J. Finan. Intermediation 19 (2010) 255–278

Contents lists available at ScienceDirect

J. Finan. Intermediation

journal homepage: www.elsevier.com/locate/jfi

The emergence of information sharing in credit markets

Martin Brown [a,*], Christian Zehnder [b]

[a] Swiss National Bank, Börsenstrasse 15, CH-8022 Zurich, Switzerland
[b] University of Lausanne, Quartier UNIL-Dorigny, CH-1015 Lausanne, Switzerland

ARTICLE INFO

Article history:
Received 30 May 2008
Available online 28 July 2009

ABSTRACT

We provide the first systematic empirical analysis of how asymmetric information and competition in the credit market affect voluntary information sharing between lenders. We study an experimental credit market in which information sharing can help lenders to distinguish good borrowers from bad ones. Lenders may, however, also lose market power by sharing information with competitors. Our results suggest that asymmetric information in the credit market increases the frequency of information sharing between lenders significantly. Stronger competition between lenders reduces information sharing. In credit markets where lenders may fail to coordinate on sharing information, the degree of information asymmetry, rather than lender competition, drives actual information sharing behavior.

1. Introduction

The systematic use of credit reports in assessing loan applications is one of the most remarkable developments in retail banking. Today, many loan approvals no longer take days or weeks, but are made in minutes, thanks to information derived from credit reports. Over the past 30 years, the number of reports issued by credit bureaus in the United States has increased 10-fold, so that nowadays over 3 million credit reports are issued on a daily basis (Hunt, 2005). Beyond the United States, the credit reporting industry has also seen substantial developments. Examining data for 129 countries, Djankov et al. (2007) show that the number of countries with a public credit registry increased from 21% in 1978 to 53% in 2003. Moreover, the number of countries with at least one private credit bureau increased from 16% to 41% over the same period.

In this paper, we provide empirical evidence on the emergence of information sharing through private credit bureaus. Private credit bureaus rely on voluntary information exchange between lenders,

* Corresponding author.
E-mail addresses: martin.brown@snb.ch (M. Brown), christian.zehnder@unil.ch (C. Zehnder).

1042-9573/$ - see front matter © 2009 Elsevier Inc. All rights reserved.
doi:10.1016/j.jfi.2009.03.001

which for these lenders involves a trade-off. On the one hand, lenders benefit from information sharing, as it helps them to select good from bad loan applicants (Pagano and Jappelli, 1993) and overcome moral hazard on the part of borrowers (Vercammen, 1995; Padilla and Pagano, 2000; Klein, 1992). On the other hand, sharing information may expose lenders to increased competition because they release private information about their existing clients (Pagano and Jappelli, 1993). Banks may therefore be wary of sharing information in competitive credit markets, and may be particularly reluctant to share information with close competitors.[1] Anecdotal evidence suggests that the emergence of voluntary information sharing is related to information asymmetries and lender competition. Historical records show that credit reporting initially emerged in the United States in the early 19th century, when interstate trade increased and information asymmetries between merchants and their debtors grew (Olegario, 2003). Anecdotal evidence from Italy suggests that information sharing initially emerged between non-competing, regional banks (Pagano and Jappelli, 1993). Recent developments in Russia also demonstrate the reluctance of banks to participate in the same credit bureau as their rivals. After the introduction of a law in 2005 forcing all lenders to join at least one bureau, many lenders set up their own credit bureaus, in order to avoid sharing information with competitors.[2]

From a theoretical perspective, the emergence of voluntary information sharing depends not only on the inherent degree of information asymmetries or competition in a credit market. It may also be subject to coordination failure between lenders, as for each lender the benefits of joining a credit bureau depend on the number of other bureau members.[3] As shown by Klein (1992) lenders may fail to coordinate on sharing information, even if a private credit bureau with full membership would be the more profitable arrangement. One might think that a bankers' association or a private credit bureau company (for example Experian in the USA) should be able to overcome coordination problems through repeated negotiations with prospective members and transparent rules for entry and exit. However, anecdotal evidence suggests that getting lenders to join a credit bureau is not a trivial task. The IFC Global Credit Bureau Programme, a multilateral initiative to foster the development of private credit bureaus, argues that commitment by lenders is a major problem in establishing credit bureaus in emerging economies (IFC, 2006). The IFC has organized roundtable discussions among lenders in several developing and emerging economies, in order to initiate voluntary information sharing. Despite these attempts and that of local bankers associations, public intervention has recently been required to get private credit bureaus off the ground in countries such as Russia, Kazakhstan, Egypt, Morocco, Kenya, Ghana, Mexico and Ecuador. Even after a private credit bureau has been established and successfully operated for many years, lenders cannot be sure that other lenders will adhere to their promises to share information. Anecdotal evidence from the US suggests that in the past some major credit companies have held back information from credit bureaus, contrary to agreement. Interestingly, industry observers at that time were worried about a de-coordination or domino effect, leading further lenders to withhold information from the bureaus (Lazarony, 2000).

So far there has been no systematic, empirical analysis of the key driving forces behind voluntary information sharing. Does asymmetric information between lenders and borrowers encourage participation of lenders in private credit bureaus? Does lender competition inhibit information sharing? And, what happens in credit markets where coordination problems imply that information sharing could take off or not? Is there a systematic relationship between the characteristics of credit markets and how lenders solve the coordination problem related to information sharing? In this paper we use experimental methods to answer these questions.

We conduct an experimental analysis of how information asymmetries and lender competition affect voluntary information sharing between lenders. We examine an experimental credit market which is characterized by adverse selection: lenders know that there are good and bad borrowers, but they can only identify the type of borrowers in their "home sector". Borrowers may switch their location, in which case lenders can only identify the type of entrants to their sector of the market if they share information with lenders who are situated in other sectors. The higher the probability that

[1] Bouckaert and Degryse (2006) show that the incentives to unilaterally disclose information on default behavior also depend on lenders' inherent market power.

[2] See <http://www.interfax.ru/e/B/0/0.html?id_issue=11383470>.

[3] The costs per member of running the bureau may also be lower if a substantial proportion of these costs are fixed.

borrowers switch location, the more severe the problem of adverse selection, and the stronger the incentives to share information. Our credit market is also characterized by lender competition, which reduces information sharing incentives. We implement a simple form of spatial competition: Each lender has one direct competitor and two lenders with whom he does not compete at all. In such a situation, lenders benefit from sharing information with non-competitors, but lose market power if they share information with direct competitors. We vary independently the degree of adverse selection in our experiment, i.e., the probability with which borrowers switch locations, as well as the intensity of competition between lenders. In two of our four treatments we have unique predictions for the level of information sharing, while in the other two treatments potential coordination failure among lenders leads to multiple equilibria.

By comparing the outcome across treatments our experiment allows us to answer three questions: (i) does adverse selection encourage voluntary information sharing between lenders? (ii) does lender competition discourage information sharing? and (iii) which of these two forces (adverse selection or competition) drives information sharing behavior when there is potential coordination failure?

Data availability thwarts a similar exercise using field evidence. Djankov et al. (2007) provide data on the emergence of information sharing in 130 countries for the period 1978–2003. Unfortunately though, reliable cross-country indicators of bank competition and information asymmetry in the credit market are hardly available for the above time period. Barth et al. (2008) provide information on banking sector competition (concentration ratios, entry restrictions, activity restrictions) for up to 152 countries. However, their data is available from 1998 onwards only.[4] Data on information asymmetries between lenders and borrowers are even more scarce. Pagano and Jappelli (1993) compile data on household mobility in 14 OECD countries and show that this measure of potential adverse selection is positively related to consumer credit reporting. To the best of our knowledge though, cross-country and time-varying indicators on potential adverse selection between lenders and borrowers, are not available. In this situation, where the necessary field data is not obtainable, a controlled laboratory experiment provides an attractive alternative.

Our results confirm the hypothesis of Pagano and Jappelli (1993); both adverse selection and lender competition systematically affect voluntary information sharing. In treatments with high borrower mobility, information sharing between our experimental lenders is more frequent than in (otherwise identical) treatments with low borrower mobility. Similarly, treatments with strong exogenous competition between lenders display lower levels of information sharing than (otherwise identical) treatments with weak lender competition. In addition, our results suggest that the impact of adverse selection on information sharing behavior may be stronger than that of lender competition. In treatments with potential coordination failure, lenders do coordinate on sharing information when borrower mobility is high, even if competition is strong. In contrast, when borrower mobility is low, lenders are less likely to coordinate on sharing information, even if competition is weak.

Our findings contribute to the growing empirical literature on the role of information sharing in financial market development. Several recent studies have demonstrated that information sharing is beneficial to credit market performance. Credit scoring models based on credit bureau data suggests that the use of credit reports allows lenders to more accurately predict loan defaults (Kallberg and Udell, 2003; Barron and Staten, 2003; Luoto et al., 2007; Powell et al., 2004). Moreover, recent experimental results indicate that information sharing disciplines borrowers to repay loans (Brown and Zehnder, 2007). Cross-country evidence, meanwhile, supports the conjecture that information sharing improves credit availability. Aggregate credit market volume is higher in countries where information sharing is more developed (Jappelli and Pagano, 2002; Djankov et al., 2007). Moreover, analyses of firm-level data (Galindo and Miller, 2001; Love and Mylenko, 2003; Brown et al., 2009) show that access to bank credit is easier in countries where credit bureaus or registries exist. While existing evidence confirms that information sharing between lenders is beneficial for credit market

[4] Claessens and Laeven (2004) estimate the degree of banking competition using the Panzar and Rosse (1987) methodology for 50 countries based on data from BANKSCOPE. However, their indicator is available for one period, the 1994–2001 average, only.

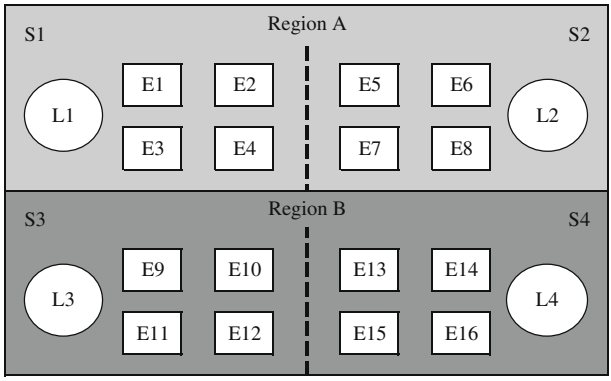

Fig. 1. Structure of the credit market. The figure provides a graphical representation of the experimental credit market. The market consists of two regions, A and B, and each region is divided into two sectors. In each sector there is one lender and four entrepreneurs. Each lender can extend credit only to entrepreneurs in his region. While credit offers in the home sector are costless, credit offers to entrepreneurs in the other sector of the region involve a transaction cost of T.

performance, there is little evidence examining the circumstances in which credit bureaus emerge. Pagano and Jappelli (1993) show that household mobility in OECD countries is positively related to consumer credit reporting. However, as their data is cross-sectional, they can't rule out that their result is driven by reverse causality: households may become more mobile when credit reporting exists, because they have easier access to credit if they move. Further studies suggest that private credit bureaus are more likely to be present in richer countries (Djankov et al., 2007) and countries where public credit registries do not exist (Jappelli and Pagano, 2002). So far however, there is no evidence on how bank competition affects information sharing incentives, and the information sharing behavior of lenders in credit markets with potential coordination failure. Our experimental results are a first attempt at closing this gap.

The rest of the paper is organized as follows: Section 2 presents our experimental design and predictions. Section 3 presents our results, and Section 4 concludes.

2. Experimental design

We examine the voluntary exchange of information between lenders in a competitive credit market characterized by information asymmetries between lenders and borrowers. Theory suggests that lenders may share information to overcome adverse selection (Pagano and Jappelli, 1993) and to mitigate moral hazard due to asymmetric information about total indebtedness (Bennardo et al., 2008), investment choice (Padilla and Pagano, 2000), and repayment behavior (Klein, 1992) of borrowers. For reasons of simplification we abstract from moral hazard in our experiment and introduce a simple form of adverse selection based on incomplete information about exogenous borrower traits. In Section 2.1 we present the set-up of our experimental market. Section 2.2 presents the four treatments which we implement and compares the predictions for each treatment. Section 2.3 discusses the key features of our design and how they affect treatment predictions.

2.1. Credit market

Our credit market is divided into two regions, A and B, and in each region there are two sectors. Sectors $S1$ and $S2$ are in region A, sectors $S3$ and $S4$ are in region B. In each sector there is one lender ($L1$ in $S1$, $L2$ in $S2$, $L3$ in $S3$, $L4$ in $S4$), and four entrepreneurs ($E1$–$E4$ in $S1$, $E5$–$E8$ in $S2$, $E9$–$E12$ in $S3$ and $E13$–$E16$ in $S4$). Each entrepreneur requires a loan of $I = 100$ points in order to realize a project. In each region there is one good entrepreneur who yields a return of $Y_g = 300$ points from his project and

three bad entrepreneurs who yield an income of $Y_b = 0$ from their project.[5] Fig. 1 provides a graphical representation of our experimental credit market.

The participants in our experiment all take the role of lenders. Entrepreneurs are simulated. The strategic interaction between our experimental lenders takes place in six phases:

In *phase 1*, each lender gets to know the type of all four entrepreneurs in his home sector. Which entrepreneur is good in each sector is randomly determined at the beginning of each period. Lenders do not get any information about the entrepreneurs' types in the other three sectors of the credit market.

In *phase 2*, each lender decides whether to join the credit bureau or not. The two lenders who are in the same region decide sequentially. In each period the "first-mover" for each region is randomly determined. Before deciding whether to join the credit bureau, the "second-mover" in each region is informed about the decision of the first-mover. Neither the first-, nor the second-mover in one region are informed about the decisions of lenders in the other region until after they have made their own decisions. Membership of the credit bureau bears no cost, and information sharing is reciprocal: All members of the credit bureau get to know the type of all entrepreneurs from the home sector of all other bureau members. Non-members receive no information on entrepreneurs outside of their home sector. In return, bureau members do not receive information on an entrepreneur if the lender from his home sector does not join the bureau.

In *phase 3*, entrepreneurs switch sectors with a probability $\alpha \in (0, 1)$. If entrepreneurs switch their sector, they do so in groups, and switch to the other region. All entrepreneurs from sector $S1$ move to sector $S3$ (and vice versa), while all entrepreneurs from sector $S2$ move to sector $S4$ (and vice versa). The fact that entrepreneurs switch in groups guarantees that, if they switch, there remain one good entrepreneur and three bad ones in each sector. The fact that entrepreneurs always switch regions simplifies the strategic interaction, as lenders know that if switching occurs they can no longer access any borrower they already have information on. Whether entrepreneurs switch or not is determined by the roll of a dice.

In *phase 4*, lenders simultaneously make credit offers. Before doing so, each lender is informed about which other lenders have joined the credit bureau, and whether the entrepreneurs have switched locations. Each lender can make credit offers to entrepreneurs who at this point in time are situated in the same region. Lenders $L1$ and $L2$ can offer credit to any entrepreneur situated in region A. Lenders $L3$ and $L4$ can offer credit to any entrepreneur situated in region B. The size of a credit is fixed at $I = 100$ points. When making a credit offer, the lender must specify his requested repayment $\widetilde{R} \in [100, 300]$. In order to make a credit offer to a particular entrepreneur, a lender must select the ID number of the entrepreneur. Each lender is endowed with funds of 200 points in each period, and can therefore make at most two credit offers. As there are two lenders and only two good borrowers per region our design implies competition between lenders for the good entrepreneurs in a region. Intra-regional competition in our experiment is however incomplete. A credit offer to the entrepreneur situated in the home sector of the lender bears no transaction costs $c = 0$. In contrast, a credit offer to an entrepreneur in the other sector of the region involves positive transaction costs of $c = T$. Overall our design implements a simple form of spatial competition: Each lender has one direct competitor with whom he competes in an incomplete manner, and two lenders with whom he does not compete at all.

In *phase 5*, each entrepreneur can accept one of the credit offers made to him. Entrepreneurs in our experiment are programmed to accept the credit offer with the lowest requested repayment. If an entrepreneur receives two credit offers with equal repayment requests he chooses that of the lender from the sector he is situated in. This is common knowledge among lenders. The lenders' repayment requests are enforceable, but we assume that there is limited liability of entrepreneurs. Thus, good entrepreneurs make actual loan repayments of $R = \widetilde{R}$, while bad entrepreneur make repayments of 0.

In *phase 6*, lenders find out the type of each entrepreneur in their region and are informed about all credit offers made by themselves and the other lender in their region. Lenders also get to know which

[5] In our experimental design we frame borrowers as entrepreneurs who can either have successful or unsuccessful projects. The reason for framing the experiment as a commercial credit market rather than a consumer credit market was to make it easier for our subjects to understand why some borrowers can repay, while others cannot.

Table 1
Experimental treatments and predictions.

	High mobility ($\alpha = .75$)	Low mobility ($\alpha = .25$)
Low competition ($T = 160$)	Full sharing	Full sharing/Partial sharing
High competition ($T = 60$)	Full sharing/Partial sharing	Partial sharing

The table summarizes the parameters and reports predicted equilibria for each of our four experimental treatment conditions. Treatments differ in the probability of entrepreneurs switching α and the transaction costs of intra-regional lending T. "*Full sharing*" indicates that there is an equilibrium in which both lenders in each region join the credit bureau. "*Partial sharing*" indicates that there is an equilibrium in which only one lender per region joins the credit bureau.

of their credit offers was accepted and their resulting payoff. Lenders receive this overview of the credit market outcome and their payoff in order to make it transparent that allocation of credit and their payoff were determined according to the predetermined rules. It is common knowledge that all lender payoffs are calculated in each period as follows:

$$\pi = \begin{cases} 200 & \text{if no credit offer is accepted} \\ 100 + R_1 - c_1 & \text{if one credit offer is accepted} \\ R_1 - c_1 + R_2 - c_2 & \text{if two credit offers are accepted} \end{cases}$$

where $R1, R2$ are repayments demanded in the lender's two offers and $c1, c2$ are the transaction costs involved if the offers are accepted.

Each session of our experiment involves 12 participants and lasts 20 periods. As all participants are assigned the role of lenders, there are three identical credit markets in each period with four lenders each. Each period involves a restart of the experiment: Lenders are randomly reassigned to one of the three credit markets, and the location of the good entrepreneur in each sector of each credit market is randomly determined. This random assignment of lenders and entrepreneurs implies that the information on credit allocation provided to subjects at the end of each period does not enable reputation effects. The complete restart of our experiment in each period also implies that we abstract from the possibility that entrepreneurs in reality can use accumulated earnings to finance projects.

2.2. Treatments and predictions

We implement four treatments of our experiment which differ only in the probability of entrepreneurs switching α and the transaction costs of intra-regional lending T. In order to study the impact of borrower mobility and lender competition on information sharing we vary both factors independently.

In our design the degree of information which lenders have about those borrowers they can lend to depends on whether borrowers switch location or not. Thus the potential adverse selection in our credit market is determined by the probability of entrepreneurs switching α, i.e., their (exogenous) mobility. We implement treatments in which this mobility is high ($\alpha = .75$) and treatments in which mobility is low ($\alpha = .25$).[6]

The degree of competition between lenders in our design is determined by the transaction costs of intra-regional lending. When these transaction costs are high, lenders are subject to low competition from their competitor in the same region. When transaction costs are low, lenders are subject to strong competitive pressure. For both levels of borrower mobility we implement one treatment in which lending competition is high, because transactions costs of intra-regional lending are low

[6] In reality the mobility of borrowers across markets is a choice variable which may be influenced by competition and information sharing between banks. For example, it has been argued that cross-border information sharing between banks in the European Union could encourage more cross-border mobility among borrowers (San José Riestra, 2002). However, since we are interested in testing the hypotheses of Pagano and Jappelli (1993), it is an advantage that our experimental design allows us to circumvent this endogeneity issue related to borrower mobility. Testing the implications of endogenous mobility could be an interesting topic for future experiments.

($T = 60$), and one treatment in which lender competition is low because transaction costs are high ($T = 160$). Table 1 summarizes our experiment design.

In Appendix A.1 we describe the full set of pure strategy equilibria for our experiment, depending on the mobility of entrepreneurs α and the degree of intra-regional competition determined by T.[7] Based on that analysis we discuss in the following the predictions for our four treatments. The income of lenders depends on whether they can identify a good entrepreneur, and whether their direct competitor can also identify that entrepreneur. No lender will make a credit offer to an entrepreneur he knows is "bad", as he would incur a certain loss. Furthermore, no lender will lend to an entrepreneur of an unknown type as the expected profit from doing so is negative. Lenders thus only make contract offers to entrepreneurs they can identify as good. If a lender knows that his competitor in the same region cannot identify a particular good entrepreneur, he will demand the maximum repayment of 300 points. If, however, the competing lender can also identify that good entrepreneur, price competition drives the requested repayment down to $100 + T$, which is the lowest profitable offer the "outside" lender can make. Thus when both lenders know a particular entrepreneur is good, the profits which lenders make are determined by the level of inter-regional transaction costs T.

Based on the impact of information conditions on lenders' income we can derive the costs and benefits of joining the credit bureau in our experiment. Joining the credit bureau can imply costs for a lender, because he risks surrendering his monopoly position over the good entrepreneur in his home sector. This will be the case if the competing lender in the same region also joins the bureau, and entrepreneurs do not switch locations. The potential loss from sharing information with the competing lender is higher when intra-regional transaction costs are low, i.e., when competition within the region is strong. The benefits from joining the credit bureau arise from the possibility to extend credit when lenders do switch location. A lender can however only benefit from joining the bureau if non-competing lenders from the other region join as well and share information on borrowers who have switched. The potential value of this information depends on whether the competing lender also joined the credit bureau and the degree of competition within regions.

In the "*HighMobility–LowCompetition*" treatment we predict that all lenders join the credit bureau. In this treatment the expected costs from joining the bureau are low. Due to high mobility it is unlikely that a lender will retain an information monopoly if he does not join the bureau. Moreover, due to high transaction costs the loss of monopoly power from sharing information with the competing lender is low. In contrast, the expected benefits of joining the bureau are high. First, due to high mobility it is very likely that the lender would benefit from sharing information with the non-competing lenders. Second, when entrepreneurs switch, information provided by non-competing lenders is valuable, as high transaction costs prevent competition from driving down repayment rates even if the competing lender also joins the bureau. As we show in Appendix A it is optimal in this treatment for all lenders to join the credit bureau.[8]

In the "*LowMobility–HighCompetition*" treatment we predict that partial information sharing takes place: only one lender per region will join the credit bureau. In this treatment the expected costs from joining the credit bureau are high. First, due to low mobility sharing information with the competing lender will often undermine a lenders monopoly position. Second, the loss of monopoly rent from sharing information with the competing lender is substantial, as inter-regional transaction costs are low. The expected benefits of joining the credit bureau in this treatment are low. Due to low mobility a lender is unlikely to benefit from sharing information with non-competing lenders. Moreover, the value of this information is limited if the competing lender also joins the bureau. In Appendix A we show that in this treatment a lender will not want to join the credit bureau if the competing lender from the same region joins. We therefore predict that the first-moving lender in each region joins the bureau, while the second-mover does not.

[7] In the appendix we establish predictions for our experiment, assuming that lenders are risk-neutral. We also show that our qualitative predictions still hold if lenders exhibit a reasonable degree of risk aversion.

[8] Note that in this treatment as well as in the other treatments there exists an equilibrium in which no lender joins the credit bureau. If no other lender joins the credit bureau it is a (weakly) best-response for the remaining lender not to join as well. However, assuming that lenders do not play weakly dominated strategies, we neglect these equilibria in the rest of the paper.

In the "*HighMobility–HighCompetition*" treatment we predict that either partial information sharing or full information sharing can take place. Due to high mobility sharing information with the competitor will rarely undermine a lender's monopoly position. However, if entrepreneurs do not switch, the loss of monopoly rent from sharing information with the competing lender is substantial, as inter-regional transaction costs are low. Considering the benefits of joining the bureau, high mobility implies that lenders will often be reliant on information from lenders in the other region. However, due to low transaction costs, the value of this information is limited if the competing lender from the same region also joins the bureau. In Appendix A we show that the first-moving lender in both regions will join the bureau in this treatment. The benefit from joining the credit bureau for the second-mover in a region exceeds the costs of joining only if both non-competing lenders also join. Thus in this treatment there are two possible equilibria. There is a full-sharing equilibria in which the second-movers from both regions join the credit bureau. However, there is also a partial-sharing equilibria in which only the first-mover lenders join. Which equilibria actually emerges depends on the "coordination" of the two second-mover lenders who simultaneously decide whether to join the bureau.

In the "*LowMobility–LowCompetition*" treatment we again predict that both partial information sharing or full information sharing can take place. Considering the costs of information sharing, low mobility implies that sharing information with the competitor has a high chance of undermining a monopoly position. However, the loss of monopoly rent from sharing information with the competing lender is low, as inter-regional transaction costs are high. Considering the benefits of joining the bureau, a lender will seldom require information from the lenders in the other region in order to profitably extend credit. However, due to high transaction costs, the value of receiving information from non-competing lenders is high if switching does occur, even if the competing lender from the same region also joins the bureau. In the appendix we show that the benefits from joining the credit bureau for the second-mover in a region exceed the costs of joining only if both non-competing lenders also join. Thus in this treatment, there is again a full-sharing equilibria in which the second-movers from both regions join the credit bureau and a partial-sharing equilibria in which only the first-mover lenders join. The outcome again depends on the "coordination" of the two second-mover lenders who simultaneously decide whether to join the bureau.

Table 1 summarizes the predictions for our four treatments and shows that our experimental design allows us to answer our three research questions. First, we can examine whether adverse selection in the credit market encourages voluntary information sharing. By comparing the outcome of the "LowMobility–HighCompetition" treatment to that of the "HighMobility–HighCompetition" treatment, we can establish whether an exogenous increase in the degree of asymmetric information (increasing α from .25 to .75) increases credit bureau participation at a given high level of lender competition. Comparing the outcome of the "LowMobility–LowCompetition" treatment to that of the "HighMobility–LowCompetition" treatment, we can establish whether an identical increase in asymmetric information has the same effect at a constant low level of competition.

Second, we can examine whether lender competition in the credit market discourages voluntary information sharing. By comparing the outcome of the "HighMobility–LowCompetition" treatment to that of the "HighMobility–HighCompetition" treatment, we can establish whether an exogenous increase in the intensity of competition (reducing T from 160 to 60) reduces credit bureau participation at a constant high level of adverse selection. Comparing the outcome of the "LowMobility–LowCompetition" treatment to that of the "LowMobility–HighCompetition" treatment, we can establish whether an identical increase in competition has the same effect at a constant low level of adverse selection.

Third, we can examine the impact of adverse selection and lender competition on information sharing behavior when there is potential coordination failure among lenders. We do this by comparing the outcome of our two treatments in which both full and partial sharing are equilibrium outcomes. If we observe that the outcome of the "HighMobility–HighCompetition" treatment is substantially closer to that of the "HighMobility–LowCompetition" than the "LowMobility–LowCompetition" treatment, we can conclude that adverse selection has a stronger impact on information sharing behavior when coordination is an issue. In contrast, if we observe that the outcome of the "HighMobility–HighCompetition" treatment is substantially closer to that of the "LowMobility–HighCompetition" than the "LowMobility–LowCompetition" treatment, we can conclude that competition has the stronger impact. If we find similar outcomes in the "HighMobility–HighCompetition" and "LowMobility–LowCompetition"

treatments, we can conclude that neither of the two forces has an overwhelming coordination effect on lenders.

Our predictions are derived under the assumption of risk-neutrality of lenders. Would risk aversion among lenders alter our main predictions? In Appendix A.2 we investigate how risk aversion affects the feasibility of partial and full information sharing in our experiment. We show there that the presence of risk-averse lenders enlarges (reduces) the set of parameter constellations for which full (partial) information sharing is feasible. This is intuitive, as full information sharing means that all lenders realize a safe payoff, while partial information sharing implies that lenders earn risky payoffs. However, it is rather unlikely that our participants are risk-averse enough to alter the equilibrium predictions for our four treatments.[9]

2.3. Discussion

Our credit market is designed to capture the key information sharing incentives for lenders, in a most simple environment. In doing so we abstract from many natural characteristics of real credit markets as well as from common features of information sharing institutions. In this section we discuss how our key design features affect the predictions for our experiment.

In our experiment *borrowers are simulated*. They are programmed to accept the best credit offer they receive and it is decided randomly whether they are able or not able to repay. In reality, borrowers choose which lenders to borrow from, how to invest their funds and whether to repay their loans. Moreover, these decisions arguably depend on the existence of a credit bureau and which banks are members of it. In our experiment, we abstract from moral hazard in the credit market, and focus on how asymmetric information on exogenous borrower traits affects information sharing incentives. Given that lenders are forced to repay if they can, and we are interested only in lenders decisions to share information, there would be no added value in having real subjects play the role of borrowers.

A second feature of our experimental design is spatial competition. Introducing *spatial competition* in our experiment yields an interesting additional prediction to the analysis of Pagano and Jappelli (1993): when market conditions cannot sustain information sharing between all lenders, there exist partial sharing equilibria in which lenders exchange information only with non-competitors (see our predictions for the "LowMobility–HighCompetition" treatment). The intuition for this result comes from the fact that in our type of spatial competition it does not hurt to share information with non-competitors.[10]

We assume that the *decisions of lenders* to join the credit bureau are sequential within each region, but simultaneous across regions. The assumption that joining decisions are made simultaneously across regions is necessary for the existence of multiple equilibria in our framework, as this generates the potential for "coordination failure" among non-competing lenders. If the decisions of lenders to join the credit bureau are made fully sequentially, the potential for "coordination failure' does not arise.[11] As discussed in the introduction, practitioners report that there are substantial difficulties in coordinating lenders to join and provide information to private credit bureaus in particular in developing

[9] The treatment that is most likely to be affected is the "HighMobility–HighCompetition" treatment. If lenders are strongly risk-averse, partial sharing is no longer an equilibrium in this treatment. However, the degree of risk aversion needed for this to be the case is implausibly high (see Observation 2 in the appendix for details). For example, a participant with such preferences would rather take a fixed payment of 108 points (CHF 0.72) instead of lottery where he would get 300 points (CHF 2.00) with probability 0.5 and zero otherwise (i.e., a risk premium of almost 30% in a decision with very low stakes). Thus, as long as the participants' preferences are not extreme, the presence of risk aversion does not affect our predictions.

[10] An alternative type of spatial competition would be to assume symmetric, imperfect competition with costs of $c = T$ for all cross-sectoral transactions. In this case, we would yield for each parameter constellation either a full sharing or a no-sharing equilibrium. Despite the improvements in communication technology we believe, however, that the assumption of "differentiated" competition among lenders is more realistic than to assume that all lenders compete with each other at the same intensity. Degryse and Ongena (2005), for example, show that distance between firms, lenders, and competitor lenders strongly influence loan terms in Belgium.

[11] Note that our predictions are not affected if we assume that lenders make completely simultaneous decisions, i.e., joining decision are not only made simultaneously across regions but also within regions. The only difference is that with completely simultaneous decisions it is not determined which of the two lenders in a region joins the credit bureau in a partial sharing equilibrium.

and emerging markets. The coordination problem in our design is thus especially relevant to these developing financial sectors, while it may be less so for mature markets with one or more established credit bureaus. Anecdotal evidence suggests that the initial set up of credit bureaus may depend on who owns the bureau (bankers association or private company), the legal environment in the country, and the support of public authorities or international organizations (IFC, 2006). In our design we abstract from institutional arrangements which may affect the degree of the coordination problem among lenders. Our experiment captures the potential for coordination failure among lenders at a most abstract level by introducing simultaneous decision making.

Our stylized credit market displays several further features which affect information sharing incentives: we assume that *initially each lender can only identify the type of borrowers in his sector*. Given that the expected profit of lending to unknown borrowers is negative, each lender thus enjoys initially a de-facto monopoly in his home sector. Obviously, in reality banks may face strong competition even in the absence of information sharing. However, even under such competition, banks typically enjoy informational advantages over competitors, which give rise to potential rents. By assuming that lenders have a de-facto monopoly we implement this information advantage in a most simple way.

In our design we implement, for reasons of simplicity, *identical market shares* and thus abstract from asymmetrical incentives of lenders to share information. Implementing asymmetric market shares (i.e., heterogeneity in the number of good borrowers per market and in the number of borrowers who switch) in our framework would reduce the potential for full information sharing in all treatments, as lenders with large market shares would have stronger incentives not to share information.[12] Moreover, the coordination problem between non-competing lenders would be accentuated, as the benefits of sharing information would not only depend on the number of non-competitors who join the credit bureau, but also on their size.

In our credit market, lenders bear *identical costs of cross-sectoral lending* to any borrowers in the other sector of his region. In reality, these costs, may be borrower-specific, in particular, as they may also be interpreted as switching costs of borrowers.[13] The qualitative predictions of our model would, however, not be altered by allowing for heterogenous transaction costs; the incentives to share information would simply depend on the total transaction costs for good borrowers in each sector.

In our experiment *all lenders make their credit offers simultaneously*. As a result, they cannot infer anything about the type of any specific borrower from credit offers of other lenders. In reality, borrowers often approach lenders sequentially, so that the conditions offered by one lender may serve as a signal of borrower quality to others. Mistrulli and Casolaro (2008) argue for example that local banks may provide a "certification" function for more distant banks in small business lending. However, in general, loan contract terms alone do not provide a lender with an exact measure of credit risk for any prospective client. If this were the case banks would not invest substantial resources to screen clients and would not need to participate in information sharing institutions at all. In our experimental design, simultaneous lending captures this imperfect verifiability of credit contracts in a most simple way.

We assume, for simplicity, that there is *only one credit bureau* which lenders can join. In reality, multiple credit bureaus exist in many countries. In some countries these credit bureaus serve the same lenders and distinguish themselves by the type of information they provide (e.g., Experian and Equifax in the US consumer credit industry). In others though, multiple credit bureaus have been initiated because competing banks are reluctant to share information with each other (see our remarks on Russia in the introduction). Our assumption that competing lenders must share information with each other (if they share information at all) may thus overemphasize the potential impact of lender competition on information sharing incentives. While this is the case, it is important to note that in reality

[12] In the US one major credit card company was long reluctant to share information through the main credit bureaus (Hunt, 2005).

[13] Gehrig and Stenbacka (2007) show in a model with heterogenous switching costs for borrowers that information sharing may have a two-way effect on bank competition. In their two period model information sharing about borrower types increases competition for known good borrowers in the second period. By doing so, it however reduces the informational rents banks earn on good borrowers, and thus reduces competition for market shares in the initial period. Bouckaert and Degryse (2004) examine a similar model.

competition still affects information sharing incentives even if multiple bureaus are possible: as long as borrowers may switch between competing lenders the basic trade off between information acquisition and loss of informational rents implemented in our design still applies.

We further fix the *type of information* which may be exchanged between our experimental lenders: lenders can exchange information about the types of borrowers in their home market, and they can do so only on a reciprocal basis. We measure the extent of voluntary information sharing by studying the frequency with which lenders use this available information sharing mechanism. In reality, the extent of information sharing depends not only on how many banks share information, but also on what type of information they exchange. Some credit registries and credit bureaus only enable the exchange of information on loan defaults ("negative information"), while others also facilitate the exchange of information on open credit lines, successful loan repayments and borrower characteristics ("positive information"). Obviously, it would be interesting to study not only how many lenders share information voluntarily, but also what type of information they would choose to share. In our experimental credit market, the only information worth exchanging relates to borrower types, as borrowers cannot default, and they cannot maintain multiple bank relationships.

Finally, in our design, lenders can *only exchange information by joining the credit bureau*. Obviously in real credit markets, lenders can and do share information through other formal channels (e.g., the exchange of information between branches of a bank through its IT system) and informal channels (e.g., phone calls between credit officers of different banks). The extent to which these alternative channels can overcome information asymmetries in the credit market depend on how well lenders are represented in different sectors of the credit market or how well-knit informal networks of credit officers are. In reality many lenders are specialized geographically or by product type (credit card companies, mortgage lenders). Moreover non-bank creditors (utilities, phone companies) also posses relevant information about the creditworthiness of firms and households. Thus, even in the presence of alternative channels, credit bureaus do enable a broader exchange of information between lenders. Our design captures this phenomenon in a most simple case by abstracting from alternative channels altogether.

2.4. Procedures

In total we conducted 20 experimental sessions, five for each of our four treatments. All experimental subjects were volunteers and each participant could only participate in one session (i.e., each subject experienced only one of the treatments). All sessions were conducted in June 2006 and participants were students at the University of Zurich or the ETH Zurich. The computerized experiment was programmed and conducted with the z-Tree experimental software (Fischbacher, 2007). A session lasted approximately ninety minutes. Subjects received a show-up fee of CHF 10 (CHF $1.2 \approx 1.00$ USD in June 2006) and, in addition, CHF 1 for every 150 points earned during the experiment. On average subjects earned CHF 55.

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. An English version of our instructions, the original German instructions, as well as the z-Tree codes are available upon request from the authors.

3. Results

3.1. Information sharing

We measure information sharing by the frequency with which lenders join the credit bureau. Table 2 displays summary statistics of this frequency by treatment. We find that in our two benchmark treatments information sharing is very close to the predicted outcome. In the "HighMobility–LowCompetition" treatment we expect all lenders to join the credit bureau. Our results show that on average 90% of all lenders in this treatment join the bureau. Moreover, information sharing is consistently high across all sessions in the treatment, with credit bureau participation ranging from

Table 2
Information sharing and information conditions.

	Session averages			Period averages			
	Mean	Max	Min	1–5	6–10	11–15	16–20
Panel A. HighMobility–LowCompetition treatment							
Join credit bureau	0.90	0.96	0.83	0.84	0.89	0.92	0.96
No lender informed	0.08	0.17	0.04	0.14	0.08	0.07	0.03
1 lender informed	0.15	0.21	0.08	0.19	0.18	0.15	0.09
2 lenders informed	0.77	0.89	0.63	0.67	0.74	0.78	0.88
Panel B. HighMobility–HighCompetition treatment							
Join credit bureau	0.86	0.91	0.78	0.84	0.87	0.86	0.85
No lender informed	0.11	0.15	0.08	0.12	0.12	0.09	0.11
1 lender informed	0.24	0.38	0.17	0.24	0.21	0.26	0.25
2 lenders informed	0.65	0.75	0.48	0.64	0.67	0.65	0.64
Panel C. LowMobility–LowCompetition treatment							
Join credit bureau	0.56	0.60	0.50	0.59	0.57	0.55	0.55
No lender informed	0.13	0.16	0.06	0.11	0.09	0.16	0.15
1 lender informed	0.65	0.70	0.60	0.61	0.67	0.64	0.69
2 lenders informed	0.22	0.28	0.15	0.28	0.24	0.20	0.16
Panel D. LowMobility–HighCompetition treatment							
Join credit bureau	0.47	0.53	0.43	0.42	0.50	0.48	0.50
No lender informed	0.14	0.20	0.08	0.18	0.12	0.11	0.15
1 lender informed	0.74	0.78	0.68	0.72	0.73	0.80	0.72
2 lenders informed	0.12	0.18	0.08	0.10	0.16	0.09	0.13

The table presents summary statistics for credit bureau participation and information conditions by treatment. For each statistic the table presents the relative frequency across the five sessions of each treatment, the highest relative frequency (max) and lowest relative frequency (min) of an individual session and relative frequencies for four different phases of the experiment (periods 1–5, 6–10, 11–15 and 16–20). *Join credit bureau* is the fraction of lenders who joined the credit bureau. *No lender informed* (1 lender informed) (2 lenders informed) is the relative frequency of cases in which none (1) (2) of the lenders who could lend to a particular sector could identify the entrepreneurs in that sector.

83% to 96%. In the "LowMobility–HighCompetition" treatment we expect only half the lenders to join the credit bureau. Our results show that on average 47% of all lenders in this treatment join the bureau, with credit bureau participation varying between 43% and 53% per session. In our two treatments where both full information sharing and partial information sharing are feasible we find two very different outcomes. In the "HighMobility–HighCompetition" treatment credit bureau participation is consistently high across sessions (78–91%), leading to an average information sharing frequency of 86%. In contrast, the "LowMobility–LowCompetition" treatment displays low levels of credit bureau participation across sessions (50–60%), leading to an average information sharing frequency of 56%.

The above results suggest first that adverse selection increases voluntary information sharing significantly. Comparing the "LowMobility–LowCompetition" to the "HighMobility–LowCompetition" treatment we see that an increase in borrower mobility α from .25 to .75 (while holding $T = 160$) raises the frequency of bureau participation from 56% to 90%. Comparing the "HighMobility–HighCompetition" to the "LowMobility–HighCompetition" treatment, we see that a similar increase in borrower mobility (while holding $T = 60$) raises credit bureau participation from 47% to 86%. Table 2 shows that all five sessions of the "HighMobility–LowCompetition" treatment display higher bureau participation than any of the five sessions of the "LowMobility–LowCompetition" treatment. Likewise, all five sessions of the "HighMobility–HighCompetition" treatment display higher bureau participation than any of the five sessions of the "LowMobility–HighCompetition" treatment. For both comparisons therefore, one-sided Mann–Whitney tests based on session averages confirm that information sharing is significantly more frequent under high borrower mobility ($p = .004$).

Second, our results suggest that an increase in lender competition reduces voluntary information sharing. Comparing the "LowMobility–LowCompetition" to the "LowMobility–HighCompetition" treatment, we see that reducing transaction costs from $T = 160$ to $T = 60$ (while maintaining bor-

rower mobility at $\alpha = .25$) reduces the frequency of information sharing from 56% to 47%. A one-sided Mann–Whitney test based on session observations suggests that the difference between the two treatments is significant ($p = .008$).[14] Comparing the "HighMobility–LowCompetition" to the "HighMobility–HighCompetition" treatment, we see that an identical reduction in transaction costs (while holding borrower mobility high) reduces the frequency of information sharing from 90% to 86%. Non-parametric tests suggest however that this difference is not significant.[15]

Third, the outcome of the "HighMobility–HighCompetition" and "LowMobility–LowCompetition" treatments suggests that when information sharing is subject to potential coordination failure, adverse selection is much stronger than lender competition in coordinating actual lender behavior. Credit bureau participation in the "HighMobility–HighCompetition" treatment (86%) is similarly high to that of the "HighMobility–LowCompetition" treatment (90%), while it is significantly higher than in the "LowMobility–HighCompetition" treatment (47%). Likewise the outcome of the "LowMobility–LowCompetition" treatment (56%) is similarly low to that of the "LowMobility–HighCompetition" treatment (47%), while it is substantially lower than that of the "HighMobility–LowCompetition" treatment (90%). Thus in both treatments where multiple equilibria are feasible the actual outcome seems to be driven by the level of borrower mobility, while it is hardly influenced by the degree of lender competition.

Does the high frequency of information sharing in our two treatments with high mobility allow lenders to overcome the greater degree of inherent adverse selection in these treatments? Our results suggest that it does. Table 2 presents the information conditions in each treatment after information sharing decisions have been made and nature has determined whether entrepreneurs switch locations. The table displays the share of sectors for which no lender, one lender or both lenders which can lend to the sector can identify the entrepreneur types in the sector. We find that the share of sectors for which no lender can identify the entrepreneur types is similarly low across treatments. In particular, we find that in treatments with high mobility there are not more instances in which neither lender is informed about entrepreneur types.

Due to stronger credit bureau participation, the information conditions and thus market power of lenders differ significantly in high-mobility treatments compared to low mobility treatments. Table 2 shows that the share of sectors in which both lenders are informed about entrepreneurs, and thus competition for the good entrepreneur is strong, is substantially higher in the "HighMobility–LowCompetition" than in the "LowMobility–LowCompetition" treatment (77% versus 22%). The frequency of two informed lenders is also higher in the "HighMobility–HighCompetition" than in the "LowMobility–HighCompetition" treatment (65% versus 12%). A comparison of session averages suggests that these differences in information and thus competitive conditions at the lending stage are statistically significant.[16]

The results from Table 2 show that our experiment does capture the two key impacts of information sharing on credit markets: a reduction of information asymmetries and an endogenous increase in competition among lenders.

3.2. Lending

The volume and quality of lending hardly differs across treatments in our experiment. On average, each lender extends roughly 1 loan per period in all treatments. Table 3 shows that the number of

[14] In the "LowMobility–LowCompetition" treatment the frequency of information sharing in the five sessions is .50, .55, .56, .60, .60, respectively,. In the "LowMobility–HighCompetition" treatment the frequency of information sharing in the five sessions is .43, .44, .48, .49, .52, respectively. A one-sided Mann–Whitney test based on session observations thus yields a coefficient of $p = .008$.

[15] In the "HighMobility–LowCompetition" treatment the frequency of information sharing in the five sessions is .82, .89, .90, .93, .96, respectively. In the "HighMobility–HighCompetition" treatment the frequency of information sharing in the five sessions is .78, .83, .87, .88, .91, respectively. A one-sided Mann–Whitney test based on session observations thus yields a coefficient of $p = .111$.

[16] All five sessions of the "HighMobility–LowCompetition" treatment display more incidences of two informed lenders than any session of the "LowMobility–LowCompetition" treatment. Likewise, all five sessions of the "HighMobility–HighCompetition" treatment display more incidences of two informed lenders than any session of the "LowMobility–HighCompetition" treatment. For both comparisons therefore, one-sided Mann–Whitney tests based on session averages confirm that the incidence of two informed lenders is more frequent under high borrower mobility ($p = .004$).

Table 3
Lending.

	Session averages			Period averages			
	Mean	Max	Min	1–5	6–10	11–15	16–20
Panel A. HighMobility–LowCompetition treatment							
Loans	0.95	0.98	0.91	0.92	0.95	0.95	0.98
% to good Entrepreneur	95.9	97.9	90.4	92.4	96.8	96.5	97.6
Repayment–competition	238	251	219	226	238	244	243
Repayment–monopoly	288	299	277	285	293	283	295
Profits	289	304	268	270	287	293	307
Panel B. HighMobility—HighCompetition treatment							
Loans	0.98	1.03	0.93	0.94	0.98	0.98	1.00
% to good Entrepreneur	89.6	87.5	88.7	91.5	89.2	91.2	86.7
Repayment–competition	175	179	171	186	174	171	167
Repayment–monopoly	283	293	269	279	286	289	284
Profits	266	277	256	270	259	269	265
Panel C. LowMobility–LowCompetition treatment							
Loans	0.91	0.98	0.89	0.92	0.94	0.90	0.90
% to good Entrepreneur	94.4	94.0	93.9	95.6	95.4	92.3	94.4
Repayment–competition	234	249	213	225	240	238	247
Repayment–monopoly	296	298	291	287	298	300	300
Profits	330	333	328	321	332	328	340
Panel D. LowMobility–HighCompetition treatment							
Loans	0.93	0.97	0.88	0.89	0.94	0.96	0.92
% to good Entrepreneur	90.9	94.4	89.2	91.4	90.8	91.0	90.6
Repayment–competition	179	186	170	180	178	179	181
Repayment–monopoly	294	297	290	287	296	297	297
Profits	340	350	331	328	340	351	341

The table presents summary statistics of lending behavior by treatment. For each statistic the table presents the mean value across the five sessions of each treatment, the highest mean value (max) and lowest mean value (min) of an individual session, and mean values for four different phases of the experiment (periods 1–5, 6–10, 11–15 and 16–20). *Loan* is the average number of loans extended per lender and period. *% to good Entrepreneur* is the fraction of loans that was extended to a borrower which the lender could identify as good. *Repayment - competition* (*Repayment–monopoly*) is the repayment paid on loans by good borrowers, when one (both) lenders in the region could identify the borrowers type. *Profits* stands for the payoffs of lender per period.

loans varies slightly across treatments, but non-parametric tests suggest that these differences between treatments are insignificant.[17] The quality of lending is extremely high in all treatments. The vast majority of loans (between 90% and 96% per treatment) are made to entrepreneurs which the lender can identify as the good type. The remaining loans are extended to entrepreneurs which are of unknown type to the lender.[18] The almost exclusive lending to entrepreneurs which were known to be of the good type is constant over the course of our experiment. Table 3 shows that already in the initial five periods of the experiment more than 90% of all loans were made to good entrepreneurs. This finding confirms that from the outset lenders were very much aware of the inherent information problem in our experiment.

While lenders in high-mobility treatments extend similar credit to those in low-mobility treatments, they do earn substantially less from these loans. On average, lenders earn 41 points more per period in the "LowMobility–LowCompetition" treatment than in the "HighMobility–LowCompeti-

[17] In the "HighMobility–LowCompetition" treatment the average number of loans per period and lender is .91, .95, .95, .96, .98, respectively. In the "HighMobility–HighCompetition" treatment this is .93, .94, .99, .99, 1.03, respectively. In the "LowMobility–LowCompetition" treatment this is .89, .90, .90, .90, .98, respectively. In the "LowMobility–HighCompetition" treatment this is .88, .90, .93, .96, .97, respectively. Two-sided Mann–Whitney tests based on session observations thus yield coefficients of $p = .42$ ("HighMobility–LowCompetition" versus "HighMobility–HighCompetition"), $p = .546$ ("LowMobility–LowCompetition" versus "LowMobility–HighCompetition"), $p = .15$ ("HighMobility–LowCompetition" versus "LowMobility–LowCompetition"), and $p = .15$ ("HighMobility–HighCompetition" versus "LowMobility–HighCompetition").

[18] There were only very few cases in which lenders actually lent to identified bad borrowers (17 of the total 4524 loans made in the experiment).

tion" treatment. Further, lenders earn 74 points more per period in the "LowMobility–HighCompetition" treatment than in the "HighMobility–HighCompetition" treatment. Non-parametric tests confirm that these differences are statistically significant in both comparisons.[19]

The reason why lenders earn lower profits in high-mobility treatments is that due to strong credit bureau participation they less often have proprietary information about a good entrepreneur in their region. This implies stronger competition for good entrepreneurs, and thus lower repayments and profits. The summary statistics in Table 3 display the mean repayments received by lenders on loans to good borrowers. If only one lender in a region knows that a particular borrower is good, then we expect him to demand the maximum repayment of 300 (this was the certain investment earning of good borrowers). If, in contrast, both lenders in a region can identify a good borrower, competition drives repayment demands down. Due to transaction costs T of lending across sector borders, the lowest repayment which the lender in the other sector of the region can demand (and make non-negative profits) is $100 + T$. If both lenders can identify the same good borrower, competition should thus lower repayment demands to $100 + T$. In the "High Competition" treatments ($T = 60$) this implies a level of 160, while in the "Low Competition" treatments ($T = 160$) it implies a repayment level of 260. Table 3 shows that in all four treatments, lenders demand repayments very close to 300, if they alone can identify the good entrepreneur. The table shows that repayments under such "information monopoly" do rise slightly over time, suggesting that lenders' awareness of the consequences of an information monopoly improves over time. However, even in the first five periods of the experiment, the mean repayment demanded under information monopoly is 285, and thus quite close to the predicted outcome. Table 3 further shows that repayments demanded from good entrepreneurs are close to competitive levels, when both lenders in a region can identify the type of the entrepreneur. In our two treatments with high transaction costs mean repayments under competitive information conditions is slightly lower than predicted (234 resp. 238 versus 260). However, the table shows that repayments do approach the predicted level over time. In our two treatments with low transaction costs, mean repayments under competitive information conditions are slightly higher than predicted (175 resp. 179 versus 160), but here again, at least in one treatment repayments approach the predicted level over time.

3.3. Coordinating information sharing

The results presented in Table 2 raise one major question: Why does credit bureau participation differ so strongly between the "HighMobility–HighCompetition" and the "LowMobility–LowCompetition" treatment, although full and partial information sharing are equally feasible in both treatments. Our predictions suggest that in the "HighMobility–HighCompetition" and the "LowMobility–LowCompetition" treatment it is payoff-maximizing for the two lenders in region A to join the credit bureau, if they expect that the two non-competing lenders in region B also join. If, however, they believe that only one non-competitor from region B joins the credit bureau, then only the first-mover lender in region A should join. According to our theory, therefore, full information sharing may emerge in the "HighMobility–HighCompetition" because in this treatment second-mover lenders coordinate on full sharing of information. In contrast, it seems that in the "LowMobility–LowCompetition" treatment second-mover lenders coordinate on partial information sharing.

Table 2 suggests that lenders in the "HighMobility–HighCompetition" coordinate on full information sharing right from the outset of the experiment. In contrast lenders in the "LowMobility–LowCompetition" treatment coordinate from the outset on partial information sharing. The table shows the frequency of credit bureau participation for four different phases of the experiment: periods 1–5, periods 6–10, periods 11–15, and periods 16–20. In the "HighMobility–HighCompetition" treatment, credit bureau participation in the initial phase for the experiment is 84% and remains at roughly this level throughout. Information sharing in the "LowMobility–LowCompetition" treatment is already

[19] All five sessions of the "HighMobility-LowCompetition" treatment display lower per period lender profits than any of the five sessions of the "LowMobility–LowCompetition" treatment. Likewise, all five sessions of the "HighMobility–HighCompetition" treatment display lower lender profits than any of the five sessions of the "LowMobility–HighCompetition" treatment. A one-sided Mann–Whitney Test based on session averages therefore confirms in both cases that information sharing is more prevalent under high borrower mobility ($p = .004$).

substantially lower than in the "HighMobility–HighCompetition" treatment in the initial phase of the experiment (59%). This suggests a strong difference in coordination of lender behavior right from the outset of the experiment.

How can we explain the different coordination patterns in these two treatments? Economic theory and experimental evidence suggests that focal points generated by the payoff structure of our game may affect equilibrium choice in coordination games. In particular subjects may coordinate on the payoff-dominant or the risk-dominant equilibrium. Since first-mover lenders join the credit bureau in the full-sharing and the partial-sharing equilibria, the equilibrium is selected by the choices of the second-mover lenders. Taking the first-mover decision as given, we can reduce the decision framework to a two-player coordination game between the second-mover lenders. This two-player game has two equilibria: either both second-mover lenders join (full sharing) or both second-mover lenders do not join (partial sharing). In Appendix A.3 we examine the characteristics of these equilibria in more detail. We show there that payoff-dominance implies, that the second-mover lenders would always join the credit bureau in both treatments. This is not what we observe. Risk-dominance (i.e., the choice of the equilibrium which yields higher expected payoffs, when the players expect that the other player randomizes between the two equilibrium strategies) does not select an equilibrium in the "LowMobility–LowCompetition" treatment, but predicts that second-mover lenders do not join the bureau in the "HighMobility–HighCompetition" treatment. This is also not in line with our findings. Thus, neither payoff-dominance nor risk-dominance can explain the observed coordination pattern. Alternatively, since each participant in our experiment plays the game for 20 periods and randomly switches between first-mover and second-mover positions across periods, one could also argue that lenders may focus on the equilibrium which maximizes the average payoff of all four lenders. However, since this would imply that the partial-sharing equilibrium is chosen in both treatments, it does not match the pattern observed in the experiment either.

Alternatively, equilibrium selection may be directly determined by what the lenders consider to be the most important feature concerning their decision to participate in the credit bureau: the degree of adverse selection or the intensity of lender competition.[20] If lenders primarily focus on the degree of adverse selection and the necessity to acquire information about potential future borrowers, then we would expect the outcome as observed in our experiment: in the "HighMobility–HighCompetition" treatment lenders coordinate to share information fully, while in the "LowMobility–LowCompetition" they do not. If the intensity of lender competition were dominant in coordinating information sharing behavior, then we would expect the opposite outcome: in the "LowMobility–LowCompetition" treatment lenders would coordinate to share information fully, while in the "HighMobility–HighCompetition" they would not.

Responses to post-experimental questionnaires support the conjecture that the degree of adverse selection is key to the coordination of credit bureau participation in our experiment. After each session we asked the participant a free-form question about their joining decision as a second-mover lender: "Did you join the credit bureau if the other lender in your region could make his joining decision first? If yes, why? If no, why not?" We categorized the participants' answers as follows: Primary focus on information acquisition (Information), primary focus on competition (Competition), equal weight on information and competition (Equal) and answers which were neither related to information acquisition nor to competition (Others). Table 4 reports the percentage of answers in each category for all four treatments. The table reveals that when borrower mobility is high, then the majority of lenders (78% in case of low competition, 67% in case of high competition) focus on information acquisition and only few borrowers consider the detrimental effects of competition on profits as most important (2% in case of low competition, 5% in case of high competition). Competition only becomes a primary concern if borrower mobility is low (54% in case of low competition, 60% in case of high competition). Thus, equilibrium selection in our experiment seems to be driven by the fact, that most borrowers primarily focus on the necessity to acquire information and only worry about the effects of stronger competition if the lack of necessary information is unlikely to be a problem.

[20] The literature on the "false consensus effect" and "social projection" suggests that people tend to assume that everyone else thinks and behaves the same way they do (see e.g., Mullen et al., 1985).

Table 4
Post-experimental questionnaire (second-mover lender decision).

Treatment	Information	Equal	Competition	Others	# Obs.
HighMobility–LowCompetition	0.78	0.05	0.02	0.15	60
HighMobility–HighCompetition	0.67	0.17	0.05	0.12	60
LowMobility–LowCompetition	0.35	0.02	0.54	0.08	48
LowMobility–HighCompetition	0.13	0.10	0.60	0.17	60

The table summarizes responses to the post-experimental free-form question: "Did you join the credit bureau if the other lender in your region could make his joining decision first? If yes, why? If no, why not?". Responses have been categorized as follows: The category *Information* (*Competition*) contains responses which revealed a primary focus on information acquisition (the negative payoff consequences of competition). The category *Equal* contains responses which expressed an equal concern for information and competition. The category *Others* contains all answers which did not relate to the acquisition of information or competition. The reported numbers are relative frequencies. Due to a computer crash we lost the responses to the questionnaire in one session of the "LowMobility–LowCompetition" treatment.

4. Conclusions

We examine how adverse selection and competition in the credit market affect voluntary information sharing between lenders. Our experimental results confirm that lenders are more likely to engage in information sharing when they face strong information asymmetries. Lenders are less likely to share information when credit market competition is intense. Our results further suggest that in credit markets with potential coordination failure among lenders the degree of adverse selection has much stronger coordination effect on information sharing behavior than that of lender competition.

Our findings may help explain a puzzling development in credit markets over the past two decades: Voluntary information sharing through private credit bureaus has grown most rapidly in the consumer credit market, despite the fact that this market is highly competitive in most countries. Our results suggest that information sharing may be high in the consumer credit market despite strong competition, because due to borrower mobility, etc. this market segment is subject to substantial information asymmetries. Under these circumstances, our findings suggest that potential adverse selection may drive information sharing behavior, while lender competition may only be of secondary importance.

Acknowledgments

We thank two anonymous referees, Inessa Love, Paolo Mistrulli, Nataliya Mylenko, Steven Ongena, and Juan Ignacio Pena, as well as seminar participants at the University of Tilburg, University of Zurich, HEC Lausanne, the 2007 FMA European conference, the 2007 EEA annual meeting and the 2008 World Bank conference on Small Business Finance for helpful comments. We further thank Franziska Heusi for providing excellent research assistance. Zehnder gratefully acknowledges financial support by the national center of competence in research on "Financial Valuation and Risk Management". The national centers in research are managed by the Swiss National Science Foundation on behalf of the federal authorities. The views expressed in this paper do not necessarily reflect those of the Swiss National Bank.

Appendix A

In this appendix we provide a formal derivation of the predictions presented in Section 2.2. In Section A.1 we assume that all lenders are risk-neutral. We apply backward induction to solve for the full set of pure strategy equilibria for our experiment, depending on the mobility of entrepreneurs α and the degree of intra-regional competition determined by T. In Section A.2 we show that the assumption of risk-neutrality is not crucial for our predictions. We illustrate that it is rather unlikely that our participants are risk-averse enough to alter the equilibrium predictions derived under risk-neutrality for our four treatments. Section A.3 contains the formal analysis of the two-player coordination game between second-mover lenders discussed in Section 3.3.

A.1. Risk-neutral lenders

Step 1: Credit

Lemma 1 characterizes the lender's offering strategy depending his own information about an entrepreneur and the information of his competitor in the same region.

Lemma 1 (*lending*). (i) *If the lender either knows that entrepreneur i is bad or does not have information about entrepreneur i's type, he does not make a credit offer.* (ii) *If the lender knows that entrepreneur i is good and his competitor does not know entrepreneur i's type, he will demand the maximum repayment* $\widetilde{R}_i = Y_g = 300$. *In this case, the lender's profit from the contract with entrepreneur i is either* $\pi_i^L = Y_g - I = 200$, *if entrepreneur i is in the lender's home sector, or* $\pi_i^L = 200 - T$ *if entrepreneur i is in the other sector of the region.* (iii) *If the lender knows that entrepreneur i is good and his competitor also has this information, the lender will make an offer with a requested repayment* $\widetilde{R}_i = I + T = 100 + T$. *If entrepreneur i is located in the lender's home sector, the lender's profit from the contract with entrepreneur i is* $\pi_i^L = T$. *If entrepreneur i is located in the other sector of the region the competitor gets the contract.*

Proof. (i) A credit offer to an entrepreneur known to be bad, yields a certain loss of $I = 100$ if the entrepreneur is situated in the lender's own sector, and a loss of $100 + T$ if the entrepreneur is in the other sector of the region. The expected profit from lending to an unidentified entrepreneur is maximally $\pi_i^L = .25 \cdot Y_g - I = -25$ if the entrepreneur is located in the lender's own sector, or maximally $\pi_i^L = -25 - T$ if the entrepreneur is in the other sector of the region.

(ii) If a lender is the only lender in his region who knows that a particular entrepreneur *i* is good, he knows that the entrepreneur will receive no credit offer from his competitor. Therefore he will demand the maximum repayment $\widetilde{R}_i = Y_g = 300$. Since this is the only offer entrepreneur *i* gets, he accepts it.

(iii) If both lenders in a region know that entrepreneur *i* is good, price competition implies that each lender will make an offer with a requested repayment $\widetilde{R}_i = I + T = 100 + T$, which is the lowest profitable offer the "outside" lender can make.[21] By assumption, entrepreneurs always accept the offer of the home lender, in the event of identical repayment requests. □

Step 2: Information sharing

Decisions to join the credit bureau are made sequentially within regions and simultaneously across regions. Lemma 2 characterizes the best-response behavior of a second-mover lender, given the decision of his competitor and the (unknown) behavior of the non-competing lenders.

Lemma 2 (*second-mover behavior*). (i) *If the first-mover lender in a region does not join the credit bureau, the second-mover lender is strictly better off by joining, if at least one non-competing lender also joins. If no other lender joins, then the second-mover lender is indifferent between joining and not.* (ii) *If the first-mover lender in a region does join the credit bureau, then the second-mover lender is better off by joining only if* $(Y_g - I)(1 - \alpha) \leqslant (1 - \alpha + \gamma\alpha)T$, *where* $\gamma \in \{0; .5; 1\}$ *is the share of non-competing lenders from the other region that join.*

Proof. (i) (first-mover does not join the credit bureau). We first calculate the second-mover lender's profit if he does not join the credit bureau. If entrepreneurs do not switch regions, the second-mover lender will conclude a credit contract with the good entrepreneur in his home market and earn a payoff of $\pi^L = (Y_g - I)$. If the entrepreneurs do switch regions, the second-mover lender has no information on any entrepreneurs in his region and will not lend. As entrepreneurs switch with probability α, the expected payoff from not joining is $E\pi^L = (1 - \alpha)(Y_g - I)$. Next, we calculate the second-mover len-

[21] For this we need to assume that outside lenders do not play weakly dominated strategies. Otherwise every requested repayment between $\widetilde{R}_i = I + T = 100$ and $\widetilde{R}_i = I + T = 100 + T$ could be sustained as an equilibrium. This assumption is standard in Bertrand competition with heterogenous costs (see Tirole, 1988, pp. 211 and 234). Furthermore, we ignore the fact that repayments need to be integers in our experiment. If this was taken into account, our analysis would remain the same except that excluding equilibria based on weakly dominated strategies would imply that both lenders make an offer with a requested repayment $\widetilde{R}_i = I + T + 1 = 100 + T + 1$.

der's profit if he joins the credit bureau. If entrepreneurs do not switch, the second-mover lender still earns $\pi^L = (Y_g - I)$ as his competitor has no information on the entrepreneurs in the lender's sector. If entrepreneurs do switch, the second-mover lender's payoff depends on the joining decisions of the two non-competing lenders. If neither of the lenders in the other region joins, the second-mover lender has no information about entrepreneurs in his region and will not lend. If one of the two lenders in the other region joins, then he has information about the entrepreneurs in one sector of his region and can conclude a credit contract with the good type. This yields a payoff of either $\pi^L = (Y_g - I)$ or $\pi^L = (Y_g - I - T)$, depending on the sector to which the known entrepreneurs move. If both lenders in the other region join, then the lender knows all good entrepreneurs who come to his region and his payoff from joining is $\pi^L = (Y_g - I) + (Y_g - I - T)$. Summarizing, the second-mover lender's expected payoff is given by the following expression, $(1-\alpha)(Y_g - I) + \alpha\gamma(Y_g - I + Y_g - I - T)$, where $\gamma \in \{0; 0.5; 1\}$ is the fraction of joining lenders in the other region. Comparing the expected payoffs from joining and not joining implies that the second-mover lender is indifferent if both lenders in the other region do not join. But, if either one or both of the lenders in the other region join, then the lender is strictly better off by joining.

(ii) (first-mover joins the credit bureau). If the second-mover lender does not join the credit bureau he will, as above, earn a payoff of $\pi^L = (Y_g - I)$ with the probability $(1-\alpha)$. If the second-mover lender does join and entrepreneurs do not switch he will now only earn a payoff of $\pi^L = T$, as his competitor also has information on entrepreneurs in both sectors. If the second-mover lender does join and entrepreneurs switch, then the following outcomes are possible: He earns a payoff of 0 if neither of the two non-competing lenders joins and he therefore does not have information on any entrepreneurs in his region. If one of the two lenders in the other region joins, then the second-mover lender earns either a payoff of $\pi^L = T$ or $\pi^L = 0$, depending on the sector to which the known entrepreneurs from the other region move. If both lenders in the other region join, then the lender's payoff is given by $\pi^L = T$, as he can conclude a credit contract with the good entrepreneur who moves to his sector. Summarizing, the expected profit from joining is given by $E\pi^L = (1-\alpha)T + \alpha\gamma T$, where $\gamma \in \{0; 0.5; 1\}$ is the fraction of lenders in the other region who join. If the first-mover lender does join the credit bureau it is therefore a best-response for the second-mover lender to join if and only if $(1 - \alpha + \alpha\gamma)T > (1-\alpha)(Y_g - I)$. □

Having characterized the best-response behavior of the second-mover in each region, we can now characterize profit-maximizing behavior of the first-mover:

Lemma 3 (*first-mover behavior*). (i) *The first-mover lender in a region is better off by joining the credit bureau if at least one non-competing lender also joins.* (ii) *If no non-competing lender joins, the first-mover lender is indifferent between joining and not.*

Proof. (i) Lemma 2 implies that if the first-mover lender joins the credit bureau, he anticipates that the second-mover lender also joins if $(Y_g - I)(1-\alpha) \leqslant (1 - \alpha + \gamma\alpha)T$, where $\gamma \in \{0; .5; 1\}$ is the share of non-competing lenders that join. Since the first-mover lender's expected payoff depends in the same way on the second-mover lender's joining behavior as vice versa, we can use Lemma 2 to determine the first-mover lender's incentive to join the credit bureau. Part (i) of Lemma 2 implies that if conditions are such that the second-mover lender does not join if the first-mover lender joins, the first-mover lender is strictly better off by joining if at least one of the non-competing lenders also joins. Part (ii) of Lemma 2 implies that if conditions are such that the second-mover lender also joins if the first-mover lender joins, the first-mover lender is also better off by joining (notice that this case can only occur if $\gamma > 0$).

(ii) If no non-competing lender joins, there are no gains from joining. However, since Part (ii) of Lemma 2 implies that the second-mover lender does not join if the first-mover lender joins in this case, the first-mover lender also does not loose anything from joining. □

Step 3: Equilibria

Lemmas 2 and 3 allow us to characterize the full set of Nash equilibria for our experiment, depending on the "mobility" of entrepreneurs α and intra-regional transaction costs T. For all combinations of

parameters there exists an equilibrium in which no lender joins the credit bureau. If no other lender joins the credit bureau it is a (weakly) best-response for the remaining lender not to join as well. However, since the no sharing equilibrium is based on weakly dominated strategies, we neglect this equilibrium in the paper.

Proposition 1 summarizes the conditions under which full sharing of information (both the first-mover and second-mover lender per region join the credit bureau) can be sustained.

Proposition 1. *There exists a Nash equilibrium in which all lenders join the credit bureau with certainty if and only if* $(Y_g - I)(1-\alpha) \leqslant T$.

Proof. If both lenders in region B join the credit bureau we have $\gamma = 1$. Now consider the best-response of the second-mover lender in region A if the first-mover has joined the credit bureau. From Lemma 2 we know that with $\gamma = 1$ the best-response for the lender is to join if $(Y_g - I)(1-\alpha) \leqslant T$. Furthermore, from Lemma 3 we know that if both non-competing lenders join the credit bureau, the first-mover lender is strictly better off by joining as well. □

Proposition 2 summarizes the conditions under which partial sharing of information can be sustained in equilibrium; i.e., only the first-mover lender per region joins the credit bureau.

Proposition 2. *There exists a Nash equilibrium in which only the first-mover lender per region joins the credit bureau if and only if* $(Y_g - I)(1-\alpha) > (1-\frac{1}{2}\alpha)T$.

Proof. Suppose that one non-competing lender joins the credit bureau so that $\gamma = \frac{1}{2}$. Now consider the best-response of the second-mover lender if the first-mover has joined the credit bureau. From Lemma 2 it is clear that with $\gamma = \frac{1}{2}$ the best-response for the lender is not to join if $(Y_g - I)(1-\alpha) > (1-\frac{1}{2}\alpha)T$. From Lemma 3 we further know that if one non-competing lender joins the credit bureau, the first-mover lender is strictly better off by joining as well. □

Implications

Comparing Propositions 1 and 2 we see that there exists a range of parameters $(G-I)(1-\alpha) < T < (G-I)(1-\alpha)\frac{2}{2-\alpha}$ for which both full sharing and partial sharing of information among lenders is feasible.[22] This implies that even when full information sharing can be sustained, partial information sharing may arise due to a "coordination failure" among non-competing lenders.

Applying Proposition 1 we see that a full-sharing equilibrium, in which both lenders in each region join the credit bureau, is feasible in three of our four treatments. The condition $(Y_g - I)(1-\alpha) \leqslant T$ is fulfilled in the "LowMobility–LowCompetition" treatment $(\alpha = .25,\ T = 160)$, in the "HighMobility–HighCompetition" treatment $(\alpha = .75,\ T = 60)$, and in the "HighMobility–LowCompetition" treatment $(\alpha = .75,\ T = 160)$. Full sharing is, however, not feasible in our "LowMobility–HighCompetition" treatment $(\alpha = .25,\ T = 60)$. By applying Proposition 2 we further see that a partial-sharing equilibrium, i.e., only 1 lender per region joins the credit bureau, is feasible in three of our four treatments. The condition $(Y_g - I)(1-\alpha) \geqslant (1-\frac{1}{2}\alpha)T$ is fulfilled in the "LowMobility–LowCompetition", "HighMobility–HighCompetition", and "LowMobility–HighCompetition" treatments. Partial sharing is, however, not feasible in our "HighMobility–LowCompetition" treatment.

Fig. A1 displays the set of feasible equilibria depending on entrepreneur's mobility and the degree of lender competition. The figure also illustrates our choice of treatments.

A.2. Risk-averse lenders

In this section we analyze how risk aversion of lenders affects our predictions for the experiment. In order to assess lender utilities we apply the result of decision theory that a risk-averse decision maker's certainty equivalent (CE) for a random income with expected value $\overline{X}$ and variance $V(X)$ can be

[22] For the same range of parameters there also exists one mixed-strategy equilibrium. In this equilibrium the first-movers in both regions join the bureau, while the second-movers both join with a positive probability.

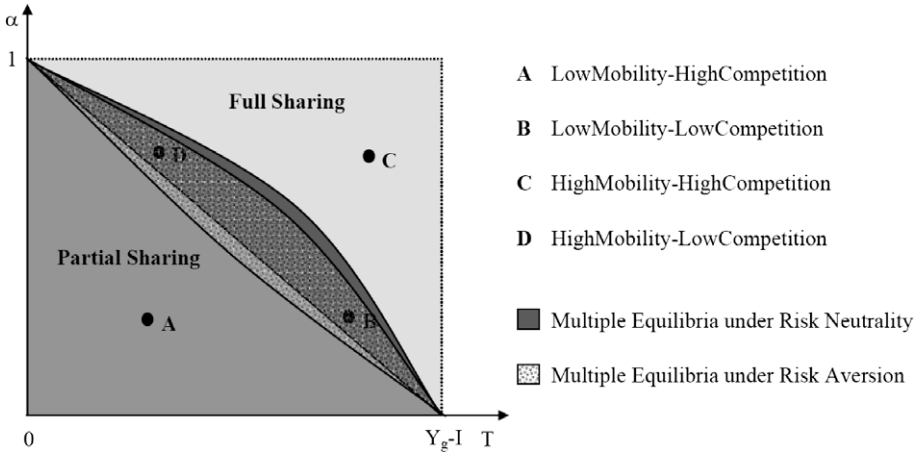

Fig. A1. Market equilibria under risk-neutrality and risk aversion. The figure displays the predictions for all possible combinations of switching probabilities α and intra-regional transaction costs T. The light (intermediate) area represents the set of parameter constellations, under which only partial (full) information sharing can be sustained in equilibrium. Parameter constellations in the dark area allow for multiple equilibria, i.e., both, full and partial information sharing are feasible. A, B, C and D show the location of our four treatment conditions in the experiment. The figure also shows how a moderate degree of risk aversion affects the set of parameter constellations under which multiple equilibria are feasible. For higher degrees of risk aversion the set of parameter constellations with multiple equilibria shifts further to the left. However, in order for A and B to drop out of this set, extreme degrees of risk aversion are necessary (see Observation 2 in the appendix for more details).

approximated as $CE = \overline{X} - \frac{1}{2}r(\overline{X})V(X)$, where r is the coefficient of absolute risk aversion. For simplicity we assume that r is constant and identical for all lenders.

Lemma 2′ (*second-mover behavior under risk aversion*). (i) *If the first-mover lender in a region does not join the credit bureau, the second-mover lender is strictly better off by joining if at least one non-competing lender also joins. If no other lender joins, then the second-mover lender is indifferent between joining and not.* (ii) *If the first-mover lender in a region does join the credit bureau, then the second-mover lender is better off by joining only if* $(1-\alpha)(Y_g - I) - \frac{1}{2}r\alpha(1-\alpha)(Y_g - I)^2 \leqslant (1-\alpha+\gamma\alpha)T - \frac{1}{2}r(1-\gamma)\alpha(1-(1-\gamma)\alpha)T^2$, *where r is the coefficient of absolute risk aversion and* $\gamma \in \{0; 0.5; 1\}$ *is the share of non-competing lenders from the other region that join.*

Proof. (i) Assume that the first-mover lender does not join the credit bureau. From the Proof of Lemma 1 we know that the expected payoff from not joining is $E\pi^L = (1-\alpha)(Y_g - I)$, while the expected payoff from joining is $(1-\alpha)(Y_g - I) + \alpha\gamma(Y_g - I + Y_g - I - T)$. Since $Y_g - I - T > 0$ any monotonically increasing utility function $u(\cdot)$ implies that the second-mover lender is indifferent if $\gamma = 0$ and strictly better off by joining if $\gamma \in \{0.5; 1\}$.

(ii) Assume that the first-mover lender joins the credit bureau. If the second-mover lender does not join the credit bureau he earns a payoff of $\pi^L = (Y_g - I)$ with the probability $(1-\alpha)$. Accordingly, his certainty equivalent for this choice is given by: $CE = (1-\alpha)(Y_g - I) - \frac{1}{2}r\alpha(1-\alpha)(Y_g - I)^2$. If the second-mover lender joins the credit bureau, his expected payoff depends on the fraction of lenders in the other region who join γ: $E\pi^L = (1-\alpha)T + \alpha\gamma T$. We can write the certainty equivalent as a function of γ in the following way: $(1-\alpha+\gamma\alpha)T - \frac{1}{2}r(1-\gamma)\alpha(1-(1-\gamma)\alpha)T^2$. If the first-mover lender does join the credit bureau it is therefore a best response for the second-mover lender to join if and only if $(1-\alpha)(Y_g - I) - \frac{1}{2}r\alpha(1-\alpha)(Y_g - I)^2 \leqslant (1-\alpha+\gamma\alpha)T - \frac{1}{2}r(1-\gamma)\alpha(1-(1-\gamma)\alpha)T^2$. □

Lemma 3′ (*first-mover behavior with risk aversion*). (i) *The first-mover lender in a region is strictly better off by joining the credit bureau if at least one non-competing lender also joins.* (ii) *If no non-competing lender joins, the first-mover lender is indifferent between joining and not.*

Proof. The sequence of arguments is identical to that for the Proof of Lemma 3. □

Proposition 1′. *If lenders are risk-averse, there exists a Nash equilibrium in which all lenders join the credit bureau with certainty if and only if* $(1-\alpha)(Y_g-I)-\frac{1}{2}r\alpha(1-\alpha)(Y_g-I)^2 \leqslant T$.

Proof. The sequence of arguments is identical to that for the Proof of Proposition 1. □

Proposition 2′. *If lenders are risk-averse, there exists a Nash equilibrium in which only the first-mover lender per region joins the credit bureau if and only if* $(1-\alpha)(Y_g-I)-\frac{1}{2}r\alpha(1-\alpha)(Y_g-I)^2 > (1-\frac{1}{2}\alpha)T-\frac{1}{2}r\frac{1}{2}\alpha(1-\frac{1}{2}\alpha)T^2$.

Proof. The sequence of arguments is identical to that for the Proof of Proposition 2. □

Implications

Observation 1 describes how the presence of risk aversion of lenders changes the sets of parameter constellations for which full information sharing and/or partial information sharing are feasible. Observation 2 shows that it is rather unlikely that the participants in our experiment are risk-averse enough to alter the equilibrium predictions for our four treatments.

Observation 1

(i) The set of parameter constellations for which full information sharing is feasible in equilibrium becomes larger when lenders are more risk-averse. Specifically, for a given degree of borrower mobility $\alpha \in (0,1)$ full information sharing is feasible under stronger competition if lenders are more risk-averse. (ii) The set of parameter constellations for which partial information sharing is feasible in equilibrium becomes smaller when lenders are more risk-averse. Specifically, for a given degree of borrower mobility $\alpha \in (0,1)$ the feasibility of partial information sharing requires stronger competition if lenders are more risk-averse.

(For a graphical representation of Observation 1 see Fig. A1.)

Proof. (i) Consider the condition for the feasibility of full information sharing in Proposition 1′: Proposition 1′ defines the minimal costs of inter-sectoral lending T for each degree of borrower mobility α, such that full information sharing can be sustained in equilibrium: $T \geqslant (1-\alpha)(Y_g-I)-\frac{1}{2}r\alpha(1-\alpha)(Y_g-I)^2$. The fact that T is decreasing in r whenever $\alpha \in (0,1)$ implies that full information sharing is feasible under stronger competition if lenders are more risk-averse.

(ii) Consider the condition for the feasibility of partial information sharing in Proposition 2′. Define $T(r,\alpha)$ as the maximum transaction costs for which a partial-sharing equilibrium is feasible for a given mobility α if lenders are risk-averse to the degree of r; i.e., for $T(r,\alpha)$ the condition in Proposition 2′ is satisfied with equality. Note that $T(r,\alpha=1)=0$ and $T(r,\alpha=0)=1$ for all $r>0$. Now consider two degrees of risk aversion $r_2 > r_1 \geqslant 0$. We show that $T(r_1,\alpha) > T(r_2,\alpha)$ for all $\alpha \in (0,1)$ if $r_2, r_1 < \frac{2}{Y_g-I}$. We assume that $r_2, r_1 < \frac{2}{Y_g-I}$ so that the certainty equivalent of the lender in case of joining or not joining the bureau is always positive.[23] From the condition in Proposition 2′ one can establish the following equality $[T(r_1,\alpha)-\frac{1}{4}\alpha r_1 T(r_1,\alpha)^2]-[T(r_2,\alpha)-\frac{1}{4}\alpha r_2 T(r_2,\alpha)^2] = (r_2-r_1)\alpha\frac{1-\alpha}{2-\alpha}(Y_g-I)^2$. As $r_2 > r_1$ the right hand side of this equality is positive. Since $r_2, r_1 < \frac{2}{Y_g-I}$ both terms on the left hand side are positive and increasing in T. As the left hand side of the above equality must be positive we must have that $T(r_1,\alpha) > T(r_2,\alpha)$. Thus for all $\alpha \in (0,1)$ partial sharing is feasible for a larger parameter range on T (i.e., for lower degrees of competition) if lenders are less risk-averse. □

Observation 2. Although the presence of risk-averse lenders affects the set of parameter constellations for which multiple equilibria can be sustained, the predictions for our four treatments are only

[23] Our analysis implicitly assumes that the degree of risk aversion is not extreme. For very high degrees of risk aversion the approximation of the certainty equivalent is no longer valid.

affected if lenders are highly risk-averse. In order for the "HighMobility–HighCompetition" treatment ("LowMobility–LowCompetition" treatment) to drop from the set of constellations with multiple equilibria the coefficient of absolute risk aversion needs to be at least $r = 0.68$ ($r = 0.77$).

Proof. Solving the condition for the feasibility of partial information sharing (Proposition 2′) for r yields:

$$r < \frac{(1-\alpha)(Y_g - I) - \left(1 - \frac{1}{2}\alpha\right)T}{\frac{1}{2}\left[\alpha(1-\alpha)(Y_g - I)^2 - \frac{1}{2}\alpha\left(1 - \frac{1}{2}\alpha\right)T^2\right]}.$$

Entering the parameter values of the experiment (converted to US-$, i.e., 150 Points = 1 Swiss Franc = 0.83 US-$) yields the reported numbers. □

A.3. Two-player coordination game among second-mover lenders

The normal-form representation of the two-player coordination game between second-mover lenders discussed in Section 3.3 is given as follows:

		Second-mover lender B	
		Not join	Join
Second-mover lender A	Not join	$(1-\alpha)(Y_g - I)$ $(1-\alpha)(Y_g - I)$	$(1-\alpha)(Y_g - I)$ $(1 - \frac{1}{2}\alpha)T$
	Join	$(1 - \frac{1}{2}\alpha)T$ $(1-\alpha)(Y_g - I)$	T T

Inserting the parameter values for the "LowMobility–LowCompetition" treatment (α=.25, T=60) and the "HighMobility–HighCompetition" treatment ($\alpha = .75$, $T = 160$) reveals that payoff-dominance predicts that the second-mover lenders would always join the credit bureau in both treatments (because $T > (1-\alpha)(Y_g - I)$ for both parameter constellations). Risk-dominance (i.e., the choice of the equilibrium which yields higher expected payoffs, when the players expect that the other player randomizes between the two equilibrium strategies) does not make a prediction for the "LowMobility–LowCompetition" treatment (because $\frac{1}{2}\left(\left(1 - \frac{1}{2}\alpha\right)T + T\right) = (1-\alpha)(Y_g - I)$), but predicts that second-mover lenders do not join the bureau in the "HighMobility–HighCompetition" treatment (because $\frac{1}{2}\left(\left(1 - \frac{1}{2}\alpha\right)T + T\right) < (1-\alpha)(Y_g - I)$). Selection of the equilibrium which maximizes the average payoff of all four lenders predicts that the partial-sharing equilibrium is chosen in both treatments (because $\frac{1}{2}\left(\left(1 - \frac{1}{2}\alpha\right)(Y_g - I) + (1-\alpha)(Y_g - I)\right) > T$, for both parameter constellations).

References

Barron, J., Staten, M., 2003. The value of comprehensive credit reports: lessons from the U.S. experience. In: Margaret, M.J. (Ed.), Credit Reporting Systems and the International Economy. MIT Press, Boston.

Barth, J., Caprio, G., Levine, R., 2008. Bank regulations are changing: but for better or worse? World Bank Policy Research Paper 4646.

Bennardo, A., Pagano, M., Piccolo, S., 2008. Multiple-bank lending, creditor rights and information sharing. University of Salerno, CSEF Working Paper 211.

Bouckaert, J., Degryse, H., 2004. Softening competition by inducing switching in credit markets. J. Ind. Econ. 52, 27–52.

Bouckaert, J., Degryse, H., 2006. Entry and strategic information display in credit markets. Econ. J. 116, 702–720.

Brown, M., Zehnder, C., 2007. Credit reporting, relationship banking, and loan repayment. J. Money, Credit, Banking 39, 1883–1918.

Brown, M., Jappelli, T., Pagano, M., 2009. Information sharing and credit: firm-level evidence from transition countries. J. Finan. Intermediation 18, 151–172.

Claessens, S., Laeven, L., 2004. What drives bank competition? Some international evidence. J. Money, Credit, Banking 36, 563–583.

Degryse, H., Ongena, S., 2005. Distance, lending relationships, and competition. J. Finance 60, 231–266.

Djankov, S., McLiesh, C., Shleifer, A., 2007. Private credit in 129 countries. J. Finan. Econ. 84, 299–329.
Fischbacher, U., 2007. z-Tree: Zurich toolbox for readymade economic experiments. Exper. Econ. 10, 171–178.
Galindo, A., Miller, M., 2001. Can credit registries reduce credit constraints? Empirical evidence on the role of credit registries in firm investment decisions. Paper prepared for the Annual Meetings of the Inter-American Development Bank, Santiago, Chile.
Gehrig, T., Stenbacka, R., 2007. Information sharing and lending market competition with switching costs and poaching. Europ. Econ. Rev. 51, 77–99.
Hunt, R., 2005. A century of consumer credit reporting in America. Federal Reserve Bank of Philadelphia, Working Paper 05-13.
IFC, 2006. Credit Bureau Knowledge Guide. International Finance Corporation.
Jappelli, T., Pagano, M., 2002. Information sharing, lending and defaults: cross-country evidence. J. Banking Finance 26, 2017–2045.
Kallberg, J., Udell, G., 2003. The value of private sector credit information. J. Banking Finance 27, 449–469.
Klein, D., 1992. Promise keeping in the great society: a model of credit information sharing. Econ. Politics 4 (2), 117–136.
Lazarony, L., 2000. Lenders defy credit-reporting crackdown, hoarding data that could save you money, Bankrate, April 28, 2000.
Love, I., Mylenko, N., 2003. Credit reporting and financing constraints. World Bank Policy Research Working Paper 3142.
Luoto, J., McIntosh, C., Wydick, B., 2007. Credit information systems in less-developed countries: a test with microfinance in Guatamala. Econ. Devel. Cult. Change 55, 313–334.
Mistrulli, P.E., Casolaro, L., 2008, Distance, lending technologies and interest rates. Bank of Italy (unpublished manuscript).
Mullen, B., Atkins, J.L., Champion, D.S., Edwards, C., Hardy, D., Story, J.E., Venderklok, M., 1985. The false consensus effect: a meta-analysis of 115 hypothesis tests. J. Exp. Social Psychol. 21, 263283.
Olegario, R., 2003. Credit reporting agencies. In: Margaret, M.J. (Ed.), Credit Reporting Systems and the International Economy. MIT Press, Boston.
Padilla, A., Pagano, M., 2000. Sharing default information as a borrower discipline device. Europ. Econ. Rev. 44 (10), 1951–1980.
Pagano, M., Jappelli, T., 1993. Information sharing in credit markets. J. Finance 43 (5), 1693–1718.
Panzar, J., Rosse, J., 1987. Testing for "monopoly equilibrium". J. Ind. Econ. 35, 443–456.
Powell, A., Mylenko, N., Miller, M., Majnoni, G., 2004. Improving credit information, bank regulation and supervision: on the role and design of public credit registries. World Bank Policy Research Working Paper 3443.
San José Riestra, A., 2002. Credit bureaus in today's credit markets. ECRI Research Report 4/2002.
Tirole, J., 1988. The Theory of Industrial Organization. MIT Press, Boston.
Vercammen, J., 1995. Credit bureau policy and sustainable reputation effects in credit markets. Economica 62, 461–478.