screen, a trading phase commences. As a lender you now have the opportunity to make credit offers to the entrepreneurs. In order to do so you must enter the following items on the right side of your screen:

- Type of credit offer (public or private)
- Credit Amount
- Desired Repayment
- Which entrepreneurs may accept the offer.

(1.6) First you must decide whether you want to make a public or private credit offer:

#### **Private credit offers**

Private credit offers are addressed to one entrepreneur only. Only this entrepreneur is informed about the offer and only this entrepreneur can accept the offer. No other lender or entrepreneur is informed about this offer. If you want to make a private offer, click on the field "private". Afterwards click on the field of the entrepreneur, to whom you want to address the offer.

#### **Public credit offers**

In contrast to private offers, **all participants in the experiment are informed about each public offer.** All entrepreneurs and lenders see all public offers on their screens. A public offer can, however, only be accepted by those entrepreneurs to whom you address it. You can address a public offer to more than one entrepreneur at the same time. If you want to make a public offer, click on the field "public". Afterwards click on the fields of those entrepreneur, to whom you want to address the offer. If you want to address a public offer to all entrepreneurs, click on the field "all".

(1.7) Once you have determined which entrepreneurs may accept the offer, you must determine the **credit amount**. You enter this in the field "credit amount". The **credit amount** may not be lower than 0 and may not exceed your capital of 50. Moreover, the credit amount must be a multiple of 5.

$$0 < \text{Credit Amount} \leq 50$$

(1.8) Finally, you must determine which repayment you desire. You enter this in the field "desired repayment". The **desired repayment** may not be lower than 0 and may not exceed 100. The desired repayment must also be a multiple of 5.

$$0 < \text{Desired Repayment} \leq 100$$



(1.9) After you have fully determined your credit offer, you must click on the "ok" button to submit the offer. As long as you have not clicked on "ok" you may revise your offer.

(1.10) As a lender you are not obliged to make a credit offer. If you do not want to make any credit offer in a period you can click on the button "**no offer**" in that period.

(1.11) At the beginning of each trading phase you as a lender are informed about the prior repayment decisions of entrepreneurs. The **information centre** compiles a table with an entry for each entrepreneur and each prior period: If an entrepreneur accepted a credit offer and made the desired repayment, an "O" is entered in the table corresponding cell. If an entrepreneur accepted a credit offer and did not make the desired repayment, an "X" is entered in the corresponding cell. If an entrepreneur did not accept enter a credit agreement in a period a "" is entered in the corresponding cell. At the beginning of each trading phase the "information center" is displayed automatically for 30 seconds. During a trading phase you can also access the information centre, any time, by clicking the button "information centre".

(1.12) On the left side of your screen you see the title "public credit offers". All public credit offers of the current trading phase are displayed here. Your public offers as well as those of all other lenders are displayed. You can see which lender made each offer, which credit amount is offered and which repayment is desired.

(1.13) All private credit offers which you have made in the current trading phase are displayed In the middle of your screen under the title "your private credit offers". You can see to which entrepreneur you addressed each offer, which credit amount you offered, and which repayment you desired.

(1.14) **Each lender can make as many private and public offers as he wishes in each period.** Each offer made by you can be accepted at any time during the trading phase.

(1.15) **Each lender can enter only one credit agreement in each period.** Once one of your offers has been accepted you will be notified about which entrepreneur accepted which offer. On the bottom of your screen you will see the number of the entrepreneur who accepted the offer, your offered credit amount, and your desired repayment. As you can enter only one trade agreement in each period, all your other offers will be automatically cancelled. Moreover, you will not be able to make any further offers

(1.11) **Each entrepreneur can enter only one credit agreement per period.** Once all entrepreneurs have entered a credit agreement, or the remaining lenders do not want to make any credit offers, or the time has elapsed, a trading phase is concluded. Following this, no more credit offers can be made or accepted in this period.

## **2. Investment Return and Actual Repayment**

(2.1) If an entrepreneur enters a credit agreement, he earns an investment return. The investment return of the entrepreneur is always double the amount of the credit he accepted:

$$\text{Investment Return of the Entrepreneur} = 2 \times \text{Credit Amount}$$

(2.2) All entrepreneurs who enter a credit agreement must decide whether to make the desired repayment. **The repayment desired by you is not binding for your entrepreneur.** Your entrepreneur can choose to make your desired repayment, or he can decide to make no repayment.

(2.3) While your entrepreneur chooses his actual repayment, we ask you to enter on a separate screen your estimation of the chance that your desired repayment will be made.

### **3. Income Calculation**

(3.1) Your income as a lender is composed of your certain income and your credit-income. Your **certain income** equals the share of your capital, which you did not extend as credit. If you did not enter a credit agreement in a period, you earn a certain income of 50 points in that period.

$$\text{Your Certain Income} = 50 - \text{Credit Amount}$$

(3.2) If you entered a credit agreement, your **credit income** is equal to the actual repayment of the entrepreneur. This actual repayment can either be your desired repayment or 0.

$$\text{Your Credit Income} = \text{Actual Repayment}$$

(3.3) Your **total income** in a period is the sum of your certain income and your credit income. Your total income depends therefore on the credit amount you agreed upon and the actual repayment of the entrepreneur.

$$\text{Your Income} = 50 - \text{Credit Amount} + \text{Actual Repayment}$$

(3.4) If an entrepreneur entered a credit agreement, he earns an investment return which is double the size of his credit amount. His income thus rises with the amount of credit agreed upon. The income of the entrepreneur declines, however, with his actual repayment to the lender.

$$\text{Income of Entrepreneur} = 10 + 2 \times \text{Credit Amount} - \text{Actual Repayment}$$

If, in any period, an entrepreneur does not enter a credit agreement, he earns an income of 10 points in that period.

(3.5) The income of all lenders and entrepreneurs are determined in the same way. Each lender can therefore calculate the income of his entrepreneur and each entrepreneur can calculate the income of his lender.

(3.6) You will be informed about your income and the income of your entrepreneur on an "**income screen**" (see below). After you have studied the income screen, please note all

information on your documentation sheet. The documentation sheet serves the purpose of informing you about all your prior credit agreements and your earned income.

Period	1 of 20	Remaining time [sec]: 32
--------	---------	--------------------------

Your identification number

The following offer has been accepted by entrepreneur

Credit amount  
Desired repayment  
Type of offer

The investment return of the entrepreneur =  
Actual repayment

Entrepreneur's income =

Your certain income =  
Your credit income =  
Your total income =

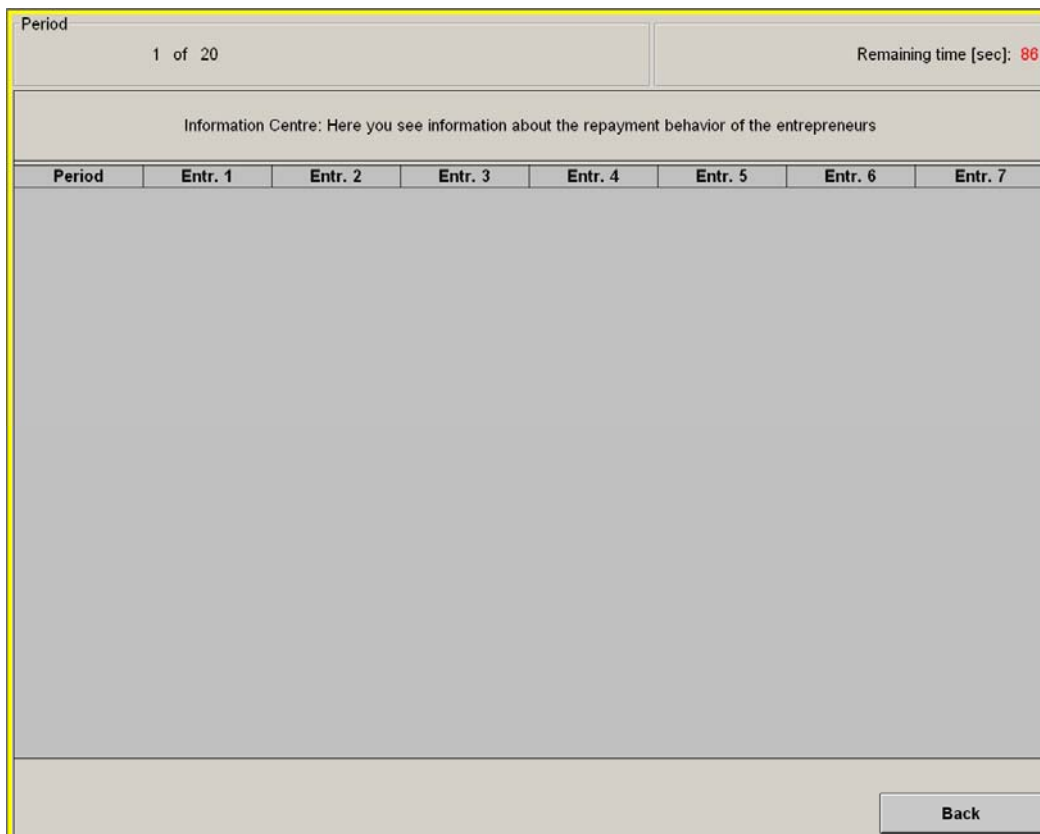
next

#### 4. Information Centre

(4.1) At the end of each period the repayment decision of all entrepreneurs will be automatically saved in the "information centre" The information centre compiles a table with an entry for each entrepreneur and each prior period:

- If an entrepreneur accepted a credit offer and made the desired repayment, an "O" is entered in the table of the information centre.
- If an entrepreneur accepted a credit offer and did not make the desired repayment, an "X" is entered in the table of the information centre.
- If an entrepreneur did not enter a credit agreement in a period a "" is entered in the table of the information centre for that period.

(4.2) At the beginning of each trading phase, the information centre shown below is displayed to all lenders. **Here, all prior repayment decisions are displayed for each entrepreneur underneath his ID number, i.e. his personal repayment history is displayed for all prior periods.** During a trading phase all lenders can access the information centre at any time. The information from the information centre is free of charge for all lenders.



The screenshot shows a web interface for the 'Information Centre'. At the top left, it says 'Period 1 of 20'. At the top right, it says 'Remaining time [sec]: 88'. Below this is a header for the 'Information Centre' with the text 'Here you see information about the repayment behavior of the entrepreneurs'. The main area contains a table with the following columns: 'Period', 'Entr. 1', 'Entr. 2', 'Entr. 3', 'Entr. 4', 'Entr. 5', 'Entr. 6', and 'Entr. 7'. The table body is currently empty. At the bottom right of the interface is a 'Back' button.

(4.3) The experiment will not commence, until all participants are completely familiar with all procedures. In order to secure that this is the case, we kindly ask you to solve the exercises below

(4.4) In addition we will conduct 2 trials of the trading phase, so that you can get accustomed to the computer. In these trial periods no repayment decisions will be made. These trial periods will not be added to the result of the experiment and therefore not remunerated. Following the trial periods we will begin the experiment which will last for 20 periods.

## Exercises

Please solve the following exercises, showing your corresponding calculations. If you have questions, please contact us. Wrong answers have no consequences for you.

### Exercise 1

In a trading phase you did not make any credit offer. How high is your income in that period?

Your Certain Income =

Your Credit Income =

Your Total Income =

### Exercise 2:

You made a public credit offer with a credit amount of 40 and a desired repayment of 50. Your entrepreneur made the desired repayment of 50.

Your Certain Income =

Your Credit Income =

Your Total Income =

Income of Entrepreneur =

### Exercise 3:

You made a public credit offer with a credit amount of 40 and a desired repayment of 50. Your entrepreneur made no repayment.

Your Certain Income =

Your Credit Income =

Your Total Income =

Income of Entrepreneur =

**Exercise 4:**

You made a private credit offer with a credit amount of 20 and a desired repayment of 35. Your entrepreneur made the desired repayment of 35.

Your Certain Income =

Your Credit Income =

Your Total Income =

Income of Entrepreneur =

**Exercise 5:**

You made a private credit offer with a credit amount of 20 and a desired repayment of 35. Your entrepreneur made no repayment.

Your Certain Income =

Your Credit Income =

Your Total Income =

Income of Entrepreneur =

**Exercise 6:**

An entrepreneur did not accept any credit offer during a trading phase. How high is his income in that period?

Income of Entrepreneur =

**Exercise 7:**

You made several credit offers during a trading phase. None of these offers was accepted by an entrepreneur. How high is your income in that period?

Your Certain Income =

Your Credit Income =

Your Total Income =

Once you have solved all exercises, we recommend that you review them and your answers. After that, please consider which decisions you intend to make during the experiment.

### Documentation Sheet - Lenders

This documentation sheet is for your own orientation. In each period please fill out the corresponding row.

<b>Period</b>	<b>ID-Nr. of your Entrepreneur</b>	<b>Credit Amount</b>	<b>Desired Repayment</b>	<b>Actual Repayment</b>	<b>Your Income (in points)</b>
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

## Instructions for Entrepreneurs

You are now taking part in an economic experiment. Please read the following instructions carefully. Everything that you need to know to participate in this experiment is explained below. Should you have any difficulties in understanding these instructions please notify us. We will answer your questions at your cubicle.

At the beginning of the experiment you will receive an **initial sum of 10 Swiss Francs**. During the course of the experiment you can earn a further amount of money by gaining points.

The experiment is divided into periods. In each period you have to make decisions which you will enter in a computer. There are 20 periods in all. The amount of points that you gain during each period depends on your decisions and the decisions of other participants. All points that you gain during the course of the experiment will be exchanged into Swiss Francs at the end of the experiment. The exchange rate will be:

**20 Points = 1 Swiss Franc**

At the end of the experiment you will receive the sum of money that you earned during the experiment in addition to your 10 Francs initial sum.

Please note that communication between participants is strictly prohibited during the experiment. In addition we would like to point out that you may only use the computer functions which are required for the experiment. Communication between participants and unnecessary interference with computers will lead to exclusion from the experiment. In case you have any questions we shall be glad to assist you.

Prior to the experiment the 17 participants were divided into 2 groups: lenders and entrepreneurs. There are 10 lenders and 7 entrepreneurs. **You shall be an entrepreneur for the entire duration of the experiment.**

**All participants have received an identification number which they will keep for the entire experiment.** Your identification number is stated on the documentation sheet in front of you.



## Overview of the Experimental Procedures

At the beginning of each period all lenders receive a capital endowment. A lender can use this capital in two ways. He can use the capital to earn a certain income. Alternatively, he can use it to extend credit to an entrepreneur. If an entrepreneur receives credit he earns an investment return. The entrepreneur then decides whether to make a repayment to the lender or not.

The experiment lasts for a total of 20 periods. In each period the procedures are as follows:

**1) Trading Phase:** In each period there is a trading phase which lasts 2 minutes. During this phase the lenders can make credit offers, which can be accepted by the entrepreneurs. When making a credit offer a lender must state the following:

- The credit amount
- The desired repayment
- And finally, which entrepreneurs may accept the offer.

In any period each lender can make as many credit offers as he wants. You as an entrepreneur can accept any offer addressed to you at any time during the trading phase. Each lender and each entrepreneur can only enter one credit agreement per period. As there are 10 lenders and 7 entrepreneurs, some lenders will not extend credit in any given period.

**2) Investment Return and Repayment:** If you as an entrepreneur enter a credit agreement during the trading phase, the credit amount is automatically invested. Hereby, you earn an investment return which is double the size of your credit amount. Following this, you decide as whether to make the desired repayment to the lender. You can decide to make the desired repayment or to make no repayment at all.

**3) Income Calculation:** As soon as all entrepreneurs have decided whether to make the repayment to their lender, all earnings have been determined. At the end of the experiment your income from all 20 periods will be summed up, exchanged into Swiss Francs and paid to you together with your initial sum of 10 Swiss Francs.

**4) Information Centre:** At the end of each period the repayment decisions of all entrepreneurs are automatically saved in an "Information Centre". This information can be accessed by all lenders in all following periods free of charge and at any time.

## Detailed Experimental Procedures

There are 10 lenders and 7 entrepreneurs in this experiment. **You are an entrepreneur for the entire duration of the experiment.** During the experiment you will enter your decisions in a computer. In the following we describe in detail how you can make your decisions in each period.

### 1. The Trading Phase

(1.1) At the start of each period all lenders receive a capital endowment of **50 Points**. They can use this capital to extend credit to entrepreneurs. Alternatively, they can use their capital to earn a certain income.

(1.2) If a lender wants to extend credit he can make credit offers to the entrepreneurs during the trading phase. As an entrepreneur you can accept one of the credit offers addressed to you during the trading phase. For this purpose, the following input screen will appear during each trading phase:

Period			1 of 20			Remaining time [sec]: 106		
Your identification number						1		
Private offers to you				Public offers				
from lender	Credit amount	Desired repayment		from lender	Credit amount	Des. repaym.		
<input type="button" value="accept"/>				<input type="button" value="accept"/>				
Here you can see your accepted offer				Your lender	Credit amount	Desired repayment		

(1.3) In the top left corner you see in which period of the experiment you are. In the top right corner you see the remaining time left in the trading phase (in seconds). Each trading phase lasts for 2 minutes (120 seconds) in each period.

(1.4) Directly underneath the time display you see your identification number. **You keep this identification number for the entire duration of the experiment, i.e. for all 20 periods.**

This also applies for all other participants in the experiment, i.e. all lenders and entrepreneurs have a constant identification number for all 20 periods.

(1.5) Once you see the above screen, a trading phase commences. As an entrepreneur you can now accept credit offers which have been addressed to you by lenders. There are two types of credit offers which you can accept:

#### **Private credit offers to you**

Each lender can offer private credit offers to you. Only you are informed about this offer and only you can accept this offer. No other lender or entrepreneur is informed about this offer. Should you receive a private credit offer, it will appear on the left side of the screen, under the title "Private offers to you". Each private offer contains the identification number of the lender who made the offer, the credit amount offered, and the repayment desired by the lender.

#### **Public credit offers**

Each lender can also make public credit offers. In contrast to private offers, all participants in the experiment ( i.e. all lenders and all entrepreneurs) are informed about each public offer. The lender can further decide which entrepreneurs can accept a public offer. A public offer can be addressed to more than one entrepreneur at the same time. If a lender makes a public credit offer, it will be displayed on the right side of your screen, under the title "Public Offers". A public credit offer again contains the identification number of the lender who made the offer, the credit amount offered, and the repayment desired by the lender. If the lender decided that you may accept the offer, an „O“ will be displayed next to the offer. If the lender decided that you may not accept the offer, an „X“ will be displayed next to the offer.

If you want to accept a credit offer, please click first on the row in which the offer is displayed. When you do this, the offer will be highlighted. If you are sure you want to accept the offer, click then on the button "accept" which is situated towards the bottom of the screen. As long as you have not clicked "accept" you can alter your choice.

(1.6) **Each entrepreneur can enter only one credit agreement per period.** Once you have accepted one credit offer, you cannot accept any further offers. As soon as you have clicked on the "accept" button the offer you have accepted will be displayed in the bottom row of your screen.

(1.7) All lenders have to observe the same rules when making credit offers. The **credit amount** may not be lower than 0 and may not exceed their capital of 50. The **desired repayment** may not be lower than 0 and may not exceed 100. Moreover, the credit amount and the desired repayment must be a multiple of 5.

$$0 < \text{Credit Amount} \leq 50$$

$$0 < \text{Desired Repayment} \leq 100$$

(1.8) **Each lender can make as many private and public offers as he wishes in each period.** Each offer that is made by a lender can be accepted at any time during the trading phase.

(1.9) **Each lender can enter only one credit agreement in each period.** Once an offer of a lender has been accepted he will be notified about which entrepreneur accepted it. As each lender can enter only one trade agreement in each period all other offers of the lender will be automatically cancelled. Moreover, he will not be able to make any further offers

(1.10) No lender is obliged to make a credit offer. For this purpose, a lender can click on the button "no offer" in any period. As an entrepreneur you are also not obliged to accept a credit offer.

(1.11) Once the time has elapsed, all entrepreneurs have entered a credit agreement, or the remaining lenders do not want to make any credit offers, a trading phase is concluded. Following this, no more credit offers can be made or accepted in this period.

## **2. Investment Return and Actual Repayment**

(2.1) If you, as an entrepreneur, have accepted a credit offer, you earn an investment return. Your investment return is always double the amount of the credit you accepted:

$$\text{Your Investment Return} = 2 \times \text{Credit Amount}$$

(2.2) Following this you must decide whether to make the desired repayment. **The repayment desired by your lender is not binding for you as an entrepreneur.** You can choose the desired repayment of your lender. You can, however, also decide to make no repayment. If you have entered a credit agreement during a trading phase, the following input screen will appear for you to make your repayment decision:

The screenshot shows a window titled "Period" with "1 of 20" in the top left and "Remaining time [sec]: 39" in the top right. The main content area contains the following text:

You have accepted the following offer

- from lender
- Credit amount
- Desired repayment
- The offer was
- Your investment return

Do you want to make the desired repayment?  Yes  No

An "OK" button is located in the bottom right corner of the window.

(2.3) In order to choose the desired repayment of your lender, click on the field "yes". If you choose to make no repayment, click on the field "no". As long as you have not pressed "ok" you can alter your choice.

### **3. Income Calculation**

(3.1) As soon as all entrepreneurs have decided whether to make the repayment to their lender, all earnings for this period have been determined. **Your income** as an entrepreneur depends on the amount of your agreed credit as well as on your repayment to the lender.

(3.2) If you entered a credit agreement, your income depends on your investment return and your repayment decision. Your investment return is double the size of your agreed credit amount. Your income thus rises with the amount of credit accepted. Your income declines, however, with your actual repayment to the lender.

$$\text{Your Income} = 10 + 2 \times \text{Credit Amount} - \text{Actual Repayment}$$

(3.3) If, in any period, you do not enter a credit agreement, you earn an income of 10 points in that period.

(3.4) If a lender does not enter a credit agreement in a period, he earns an income of 50 points in that period. If he does enter a credit agreement, his income rises with the actual repayment of the entrepreneur.

$$\text{Income of the Lender} = 50 - \text{Credit Amount} + \text{Actual Repayment}$$

(3.5) The income of all lenders and entrepreneurs are determined in the same way. Each lender can therefore calculate the income of his entrepreneur and each entrepreneur can calculate the income of his lender.

(3.6) Please note that entrepreneurs can incur losses in each period. Losses can, however, always be prevented through your own decisions. If you make a loss, you have to pay this from earnings in earlier periods or from your initial sum of money.

(3.7) You will be informed about your income and the income of your lender on an "**income screen**" (see below). After you have studied the income screen please note all information on your documentation sheet. The documentation sheet serves the purpose of informing you about all your prior credit agreements and your earned income.

Period	1 of 20	Remaining time [sec]: 54
--------	---------	--------------------------

Your identification number

You have accepted the following offer from

Credit amount

Desired repayment

Type of offer

Your investment return =

Actual repayment

Your lender's income =

Your income =

next

## 4. Information Centre

(4.1) At the end of each period your repayment decision and that of all other entrepreneurs will be automatically saved in the "information centre" The information centre compiles a table with an entry for each entrepreneur and each prior period:

- If you as an entrepreneur accepted a credit offer and made the desired repayment, an "O" is entered in the table of the information centre.
- If you accepted a credit offer and did not make the desired repayment, an "X" is entered in the table of the information centre.
- If you did not enter a credit agreement in a period a "" is entered in the table of the information centre for that period.

(4.2) At the beginning of each trading phase, the information centre shown below is displayed to all lenders. **Here, all your prior repayment decisions are displayed underneath your ID number, i.e. your repayment history is displayed for all prior periods.** During a trading phase all lenders can access the information centre at any time. The information from the information centre is free of charge for all lenders.

Period	Entr. 1	Entr. 2	Entr. 3	Entr. 4	Entr. 5	Entr. 6	Entr. 7

(4.3) The experiment will not commence, until all participants are completely familiar with all procedures. In order to secure that this is the case, we kindly ask you to solve the exercises below

(4.4) In addition we will conduct 2 trials of the trading phase, so that you can get accustomed to the computer. In these trial periods no repayment decisions will be made. These trial

periods will not be added to the result of the experiment and therefore not remunerated. Following the trial periods we will begin the experiment which will last for 20 periods.

## Exercises

Please solve the following exercises, showing your corresponding calculations. If you have questions, please contact us. Wrong answers have no consequences for you.

### Exercise 1

In a trading phase you did not accept any credit offer. How high is your income in that period?

Your Income =

### Exercise 2:

You accepted a public credit offer with a credit amount of 40 and a desired repayment of 50. You make the desired repayment of 50.

Your Income =

Income of the Lender =

### Exercise 3:

You accepted a public credit offer with a credit amount of 40 and a desired repayment of 50. You make no repayment.

Your Income =

Income of the Lender =



**Exercise 4:**

You accepted a private credit offer with a credit amount of 20 and a desired repayment of 35. You make the desired repayment of 35.

Your Income =

Income of the Lender =

**Exercise 5:**

You accepted a private credit offer with a credit amount of 20 and a desired repayment of 35. You make no repayment.

Your Income =

Income of the Lender =

**Exercise 6:**

A lender made several credit offers during a trading phase. None of these offers was accepted by an entrepreneur. How high is the income of the lender in that period?

Income of the Lender =

Once you have solved all exercises, we recommend that you review them and your answers. After that, please consider which decisions you intend to make during the experiment.

## Documentation Sheet - Entrepreneurs

This documentation sheet is for your own orientation. In each period please fill out the corresponding row.

<b>Period</b>	<b>ID-Nr. of your Lender</b>	<b>Credit Amount</b>	<b>Desired Repayment</b>	<b>Actual Repayment</b>	<b>Your Income (in points)</b>
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

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