The Size and Ownership of Private Credit Bureaus*

Artashes Karapetyan† and Bogdan Stacescu‡

Abstract

The proportion of lenders participating in a private credit bureau varies across countries. We study the determinants of the size of private credit bureaus, and find that ownership - being owned by lenders versus by an independent agency (e.g., Experian) is key for this coverage. Lender-owned bureaus, while having limited coverage, may be the preferable choice for the banks. Independent credit bureaus will provide higher coverage of potential borrowers, but may lead to lower bank profits. Our empirical findings largely support the implications of our model.

JEL classification: G20, D82, L12

Keywords: Information sharing; Credit markets; Ownership; Adverse selection

*We would like to thank Anke Gerber, Michel Habib, Ulrich Hege, Steven Ongena, Rene Stultz, Lucy White, seminar participants at the European Finance Association, Washington Finance Association at the George Washington University, European Economic Association, Fordham Business School, Harvard University, Harvard Business School, University of Vienna, University of Zurich, Portuguese Finance Network and the Swiss Doctoral Workshop in Gerzensee. All remaining errors are ours.

†Norges Bank, Bankplassen 2, P.O. Box 1179 Sentrum, Norway. Tel: + 47 22 31 62 52

‡Norwegian School of Business, Nydalsveien 37, 0484 Oslo. Tel: +47 46 41 05 19

1 Introduction

Information is a crucial input in the banking industry. When making lending decisions, banks need to have good knowledge of their potential borrowers. They also accumulate details about existing borrowers over the length of lending relationships (Boot, 2000). That information allows banks to select creditworthy projects for funding, and therefore plays a key role in capital allocation in the economy.

Credit bureaus share information between lenders, and thus enable banks to add data coming from other sources to their own. Each member of a bureau gets details about a borrower's credit history from other lenders, and in turn provides data on its own borrowers. The existing empirical evidence indicates that credit bureaus are a useful way to reduce information asymmetries (Jappelli and Pagano 1993, 2002). A cross-country survey by the World Bank reveals the majority of banks agree that the most important input in deciding credit terms is the borrower's past history (Miller, 2003). Twice as many banks indicated credit history data was important compared to collateral, 60 percent of banks responded that the absence of credit reporting would increase cost of credit by at least 25 percent, while approximately 70 percent of respondents indicated that its absence would increase defaults by at least 25 percent. Over the last three decades, more and more countries have got local credit bureaus.

Despite their obvious practical importance, little is known about how credit bureaus function, and what influences their size. In this paper we examine the conditions under which a private credit bureau can be established and the determinants of its resulting coverage of borrowers in the economy.

Our main observation is that in some countries private bureaus are *lender-owned*, while in others an *independent* (i.e., a non-lending firm) firm owns it. We examine this ownership structure of private credit bureaus - lender-owned versus independent agency - , and study the optimal size in each case. We find that the ownership of private credit bureau is key in explaining variation in coverage across countries.[1] We also study the conditions that may favor one ownership structure over the other.

In our theoretical model, borrowers have a history with multiple banks, and sharing information creates value by allowing banks to better evaluate borrowers. For both lender-owned and independent credit bureaus, sharing is based on reciprocity: lenders can get access to information conditional on providing their own data. We examine each of the two types of ownership separately.

[1] The term "bureau" usually refers to private arrangements, as opposed to registries. They are the main focus of our paper. We observe public registries, that operate on the principle of mandatory participation, in a number of countries. Their main objective is to strengthen the supervision and regulation of financial institutions. For that purpose, in most countries, public registers only collect information on large loans, since their main focus is on the overall stability of the banking system. For example in Germany the exposure hurdle rate equals 1.5 million euros. However, in some cases they cover also small loans (e.g., in Spain the threshold is as low as 6,500 Euros), and play a more important role in sharing information. We address those concerns in our empirical section.

First, in the lender-owned model members share information to maximize their individual profits from financing potential borrowers. The "inside" banks use the shared information directly to improve their lending decisions. They also have to also provide information on their own credit files, and that can facilitate the access of competing lenders to their existing borrowers. Since they are the owners of the credit bureau, lenders will also receive part of the profits from selling credit reports.

In contrast, an independent credit bureau aims to maximize the profits coming from the credit reports sold to participating banks. As a result, the focus is on maximizing the total surplus rather than the per-bank profit. Moreover, since lenders are no longer the owners of the bureau, the cost of credit reports is no longer part of their earnings.

We find that these differences have an impact on the likelihood a private credit bureau can be established, and on its size. A lender-owned bureaus may be more difficult to set up, and that it can lead to lower coverage of potential borrowers. The reason for this is that the addition of a new lender leads to both an increase in information and an increase in competition within the bureau.

If the price of a credit report is very low, the potential increase in customer poaching among lenders may mean that lenders do not find it worthwhile to set up a bureau. With an independent agency as the owner of the bureau, banks bear the full cost of a report, poaching is more expensive and information sharing may be feasible even with relatively low credit report prices. When a bureau exists, its size is likely to be smaller under lender ownership. Lenders are interested in maximizing the profit that each of them can derive from financing potential borrowers. Independent agencies are interested in the total available surplus from all members of the bureau. The point at which the total surplus is maximized is higher or equal to that for the individual surplus, and as a result independent agencies will favor broader information sharing arrangements. Our main prediction is therefore higher coverage under independent credit bureaus.

From a policy point of view, one can be interested in total welfare and in the welfare of potential borrowers. Total welfare can be increased by reducing lending losses. As a result, higher coverage - which also improves the information available on potential borrowers and thus the quality of lending decisions - is preferable. Since independent credit agencies tend to provide higher coverage, this is an argument for supporting them. Even if total welfare is maximized, however, one may be concerned that the surplus accrues to lenders and/or independent agencies rather than borrowers. This can be prevented by reducing the price of credit reports and therefore enhancing competition inside the credit bureau. Indeed, the price of report is regulated in many countries. Since an independent credit bureau is more likely to be feasible with low credit report prices, this is again an argument in their favor.

The existence of the independent credit bureau can be undermined by the potential for collusion between the independent credit agency and individual banks. One can think of the scenario in which one of the banks gets unrestricted access to the entire database and thus has the possibility to capture (an important share of) the other banks' market. The independent agency may be willing to collaborate in this deviation if it gets a share of the one-period rents. If creditor rights are weak, this type of potential collusion may deter the formation of independent credit bureau, making lender-based arrangement more likely. Indeed, in a survey conducted by the World Bank it is noted that "in most cases, lenders are reluctant to share information with an independent credit bureau because of a lack of trust."[2] In the meantime, large banks will have little to gain from such collusion in terms of gaining additional share as well as putting reputation at risk.

We take the predictions of the model to data. We look at the ownership structure and coverage in a cross-section of countries. We use hand-collected data on credit bureau ownership, and cross-check with the Orbis database whenever possible. We link that to the credit bureau coverage provided by the Doing Business project at the World Bank. Our findings largely support our theoretical predictions. Lender-owned bureaus have significantly lower coverage, while independent credit bureaus provide high coverage. The difference is economically large: 44 vs. 60 percent on average. The result holds when we control for the bank concentration, the level of access to finance and private credit, and the existence of public registers (Jappelli and Pagano, 2002) in a given country.

Our approach is largely positive: we are trying to understand the mechanisms governing credit information sharing as seen in practice. However, our work also has normative implications. In implies that encouraging independent credit bureaus is more likely to result in information sharing and better credit allocation. The regulation of credit report prices, which is used in many countries, can also influence the scope of information sharing through its effects on borrower poaching. Our findings also suggests that the need for public registers based on mandatory information sharing for all lenders is highest in developing countries where collusion might threaten the existence of private bureaus. These are countries with underdeveloped banking systems and weak creditor rights[3].

The paper proceeds as follows: In section 2, we review the related literature. Sections 3 and 4 present a simple and more developed version of the model and analyze the two ownership structures. Section 5 provides empirical evidence and section 6 concludes.

[2]See the IFC Credit Bureau Knowledge Guide, World Bank Group 2006.

[3]Djankov, McLiesh and Shleifer (2006) find a significant increase in credit availability following the establishment of public registers in developing countries with French legal origin.

2 Related Literature

A number of recent studies analyze the impact of information sharing on loan volume, prices and quality, and on incentives to collect information about borrowers. Overall, the effects of information are large and important. And yet, we are not aware of any work studying the determinants of their ownership structure and size.

In an adverse selection model, Pagano and Jappelli (1993) show that information sharing decreases defaults and reduces the average interest rate. In the model each lender has informational monopoly over the local borrowers, but no information about switching customers. In a moral hazard model where each lender again possesses ex-ante informational monopoly, Padilla and Pagano (1997) show how borrowers' incentives to perform increase with information sharing. Padilla and Pagano (2000) show that the borrowers' effort can increase even when there is no ex-ante informational monopoly. In this model, when banks share default information, rather than information about borrowers' types, both the adverse selection and disciplinary effect may be alleviated. When default information is shared, past defaults become a sign of bad quality not only for the lender-bank, but also for all other banks, with whom information is shared. Realizing this adverse reputation effect, borrowers are encouraged to exert more effort. Unlike our paper, these studies do not look at the ownership of the information sharing institution.

Bouckaert and Degryse (2006) study poaching by competitor banks when the incumbent has informational monopoly. Entry is feasible when the incumbent shares full information and customers may switch to the competitor that offers a discount. The incumbent can strategically reveal only partial information and make it unattractive for the entrant to contract with the rest of borrowers among whom adverse selection remains high. Karapetyan and Stacescu (2014a) study the effect of default information sharing on soft information acquisition. Default information may soften competition for borrowers who have defaulted before. Since they are less likely to switch, the incumbent may invest more in soft information to learn more about their creditworthiness. Vercammen (1995) shows that full information sharing about a particular borrower may not be optimal in a dynamic set-up: a mechanism that limits access to the length of repayment history exchanged between lenders can lead to higher welfare. Rather than studying the type, amount or length of information shared, we analyze the difference in sharing the same, black and white information by bureaus with two distinct ownership structures.

Jappelli and Pagano (2002) offer the first empirical investigation of the existence and impact of credit bureaus in various economies around the world. They find that the presence of private credit bureaus or public credit registries is associated with broader credit markets and lower credit risk. They find no differential effect between public and private institutions on credit market performance, and argue that public credit registries are more likely to arise where there is no preexisting private credit bureau and creditor rights are poorly protected. Similar empirical results are obtained by Djankov, McLiesh and Shleifer (2007), who use macro level data from 129 countries and find that credit rises after improvements in information sharing. In a sample of Central and Eastern European countries, Brown et al. (2009) find that introducing information sharing in a country may increase access to and decrease cost of capital there. Kallberg and Udell (2003) and Love and Mylenko (2003), using micro level data, support the finding that information sharing adds value by enhancing credit availability. More recently, Doblas-Madrid and Minetti (2013) use contract-level evidence from US to find that the entry of lenders into the credit bureau reduces the incidence of contract delinquencies and reduces the size of contracts. In line with Karapetyan and Stacescu (2014b), they also find an increased use of guarantees.

3 A model with two banks: the existence of a credit bureau

We begin by presenting a basic version of our model, in which we have two banks that decide whether to share information about their borrowers' credit histories. The information can be shared through a credit bureau owned by the banks themselves, or through an independent credit bureau. We derive the conditions under which information sharing is feasible (arises endogenously), and show that the threat of borrower poaching may mean that information sharing is feasible through an independent credit bureau, but not through a lender-owned bureau. In the next session we use a model with multiple banks to derive additional results about the coverage of the credit bureau.

We model an economy with two banks and a continuum of borrowers borrowers of mass 1. A proportion λ of the borrowers are high-type (talented), while the remaining $1-\lambda$ are low-type. Banks know λ but initially do not know a given borrower's type. Both types of borrowers have accumulated credit histories. A proportion θ has had loan contracts with both banks, with equal amounts borrowed from each, while a proportion $1-\theta$ has borrowed a similar total amount from just one of the two banks. In the latter group, we assume an equal fraction of $\frac{1-\theta}{2}$ has borrowed from each bank. High-type borrowers have repaid all of their loans, while low-type borrowers have repaid nothing with probability $\frac{1}{3}$, half of the amount borrowed (i.e., one of the two loans if they borrowed from two banks) with probability $\frac{1}{3}$, and have repaid everything with probability $\frac{1}{3}$.

In the second period, high- and low-type borrowers once again apply for bank loans. High-type borrowers are always successful in the projects they decide to undertake. Their individual demand given the interest rate R is equal to $k-sR$, where k and s are constants. The intuition here is that as the interest rate increases, the number of positive NPV projects goes down. For simplicity, we assume low-type borrowers will default on all their loans in the second period, but they still derive some nonmonetary benefits from being in business. In order to receive a loan, low-type borrowers will try to mimic high-type borrowers and demand similar amounts of loans.

We assume that banks are price takers on their "input" (i.e. deposit) market. The banks' cost of funds per dollar of deposits is equal to $\bar{R}$. Banks decide on the quantity of deposits they need for lending given that cost. On the "output" (i.e. loans) market, banks can set their interest rates. Borrowers choose their banks based on the interest rates they anticipate.

Banks that have had a lending relationship with a given borrower can update their beliefs about its likely type based on the borrower's repayment record. A default indicates a low-type borrower; a successful repayment allows the bank to update the probability that the borrower is high-type above the unconditional λ.

If banks join a credit bureau, they can extend their information by getting access to the lending records of the other banks involved in the information sharing arrangement. A default observed by either bank in the bureau would indicate a low-type borrower, while more successful repayments increase the probability of having a high-type customer. At the same time, the bank will have to make its own information available to the credit bureau.

We examine and compare the case in which banks do not share information to the case in which information is shared either through a bank consortium (a credit bureau owned and administered by the banks) or through an independent credit agency (a credit bureau which is a separate entity from the banks).

3.1 No information sharing

Without information sharing via a credit bureau, banks only know the repayment history of their own previous loans. Each bank has the full credit history (default or successful repayment) for borrowers that have only borrowed from it, and the partial history for borrowers that had loans with both banks. A default clearly indicates a low-type borrower, while a successful repayment allows the bank to update the probability of the borrower being high-type above λ.

Banks choose the amount of deposits they need, and have to pay the cost of $\bar{R}$ per dollar. They then quote their interest rates for the new loans, conditional on the credit history they have observed, and borrowers choose their bank based on the interest rates they are offered[4].

In order to keep the algebra simple, we assume that banks will not find it worthwhile to finance "unknown" borrowers. That is, the expected payoff from lending to the average borrower that did not receive a loan from the bank in the first period is negative[5]. They will do that if the proportion of high-types among unfamiliar borrow-

[4] This structure of bank competition is in line with Kreps and Scheinkman 1983

[5] We could also consider the case where banks are willing to lend even to "unknown" borrowers. This would lead to a mixed-strategy equilibrium (von Thadden 1998). This case leads to more involved computation, but the basic intuition remains the same.

ers is low enough. Incumbent banks will therefore have a monopoly over the borrowers that have only borrowed from them previously. They will only lend to borrowers with good credit histories. The updated probability that those borrowers are high-type is $\lambda_2 = \frac{\lambda}{\lambda+(1-\lambda)(1-\frac{2}{3})}$.

Among the group of borrowers that have had loans with both banks, banks will again select only non-defaulting borrowers. However, high-type borrowers in this group have fully repaid their loans with both banks, and lenders therefore have symmetric information with respect to them. Each bank will offer a similar interest rate based on the updated probability that a successful borrower is high-type $\lambda_1 = \frac{\lambda}{\lambda+(1-\lambda)\frac{1}{2}}$, and good borrowers will split their demand between the two banks[6].

Banks choose how much money they want to attract in deposits, and then come up with the interest rates that will be charged to borrowers that only borrowed from them, and to borrowers that had loans from both banks. The outcome of the competition among banks in the absence of information sharing is summarized in the following proposition.

Proposition 3.1 *If there is no information sharing, banks will only lend to their successful previous borrowers. The interest rate they charge to borrowers that have only borrowed from them is*

$$R_m = \frac{\lambda_2 k + s\bar{R}}{2\lambda_2 s},$$

and the interest rate they charge to borrowers that have borrowed from both banks is

$$R_1 = \frac{\frac{1}{3}\lambda_1 k + \frac{2}{3}s\bar{R}}{\lambda_1 s}.$$

The per-bank profit is equal to

$$\Pi^{ns} = B_2\frac{(\lambda_2 k - s\bar{R})^2}{4s\lambda_2} + \frac{2}{9}B_1\frac{(\lambda_1 k - s\bar{R})^2}{s\lambda_1}, \tag{1}$$

where $B_2 = \frac{1-\theta}{2}(\lambda + (1-\lambda)(1-\frac{2}{3}))$ *and* $B_1 = \theta(\lambda + (1-\lambda)\frac{1}{2})$.

Proof See Appendix.

The first term in the expression for bank profits represents the profits on borrowers that have only historically borrowed from the bank and not from its competitor, and the second term represents profits on shared borrowers (borrowers that have credit

[6] In order to save on contracting costs, borrowers may also choose randomly just one of the banks. Results are similar in that case.

histories with both banks). For the second group, bank profits are reduced by the fact that banks only have part of a given borrower's credit history. That issue can be addressed by sharing information through a credit bureau which provides the full information which can be used to better select borrowers and reduce credit losses. We look at credit bureaus below, and distinguish between the case in which the bureau is owned by the banks themselves and the case in which the credit bureau is owned by an independent agency (firm).

3.2 Information sharing

3.2.1 Lender-owned bureau

We first look at the case in which a credit bureau exists and is bank-owned. Banks provide their own information to the bureau and can acquire credit reports containing the pooled credit history with both banks.

In our exposition we take the cost of a credit report as given, and describe the equilibrium as a function of those costs. One reason is that in many countries credit report prices are regulated. For instance, in the U.S. a credit reporting company may charge individuals no more than \$12 for a credit report. Moreover, it should be noted that the cost of a credit report is not negligible[7]. We show below that the level of the cost can influence the existence of a credit bureau and its ownership as well as bank profits. If the banks are free to choose the price of a credit report, they try to choose a level that maximizes their profits. We show below that having an independent rather than lender-owned credit bureau may actually lead to less customer poaching and a higher likelihood of information sharing.

If the cost of a credit report is relatively high, banks will be selective and only ask for credit reports about their previous borrowers with successful repayments. If the cost of a report is relatively low, banks can also ask for credit reports about borrowers they have not lent to - and thus try to poach each other's borrowers. We examine the two cases below.

Proposition 3.2 *Under a lender-owned credit bureau with high credit report prices, banks will only lend to their successful previous borrowers. The interest rate each bank charges to borrowers that have only borrowed from it is*

$$R_m = \frac{\lambda_2 k + s\bar{R}}{2\lambda_2 s},$$

and the interest rate it charges borrowers that have borrowed from both banks is

[7] Prices range from \$11 for consumers to \$99 per month for a full-featured report on Experian; with Equifax, a business credit report can cost as much as \$99.95, see http://www.equifax.com/business/business-credit-reports-small-business. See also http://www.consumerfinance.gov/askcfpb/1281/how-much-does-it-cost-get-copy-my-credit-report-if-ive-already-received-all-my-free-credit-reports.html.

$$R^{high} = \frac{\frac{1}{3}\lambda_2 k + \frac{2}{3}s\bar{R}}{\lambda_2 s}.$$

The per-bank profit is equal to

$$\Pi^{high} = B_2 \frac{(\lambda_2 k - s\bar{R})^2}{4s\lambda_2} + \frac{2}{9} B_{1,share} \frac{(\lambda_2 k - s\bar{R})^2}{s\lambda_2}, \tag{2}$$

where $B_2 = \frac{1-\theta}{2}(\lambda + (1-\lambda)(1-\frac{2}{3}))$, $B_{1,share} = \theta(\lambda + (1-\lambda)(1-\frac{2}{3}))$, $B^1 = \theta(\lambda + (1-\lambda)\frac{1}{2})$, $\lambda_2 = \frac{\lambda}{\lambda + (1-\lambda)(1-\frac{2}{3})}$.

Proof See Appendix.

The first part of the expression for bank profits represents profits coming borrowers that only had a lending relationship with the bank; under high credit report costs the incumbent bank still has a monopoly over those borrowers and profits are the same as under no information sharing. The remainder represents the profits from borrowers that borrowed from two banks. Each bank will require the credit history of the borrowers that have successfully repaid their loan (B_1), and will lend only to borrowers that have repaid both banks in full ($B_{1,share}$).

We next look at the case in which the cost of a credit report(c) is relatively low, and banks will find it profitable to ask for credit reports about borrowers they did not lend to in previous periods.

Proposition 3.3 *Under a lender-owned credit bureau with low credit bureau prices, banks will lend to their successful previous borrowers, but also compete for borrowers that have only borrowed from the other bank. The interest rate they charge to borrowers with a good credit history is*

$$R^{low} = \frac{\frac{1}{3}\lambda_2 k + \frac{2}{3}s\bar{R}}{\lambda_2 s}.$$

The per-bank profit is equal to

$$\Pi^{low} = \frac{2}{9} B_{low} \frac{(\lambda_2 k - s\bar{R})^2}{s\lambda_2}, \tag{3}$$

where $B_{low} = \lambda + (1-\lambda)(1-\frac{2}{3})$.

Proof See Appendix.

Bank profits are higher in the first case than in the second, when poaching of previously unknown borrowers occurs. Banks would obviously prefer high profits and no poaching; however, under low credit report prices the equilibrium described in proposition 3.2 is vulnerable to a deviation from one of the banks that can ask for reports not just about its own successful borrowers.

Given that the banks are the owners of the credit bureau, the credit report costs become the profits of the bureau distributed to the banks. A bank that deviates by trying to poach the other bank's existing exclusive borrowers is faced with the additional cost of the credit reports about them; half of that will revert to it as a share of the bureau's profits, but the other half is the net cost of the deviation.

It is immediate to see that banks will not deviate under high report prices: whenever $\frac{c}{2} > \frac{B_2}{(1-\theta)/2}\frac{(\lambda_2 k - s\bar{R})^2}{4s\lambda_2}$, banks will not find it worthwhile to purchase a report on an unknown borrower from the competitor's niche. If the condition does not hold, banks will ask for credit reports about the unknown borrowers and undercut their previous lender.

Depending on credit report prices and the resulting bank competition, bank profits may be higher or lower in the presence of a lender-owned credit bureau. This will determine whether there can be a credit bureau or not. We detail the condition for the existence of voluntary information sharing in the next section.

3.2.2 Independent bureau

Many countries have independent credit bureaus. Examples of such bureaus are Experian or Equifax. Independent credit agencies collect information from banks, assemble the available information for each borrower and sell the resulting credit reports to potential lenders. It is important to note that the ones who "generate" the credit information are the banks, and unlike the previous case, the independent credit bureau does not use information as input for lending: it does not lend, but delivers information to lenders. We examine the case of independent credit bureaus in this section.

We first look at an independent credit bureau which has a monopoly on the market, and then consider potential competition among independent credit bureaus (i.e., there are other firms that may decide to enter the market).

The independent credit bureau can charge a combination of a fixed fee F from members and report price $c \geq 0$ for each report[8].

The timing of the game

The timing of the game is as follows:

1. The independent bureau announces fixed fee F for participation and report price c.
2. Banks decide whether or not to join.
3. Information on credit histories is collected and provided to banks upon request at a price c per report.

[8]One can also think of a per-bank fixed fee in the case of lender-owned credit bureaus; however, in that case, banks will receive the fee back as profits, since they are the shareholders of the bureau.

4. Banks choose their deposits.
5. Banks choose their interest rates conditional on the credit history of each borrower.

The monopolist's maximization problem is given by

$$\begin{aligned} \max \quad & \Pi_M \\ s.t. \quad & \Pi_{ib} \geq \Pi^{ns} \\ & \Pi_{ib} \geq \Pi^{lender} \\ & \Pi_M \geq 0, \end{aligned}$$

where Pi_M is the monopolistic independent bureau's profit, Pi_{ib} is the bank profit with an independent credit bureau, Π^{ns} is the bank profit under no information sharing, and Π^{lender} is the bank profit under a lender-owned credit bureau.

Denote $C \equiv \frac{B_2}{(1-\theta)/2} \frac{(\lambda_2 k - s\bar{R})^2}{4s\lambda_2}$.

Proposition 3.4 *1. When $C \leq c < 2C$ and $\Pi^{ns} > \Pi^{low}$, information sharing will not occur with lender-owned bureaus. In this case an independent bureau can provide information sharing by offering a pair $c \in (C; 2C); F(c) = \Pi^{high} - \Pi^{ns}$ to both lenders. When $\Pi^{low} > \Pi^{ns}$ a lender-owned bureau is feasible, but the independent bureau can also provide information sharing under the same conditions with $F(c) = \Pi^{low} - \Pi^{ns}$.*

2. When $c > 2C$ a lender-owned bureau is feasible, provided $\Pi^{high} > \Pi^{ns}$. The independent bureau can provide information sharing under the same conditions, with $F(c) = \Pi^{high} - \Pi^{ns}$.

3. When $c < C$ a lender-owned bureau is feasible, provided $\Pi^{low} > \Pi^{ns}$. The independent bureau can provide information sharing under the same conditions, with $F(c) = \Pi^{low} - \Pi^{ns}$.

The main message, as stated in the first section of the proposition, is that under "moderate" credit report prices information sharing may be feasible with an independent credit bureau, but not with a lender-owned bureau. The reason is that the credit report charges received by the independent credit bureau prevent excessive customer poaching by the banks. As a result, banks will prefer to provide their information to the independent bureau, pay for credit reports and still realize higher profits than under no information sharing.

In sum, independent credit bureaus make information sharing more likely.

4 The model with multiple banks: the coverage of the credit bureau

The two-bank case has allowed us to draw the basic conclusions about when information sharing is feasible, and to show that independent credit bureaus are likely to be viable under a wider parameter range. We now extend the model to look at the case when we have many banks, and each borrower may have credit histories with several of them. This will allow us to draw further conclusions about the likely coverage of a credit bureau, by examining how many banks would be willing to join.

We model an economy with N distinct banks and B borrowers, where $N < B$. A proportion λ of the borrowers are high-type, while the remaining $1 - \lambda$ are low-type. Banks know λ but do not observe a given borrower's type.

Both high- and low-type borrowers have accumulated credit histories. Each borrower of either type has borrowed from m banks during its history. High-type borrowers have repaid all of their m loans. In contrast, low-type borrowers have a probability $\frac{1}{m}$ of having repaid exactly 0, 1, ..., $m - 1$ of their loans.

In the current period, high- and low-type borrowers once again apply for bank loans. High-type borrowers are always successful in the projects they decide to undertake. As in the two-bank case, their individual demand given the interest rate R is equal to $k - sR$, where k and s are constants. The intuition here is that as the interest rate increases, the number of positive NPV projects goes down. Low-type borrowers are less likely to be successful; for simplicity, we assume they will default on all their loans. We assume that low-type borrowers derive some nonmonetary benefits from being in business, and therefore will still be applying for loans; in order to receive a loan, low-type borrowers will try to mimic high-type borrowers and demand similar amounts of funding.

We assume that banks are price-takers on their "input" (i.e. deposit) market. The banks' cost of funds per dollar of deposits is equal to $\bar{R}$. Banks decide on the quantity of deposits they need for lending given that cost. On the "output" (i.e. loans) market, banks can set their interest rates. Borrowers choose their banks based on the interest rates they anticipate.

Banks that have had a lending relationship with a given borrower can update their beliefs about its likely type based on the borrower's repayment record. A default indicates a low-type borrower; a successful repayment allows the bank to update the probability that the borrower is high-type above the unconditional λ.

If a bank joins a credit bureau, it can extend its information by getting access to the lending records of the other banks involved in the information sharing arrangement. A default observed by any bank in the bureau would indicate a low-type borrower, while more successful repayments increase the probability of having a high-type customer. At the same time, the bank will have to make its own information available to the credit bureau.

We examine and compare the case in which banks do not share information to the case in which information is shared either through a bank consortium (a lender-owned credit bureau) or through an independent credit agency (an independently owned credit bureau).

4.1 No information sharing

In the absence of information sharing, banks will only know the credit history of their own previous borrowers. If they observe any defaulting borrowers in their portfolio, they will deny them further loans, since they are obviously low-type and will not reimburse any money lent in the second period. If they observe successful repayments, they can update the probability of those borrowers being a high type to a higher level. If they are faced with loan demand from firms that have not had a lending relationship with them in the first period, banks will not have any additional information to help them distinguish between high- and low-type borrowers.

We assume once again for simplicity that banks will not find it worthwhile to finance "unknown" borrowers. That is, the expected payoff from lending to a borrower that did not receive a loan from the bank in the first period is negative. Under these circumstances, banks will only lend to their own first-period borrowers that have successfully repaid their initial loans.

Each bank will be competing with $m-1$ other banks for each of its successful borrowers. Banks choose the amount of deposits they plan to attract at a cost $\bar{R}$ per dollar, given the anticipated borrower demand, and then compete in interest rates. In equilibrium, all the m banks will offer the same interest rate, and we assume that good borrowers will split their demand among banks. (We could also assume they randomly pick one of the banks, without any significant changes to our results.)

The demand of the high-type borrowers will be given by $k - sR_0$, where R_0 is the equilibrium interest rate without information sharing. The low-type borrowers will mimic the high-type by applying for the same amount from each bank where they did not default on the previous loan. In the absence of additional data, those banks will be unable to distinguish between the two groups of borrowers. What banks can do, however, is to update the probability that their lenders are high-type, conditional on one successful repayment:

$$\lambda^0 = \frac{\lambda}{\lambda + (1-\lambda)\left(1 - \frac{1}{m}\right)} = \frac{\lambda m}{m - 1 + \lambda}.$$

The outcome of the competition among banks in the absence of information sharing is summarized in the following proposition.

Proposition 4.1 *If there is no information sharing, banks will only lend to their successful previous borrowers. The interest rate they charge is*

$$R_0 = \frac{k\lambda_0 + sm\bar{R}}{s(m+1)\lambda_0},$$

and the average per-bank profit is equal to

$$\Pi^0 = B_0 \pi^0, \tag{4}$$

where $\pi^0 = \frac{(\lambda_0 k - s\bar{R})^2}{s\lambda_0 (m+1)^2}$ *and* $B_0 = \frac{B}{N}\left(\lambda m + (1-\lambda)\frac{m-1}{2}\right)$.

Proof See Appendix.

It can be seen that the banks' profits are decreasing in the number of bank relationships m (which increases competition among banks), increasing in the share of high-type borrowers in the initial pool λ, and decreasing in the interest sensitivity of the demand for loans s.

It may seem intuitive that banks can increase their profits by sharing information on their borrowers. This is because they are able to eliminate more of the low-type borrowers and thus increase the quality of their portfolio. The bright side of information sharing may however hide potential downside risks for the banks, such as increased competition or even the misuse of credit information. We analyze the feasibility, as well as the pros and cons of information sharing in its two main organizational forms: bank consortia and independent credit bureaus.

4.2 Lender-owned bureaus

In a lender-owned bureau several banks pool the information on their borrowers allowing member banks to learn a firm's credit history even without the benefit of a previous direct relationship. While this will enhance the quality of lending decisions and thus the quality of bank portfolios, information sharing may increase competition among banks since each bank foregoes its informational monopoly. We examine the tradeoff between the two effects of information sharing, and its impact on the size and structure of the credit bureau.

The timing of events is as follows:

1. if banks prefer to share information, a lender-owned bureau of size $n \geq 2$ is formed; banks also decide on the cost of a credit report c and the fixed charge F to join the bureau;
2. information on credit histories is shared among banks in the bureau;
3. inside and outside banks choose their deposits;

4. banks choose their interest rates conditional on the credit history of each borrower.

Borrowers that have a credit history both inside and outside the bureau can potentially choose to repay (in the case of low-type borrowers) and apply for credit from both groups of banks. If a borrower has more than one successful contract inside the consortium it will choose credit from consortium in period 2 since it will be cheaper in the competition. For simplicity we assume that borrowers with one successful contract only in consortium will still borrow from inside banks.

Thus some of the borrowers that have had successful contracts with outside banks will not borrow from them in the new period - they will completely "migrate" inside the lender-owned bureau.

Inside banks share a common database, and they compete for all inside borrowers, including those that have not had a direct credit relationship with them in the first period. This will occur when the price per report c is low.

It is important to note that borrowers inside the bureau will receive different interest rates depending on the number of successful contracts they have had with the inside banks. This is because in equilibrium the banks' "margin" on the funds they have lent must be the same for all borrowers:

$$\lambda_i R_i - \bar{R} = \lambda_j R_j - \bar{R}$$

where i and j denote the number of successful contracts a borrower has inside the lender-owned bureau, and λ_i and λ_j are the updated probability that a borrower that has repaid i (j) contracts is a high-type borrower. If margins were different, then the bank could reallocate more funds to more profitable borrowers.

We can now determine the interest rates and amounts lent to borrowers with various numbers of successful contracts inside the bureau.

Proposition 4.2 *Given the size of the lender-owned bureau n, the inside interest rate for a borrower with one successful contract will be:*

$$R_1 = \frac{\frac{k}{n+1}\sum_{j=1}^{m} B_j + \frac{n}{n+1}\bar{R}s\sum_{j=1}^{m}\frac{B_j}{\lambda_j}}{s\lambda_1\sum_{j=1}^{m}\frac{B_j}{\lambda_j}}$$

The expected profits of an inside bank will be equal to

$$\Pi^{inside} = D^*(\lambda_1 R_1 - \bar{R}) = \frac{1}{(n+1)^2}\frac{1}{s\sum_{j=1}^{m}\frac{B_j}{\lambda_j}}\left(k\sum_{j=1}^{m} B_j - \bar{R}s\sum_{j=1}^{m}\frac{B_j}{\lambda_j}\right)^2 \tag{5}$$

Proof See Appendix.

where B_j is the number of borrowers with j successful contracts inside the bureau.

We next have a first look at the optimal size of the bureau. We show that, when the price of a credit report is low and lenders find it worthwhile to ask for reports on their competitors' initial customers, we have an upper limit on the coverage provided by the bureau.

Proposition 4.3 *If the cost of a credit report is low, the per-bank profit of banks inside the credit bureau is decreasing in the number of banks in the bureau for* $n \geq m$.

The bureau grows up to the point where adding another bank would decrease the per-bank profit for the inside banks. That is, the group of inside banks taken as a whole will reject the membership of an additional bank if that leads to a decrease in their individual profits. The proposition shows that the limit point is reached before $n = m$, and as a result we have incomplete coverage of borrowers in the economy.

4.3 The independent credit bureau

We next examine independent credit bureaus.

The timing of the game is as follows:

1. The independent bureau announces fixed fee F for participation and report price c.
2. Banks decide whether or not to join.
3. Information on credit histories is collected and provided to banks upon request at a price c per report.
4. Inside and outside banks choose their deposits.
5. Banks choose their interest rates conditional on the credit history of each borrower.

The independent bureau's maximization problem is given by

$$\begin{aligned} \max \quad & \Pi_M \\ s.t. \quad & \Pi(n) \geq \Pi^{out}(n), \\ & \Pi(n) \geq \Pi^{ns}, \\ & \Pi_M \geq 0. \end{aligned}$$

where $\Pi^{out}(n)$ is the outside bank profit when the bureau size is n, Π^{ns} is per-bank profit when there is no information sharing. The independent bureau will choose report prices and entry fees that maximize its total profits, subject to the banks being better off inside rather than outside the credit bureau.

Proposition 4.4 *The profit of the independent credit bureau is be equal to*

$$\Pi^{independent} = n \times \Big[\frac{\left(k\sum_{j=1}^{m} B_j - \bar{R}s\sum_{j=1}^{m}\frac{B_j}{\lambda_j}\right)^2}{s(n+1)^2\sum_{j=1}^{m}\frac{B_j}{\lambda_j}} - \frac{B}{N}\frac{N-n-m+1}{N-n}\Big(\lambda m + (1-\lambda)\frac{m-1}{2}\Big)\frac{(\lambda_0 k - s\bar{R})^2}{s\lambda_0(m+1)^2}\Big].$$

Proof See Appendix.

The independent credit bureau will choose a number of inside banks n to maximize its profits.

We can now compare the equilibrium size of the independent credit bureau to that of a lender-owned bureau. Given the profit function in proposition 4.4 and the per-bank profits in proposition 4.3, we can show the following result.

Proposition 4.5 *The coverage in the case of an independent credit bureau is higher or equal to the coverage in the case of a lender-owned bureau.*

Proof See Appendix.

The intuition behind our result is as follows. The lender-owned credit bureau aims to maximize the profit per bank. In determining the optimal size of the bureau, it is faced with a tradeoff: adding more banks improves the information available to the members of the bureau, and thus reduces potential lending losses, but it also increases competition, especially when credit report prices are low. The independent credit bureau focuses on the total surplus available within the credit bureau. Once again, adding one more bank improves lending decisions (and increases the surplus), but also competition (thus potentially reducing it). If the bureau becomes very large, the second effect may become more important than the latter. However, the size of the credit bureau where that happens is larger than the size where the per-bank profit is maximized.

5 Empirical results

The main prediction of our model is that coverage will be significantly higher in the case of independent agencies. In particular, the model shows that there are several factors that can limit the number of banks participating in a consortium, while an independent agency will be more likely to accept additional lenders, and thus generate higher coverage. We test the empirical implications of the model in this section.

The data concerning credit bureau coverage, creditor rights, and contract enforcement is taken from the Doing Business project at the World Bank. Credit bureau coverage reports the number of individuals and firms listed in a credit bureau database as a percentage of the adult population. The data on credit bureau ownership comes from hand-collected information from the websites of the bureaus. Where possible we cross-check with company information from the Orbis database. All other country-level data come from the World Bank databases.

In total, our largest sample covers 165 countries. 88 of the countries have private credit bureaus, which operate based on voluntary participation: we drop from the sample the few cases where the private bureau participation is mandatory.[9] 33 of the countries have bank consortia.

Table I presents the results about the relative coverage of the two types of credit bureaus. In preliminary univariate tests, the data show that the average coverage of a consortium is 44%, while the average coverage of independent agencies is 60%. The difference is statistically significant and economically large.

In the first set of regressions, we examine the difference in coverage for the two types of bureaus. We regress credit bureau coverage on the ownership dummy (equal to one if the credit bureau is lender-owned and zero if it is owned by an independent agency) and several controls: the existence of a public credit registry, the concentration of the banking system, the strength of legal rights index, and a measure of access to finance in a given country. Previous work has shown that there may be some substitutability between private and public information sharing (Jappelli and Pagano, 2002). We therefore include this in our regressions.

One may expect that in more developed countries with widespread access to banking coverage should be higher. In one of our specifications we include *access to finance*, which shows the share of borrowers with access to commercial banking (per 1000 adults). A higher share of private credit (as a percentage of GDP) should support more pervasive information sharing as well. Finally, countries with stronger creditor rights may need less information sharing. The index we use ranges from 1 to 10 and measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending.

Regression results confirm our main hypothesis: the proportion of borrowers included in information sharing arrangements is higher for independent agencies, whether additional controls are added or not. There also seems to be a residual effect of bank concentration. Access to finance corrects for the gap between our coverage in the model (percentage of banks in the industry), and our measure of coverage in data (percentage of adult population), but it unfortunately has few observations (column 5).

We next study the factors that influence the existence of a private credit bureau.

Our model predicts that bank concentration may matter. However, it does not tell us the sign of this effect on the existence of a private bureau. On the one hand higher concentration may make consortia less likely due to large banks being unwilling to join[10]. On the other hand, our model predicts that large banks are also less likely

[9] Our results are unchanged when we include those countries.

[10] For instance, large banks in Hungary and Russia were against sharing data with the private bureau. In Hungary OTP bank opposed to share consumer credit history with Hungary's BISZ bureau until 2007. In Russia, all banks have to share their data with a private credit bureau, and Sberbank did so with InfoCredit, a bureau established by itself, that was serving only Sberbank, until 2009 when it merged

Table I. Dependent variable: the share of borrowers as a percentage of population

The dependent variable (coverage) is the percentage of the adult population registered in a private bureau. Ownership is a dummy equal to 1 if more than 50 percent of the credit bureau is owned by lenders. Public credit registry is a dummy equal to 1 of the country operates a public credit registry. Strength of legal rights measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders (1-10). Access to finance shows the share of borrowers with access to commercial banking per 1000 adults. Private credit is the share of private credit as a percentage of GDP. Stars *, **, *** indicate significance at 10, 5 ,1 percent respectively.

Variable	(1) coverage	(2) coverage	(3) coverage	(4) coverage	(5) coverage
Lender ownership	-15.946**	-15.639**	-18.536**	-17.805**	-19.196*
	[7.357]	[7.598]	[7.989]	[8.057]	[10.707]
Public register		1.360	-3.804	-1.521	-5.088
		[7.649]	[8.349]	[8.825]	[10.352]
Bank concentration			-0.146	-0.150	-0.708**
			[0.199]	[0.199]	[0.274]
Strength of legal rights				1.288	-0.715
				[1.582]	[1.872]
Private credit					0.124
					[0.164]
Access to finance					0.041*
					[0.023]
Constant	60.824***	60.220***	73.902***	65.079***	99.799***
	[4.488]	[5.651]	[16.175]	[19.501]	[26.024]
Pseudo R-squared	0.05	0.05	0.07	0.08	0.41
Number of obs.	86	86	81	81	36

to collude with an independent bureau.

The existence of public credit registries (Jappelli and Pagano, 2002) is expected to have a negative effect on the likelihood of a private credit bureau being established in a given country. Furthermore, to see whether stronger banking systems are more likely to support bureaus, we regress the existence of a bureau (Table II) on the loans from financial institutions (as a share of GDP), as well as the strengths of legal rights index. To take account of the level of economic development, we include per capita gross national product. On all counts, more developed indicators indeed increase the likelihood that a bureau exists. Results are nearly identical when we use probit estimation.

In the third step, we study whether the influence of the main factors is different for bank consortia and independent credit agencies. Table III shows that bank concentration plays a different role for the two types of bureaus: it is negative and insignificant in the case of lender-owned and positive and significant in the independent bureau case. Higher concentration may make lender-owned bureaus less likely due to large banks' unwillingness to share information; in extreme when the largest bank in the industry has a size at least equal to the optimum size of the bureau n, it would only decrease its member (pro-rata) profits if shared data with another bank. On the other hand, however, higher concentration also makes collusion less likely, and thus a consortium more viable. Collusion is more likely when there are many small banks since, first, for

with Experian-Interfax in Russia. See http://www.rb.ru/article/sberbank-otkryvaet-kreditnye-istorii-svoih-klientov/5877947.html.

Table II. Dependent variable: dummy equal to 1 if a private credit bureau exists in the country

Loans from financial institutions is measured as a share of GDP. Strength of legal rights measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders (1-10). Stars *, **, *** indicate significance at 10, 5 ,1 percent respectively.

Variable	(1) bureau	(2) bureau	(3) bureau	(4) bureau
GDP per capita		0.001***	0.001**	0.001**
		[0.000]	[0.000]	[0.000]
Loans from financial institutions			0.014**	0.011
			[0.007]	[0.007]
Strength of legal rights				0.016
				[0.017]
Bank concentration	-0.003*			-0.003
	[0.002]			[0.002]
Const.	0.738***	0.388***	0.277***	0.269**
	[0.147]	[0.047]	[0.071]	[0.111]
Pseudo R-squared	0.06	0.06	0.06	0.06
Number of obs.	165	158	158	142

a small bank there is more to gain learn from rest of the market (as would be implied by the model), and, second, banks have less reputation concerns. Overall, the effect is unclear. In the case of the independent agency the first problem does not occur, since the independent firm would aim to obtain full coverage, while the concern regarding collusion is still important, thus suggesting a positive relationship between the two.[11]

Table III. Dependent variable: type of credit bureau.

Public credit registry is a dummy equal to 1 of the country operates a public credit registry. Strength of legal rights measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders (1-10). Private credit is the share of private credit as a percentage of GDP. Stars *, **, *** indicate significance at 10, 5 ,1 percent respectively.

Variable	(1) lender-owned	(2) lender-owned	(3) lender-owned	(4) independent	(5) independent	(6) independent
Bank concentration	-0.003	-0.003	-0.004	-0.001	0.005*	0.006**
	[0.002]	[0.003]	[0.003]	[0.002]	[0.003]	[0.003]
Public registry		-0.319***	-0.392***		0.325***	0.370***
		[0.106]	[0.117]		[0.109]	[0.120]
GDP per cap		-0.000	0.000		0.000	0.000
		[0.000]	[0.000]		[0.000]	[0.000]
Strength of legal rights			-0.027			0.005
			[0.023]			[0.024]
Private credit			-0.001			0.001
			[0.001]			[0.001]
Constant	0.374***	0.724***	1.016***	0.364***	0.005	-0.134
	[0.116]	[0.194]	[0.256]	[0.137]	[0.200]	[0.263]
Pseudo R-squared	0.06	0.08	0.06	0.08	0.08	0.09
Number of obs.	165	84	77	165	84	77

Interestingly, the public credit registry existence is significant and has opposite

[11] One caveat is that in our model we only consider symmetric banks. In real life, however, most banking systems are quite asymmetric: a small number of very large banks co-exist with many small banks. The result of this asymmetry is that large banks with many borrowers may be very unwilling to share information with the small banks. In terms of our model, a large bank that is n times as big as a small one is n banks and its profit maximization is the same (up to scaling factor).

signs for consortium (negative) and the independent bureau (positive). Intuitively, less asymmetric information implies banks have weaker incentives to set up a consortium, since consortia may or may not bring higher rents. For instance, if the public registry's coverage is above what the would-be optimum size n in the absence of the public registry, then such a consortium would not be able to compete with informational advantage. However, for an independent agency, the existence of a public register cannot render its business unprofitable unless it has full coverage. Indeed, in our model the independent agency expect to obtain full coverage. One may think that the technology for database management in place may only support the occurrence of an outside bureau.

The World Bank survey evidence of bank managers (IFC, 2006) suggests that a potential problem of collusion is present in case of outside ownership: many bank managers do not entrust their data to an outside entity fearing misuse of information with other competitors. In the model we think of it as a collusion between the bureau and a member bank, and the bank can then undercut its competitors for one period and share the proceeds with the agency. If banks anticipate this, they will decide to stay out and the credit bureau will not be feasible.

6 Conclusions

Looking at alternative arrangements to share credit information, we have shown that lender-owned credit bureaus are associated with lower coverage. Independent bureaus provide higher coverage, and are more likely to be established even with low credit report prices.

A lender-owned credit bureau will generally be more profitable for its member banks than an independent credit bureau. If the banking system is extremely fragmented, however, banks may still choose not to share information even in a consortium structure.

We show that a lender-owned bureau will usually not involve all lenders in the economy. If there is no collusion between banks inside the credit bureau, adding one more bank to an already large credit bureau will decrease per-bank profits. This is because an additional bank brings both better information and more competition to the consortium, and beyond a certain point the positive effect of the former is smaller than the negative impact of the latter.

Independent credit bureaus will be less likely to limit entry. This is because the main source of their profits is the sale of credit reports, and the income from selling reports is directly related to the number of banks included in the information-sharing arrangement. The higher coverage seems to be a virtue of this particular type of arrangement. Our empirical results largely confirm the predictions of our model.

While largely focusing on the positive aspect, our paper also has normative implications. It points to the advantages of independent credit bureaus, credit report price regulations, as well as the potential role of public registers in countries with underdeveloped banking systems.

References

[1] Bouckaert, J., Degryse, H., 2006, ”Entry and Strategic Information Display in Credit Markets”, *Economic Journal*.

[2] Brown, M., Jappelli, T., Pagano, M., 2009, Information Sharing and Credit Market Performance: Firm-Level Evidence from Transition Countries. *Journal of Financial Intermediation* 18, 151-172.

[3] Djankov S., McLiesh C., Shleifer A., 2007, “Private Credit in 129 Countries”, *Journal of Financial Economics*.

[4] Doblas-Madrid, A., Minetti, R., 2013, “Sharing information in the credit market: Contract-level evidence from U.S. firms”, *Journal of Financial Economics*.

[5] International Finance Corporation, “Credit Bureau Knowledge Guide”, World Bank Group, 2006.

[6] Jappelli T., Pagano M., “Information Sharing in Credit Markets: The European Experience”, WP no 35, 1999.

[7] Jappelli T., Pagano M., “Information Sharing in Credit Markets: A Survey”, WP no 36, 2000.

[8] Jappelli T., Pagano M, “Information Sharing in Credit Markets”, *Journal of Finance*, 1993.

[9] Jappelli T., Pagano M., “Information Sharing, Lending and Defaults: Cross Country Evidence”, *Journal of Banking and Finance*, 2002.

[10] Kallberg J., Udell G., ”The Value of Private Sector Business Credit Information Sharing: The US Case”, *Journal of Banking and Finance*, 2003.

[11] Karapetyan, A., Stacescu, B., “Does Information Sharing Reduce the Use of Collateral as a Screening Device?”, *Journal of Banking and Finance*, 2014.

[12] Karapetyan, A., Stacescu, B., “Information Sharing and Information Acquisition in Credit Markets”, *Review of Finance*, 2014.

[13] Kreps, D. M., Scheinkman, J. A., “Quantity Pre-Commitment and Bertrand Competition Yield Cournot Outcomes”, *Bell Journal of Economics*, 1983.

[14] Love M., Mylenko N., “Credit Reporting and Financial Constraints”, World Bank WP 3142, 2003.

[15] McIntosh C., Wydick B., “Competition and Microfinance”, WP, University of California at San Diego and University of San Francisco, 2004a.

[16] Miller M., "Credit Reporting Systems and the International Economy", MIT Press, 2003.

[17] Padilla J., Pagano M., "Endogeneous Communication Among Lenders and Entrepreneurial Incentives", *Review of Financial Studies*, 1997.

[18] Padilla J., Pagano M.,"Sharing Default Information as a Borrower Discipline Device", *European Economic Review*, 2000.

[19] Stiglitz J., Weiss A.,"Credit Rationing in Markets with Imperfect Information", *American Economic Review*, 1981

[20] Vercammen J.,"Credit Bureau Policy and Sustainable Reputation Effects in Credit Markets", *Economica*, 1995.

[21] von Thadden, E.-L., 2004, "Asymmetric information, bank lending and implicit contracts: the winner's curse," *Finance Research Letters*.

Appendix
Proof of Proposition 3.1

We first look at borrowers that have borrowed the full amount from just one bank. We have $\frac{1-\theta}{2}$ such borrowers for each bank. All high-type borrowers and some low-type borrowers have repaid in full; in total, successful borrowers represent $B_2 = \frac{1-\theta}{2}(\lambda + (1-\lambda)(1-\frac{2}{3}))$ and the probability that they are high-type and will successfully repay the new loan is $\lambda_2 = \frac{\lambda}{\lambda+(1-\lambda)(1-\frac{2}{3})}$.

Each bank solves the following maximization problem:

$$\mathrm{Max} D_m(\lambda_2 R_m - \bar{R}),$$

subject to $D_m = B_2 \times (k - sR_m)$ (the market clearing condition), where D_m is the amount of deposits lent to this group of borrowers, and R_m is the interest rate charged by the bank.

The market clearing condition can be rewritten as $R_m = \frac{k-\frac{D_m}{B_2}}{s}$, and the first-order condition is $\frac{\lambda_2}{s}\left(k - \frac{D_m}{B_2}\right) - \bar{R} - D_m \frac{\lambda_2}{sB_2} = 0$.

Solving, we get $D_m = B_2 \frac{\lambda_2 k - s\bar{R}}{2\lambda_2}$ and $R_m = \frac{\lambda_2 k + s\bar{R}}{2\lambda_2 s}$. Therefore bank profits on this borrower group are $\Pi^m = B_2 \frac{(\lambda_2 k - s\bar{R})^2}{4s\lambda_2}$.

We then look at borrowers that have credit histories with both banks. We have θ such borrowers, and each bank observes $B^1 = \theta(\lambda + (1-\lambda)\frac{1}{2})$ successful repayments. Banks know that high-type borrowers have repaid both loans in full, and try to attract them for the new loans. In the case of these borrowers, both banks have received a similar good signal (a successful repayment of their portion of the loan), and both banks make similar loan offers. Low-type borrowers that have defaulted will be rejected by the bank that has observed the default; successful low-type borrowers will try to mimic the demand of high-type borrowers in order to receive a loan. The probability that a borrower with a successful repayment is high type is $\lambda_1 = \frac{\lambda}{\lambda+(1-\lambda)\frac{1}{2}}$. Banks choose the amount of deposits D^1 and the interest rate R_1 for these borrowers. Each bank j solves the following maximization problem:

$$\mathrm{Max} D^{1,j}(\lambda_1 R_1 - \bar{R}),$$

subject to $\sum_{j=1}^{2} D^{1,j} = 2B^1 \times (k - sR_1)$ (the market clearing condition).

Solving, we get $D^1 = \frac{2}{3}B^1 \frac{\lambda_1 k - s\bar{R}}{\lambda_1}$ and $R_1 = \frac{\frac{1}{3}\lambda_1 k + \frac{2}{3}s\bar{R}}{\lambda_1 s}$. Therefore bank profits on this borrower group are $\Pi^1 = \frac{2}{9}B^1 \frac{(\lambda_1 k - s\bar{R})^2}{s\lambda_1}$. Note that in this case banks have different profit margins on their full and partial existing borrowers, given that they have a monopoly position over borrowers that only had a contract with them and not the competition.

Total profits for each bank under no information sharing are therefore $\Pi^{ns} = B_2 \frac{(\lambda_2 k - s\bar{R})^2}{4s\lambda_2} + \frac{2}{9} B^1 \frac{(\lambda_1 k - s\bar{R})^2}{s\lambda_1}$.

Proof of proposition 3.2

For the borrowers ($\frac{1-\theta}{2}$) that only borrowed from the bank during their previous history, we still have a monopoly situation under high credit report prices and profits are identical to those derived in the proof for proposition 3.1.

We also have θ borrowers that have borrowed from both banks. Each bank observes $B^1 = \theta(\lambda + (1-\lambda)\frac{1}{2})$ successful repayments, and asks for credit reports about those borrowers. $B^{1,share} = \theta(\lambda + (1-\lambda)(1-\frac{2}{3})$ of those borrowers have repaid their loans with both banks (they have a successful credit history) and the bank will offer them a loan. The other bank will ask for credit reports about its own previously successful borrowers. Both banks are interested in attracting the same high-type borrowers, which have generated the same signal (two successful repayments) for both banks and receive competing offers from both. The probability that a borrower with a good credit report is high type is $\lambda_2 = \frac{\lambda}{\lambda + (1-\lambda)(1-\frac{2}{3})}$. Banks choose the amount of deposits D^{high} and the interest rate R^{high} for these borrowers. Each bank j solves the following maximization problem:

$$\text{Max} D^{high,j}(\lambda_2 R^{high} - \bar{R}) - cB^1,$$

subject to $\sum_{j=1}^{2} D^{high,j} = 2B^1 \times (k - sR^{high})$ (the market clearing condition). The second term reflects the cost of credit reports acquired by the bank about its previously successful borrowers B^1.

Solving, we get $D^{high} = \frac{2}{3} B^{1,high} \frac{\lambda_2 k - s\bar{R}}{\lambda_2}$ and $R^{high} = \frac{\frac{1}{3}\lambda_2 k + \frac{2}{3} s\bar{R}}{\lambda_2 s}$. Therefore bank profits on this borrower group are $\frac{2}{9} B^{1,high} \frac{(\lambda_2 k - s\bar{R})^2}{s\lambda_2}$. Given that banks own the credit bureau, and that credit report costs are symmetric, banks will recoup the credit report costs through their share in the credit bureau's profits.

Total profits for each bank under a lender-owned credit bureau with relatively high credit report prices are therefore $\Pi^{high} = B_2 \frac{(\lambda_2 k - s\bar{R})^2}{4s\lambda_2} + \frac{2}{9} B^{1,share} \frac{(\lambda_2 k - s\bar{R})^2}{s\lambda_2}$.

Proof of Proposition 4.1

Under no information sharing, borrowers can only get funding from banks where they have not defaulted - m banks in the case of high-type borrowers. Thus m banks compete for each high-type borrower. Banks will choose the deposits they need and then compete in interest rates in order to attract borrowers.

Given binding deposit constraints, the equilibrium interest rate is given by

$$k - sR^0 = \sum_{j=1}^{m} D_j^0;$$
$$R^0 = \frac{k - \sum_{j=1}^{m} D_j^0}{s}.$$

In choosing their deposits, banks solve the following maximization problem:

$$\mathrm{Max}_{D_j^0} D_j^0 (\lambda^0 R^0 - \bar{R})$$

where λ_0 is the updated proportion of high-type borrowers conditional on observing a successful repayment:

$$\lambda_0 = \frac{\lambda}{\lambda + (1-\lambda)\left(1 - \frac{1}{m}\right)} = \frac{\lambda m}{m + \lambda - 1}.$$

The first-order condition of the maximization problem is:

$$\lambda^0 \frac{k - D_j^0 - \sum_{j=1}^{m} D_j^0}{s} = \bar{R}$$

hence optimal deposits per successful borrower are:

$$D_j^0 = \frac{\lambda_0 k - s\bar{R}}{\lambda_0 (m+1)}.$$

Plugging in he expression for optimal deposits we get the interest rate without information sharing:

$$R^0 = \frac{k}{s}\frac{1}{m+1} + \frac{m\bar{R}}{(m+1)\lambda_0}.$$

The expected profits per contract are:

$$\pi^0 = \frac{(\lambda_0 k - s\bar{R})^2}{s\lambda_0 (m+1)^2}.$$

The average per-bank profit will be the product between the average number of successful contracts and the expected profit per borrower: $\Pi^0 = B_0 \pi^0$, where

$$B_0 = \frac{B}{N}\Big(\lambda m + (1-\lambda)\Big(m - \frac{m(m+1)}{2m}\Big)\Big) = \frac{B}{N}\Big(\lambda m + (1-\lambda)\frac{m-1}{2}\Big).$$

Proof of Proposition 4.2

To visualize the interaction between banks and borrowers, one can think of the N banks and B potential borrowers (with $N \gg B$) as uniformly distributed on a circle as illustrated in the figure. Each borrower has signed m contracts in the first period, starting from a given bank and going clockwise along the circle ($m = AC'$). The initial quality of borrowers is assumed to be similar at each "bank point" on the circle in the first period. We also assume that banks "do not know" where they are on the circle - they know only whether they are inside or outside the consortium in the second period (green arrow BC'). This is because we want to maintain the simplicity of the geometric illustration (which avoids overly complicated and unnecessary combinatorics), while avoiding the artificial effects generated for instance by a bank's location "on the edges" of the credit bureau[12].

While we use a geometric illustration, we are not building a location model - there are no "transportation costs" in our model. Adding transportation costs may be useful in terms of modeling borrowers' preferences for various banks - preferences that are unrelated to the pure price-based lending relationship and that may be important in real life. This addition would also complicate computations and make results less transparent. The model can still obviously be extended in that direction, however.

The circle in Figure 1 represents the whole economy (N banks located uniformly in N districts, across the whole circle), while segment BC' is the consortium, the size of which is to be determined For simplicity, we assume that each borrower signs contracts with the banks located clockwise up to distance m from the borrower's location. On our circle, this will lead to the existence of four distinct segments:

- borrowers who have all their contract in the consortium - these are borrowers on segment BA. Inside banks therefore have the best "possible" information on those borrowers, and will be able to select just those borrowers that have repaid the full amount.
- borrowers who have "partial" contact with the consortium - these are borrowers on segment AC'(segment 1), and CB (segment 3). These borrowers have a credit history both inside and outside the consortium. They can repay both inside and outside (the high types will pay both in all cases). They can also receive credit from either group of banks.

[12] The main intuition of our model would be preserved in more complicated setups.

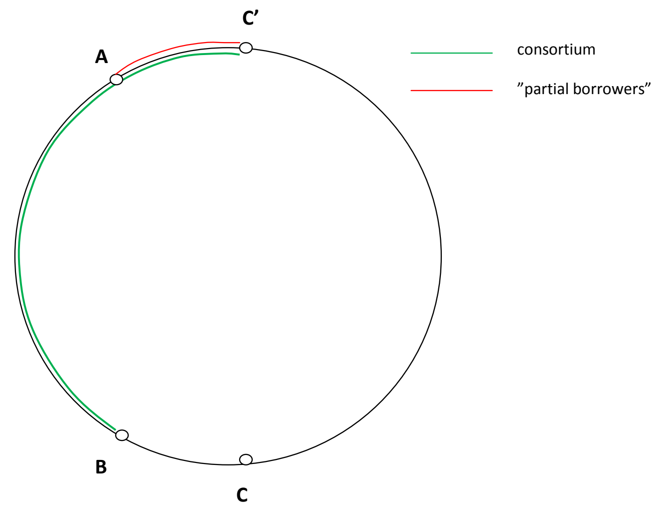

Figure 1: Geographic representation: N banks (and B borrowers) are uniformly distributed along the circle. Borrowers sign contract with $m = BC = AC'$ banks.

- borrowers that have had no contracts inside the consortium (segment CC'). These borrowers can only get credit from outside banks.

Low-type borrowers that have a credit history both inside and outside the credit bureau can choose where to repay or default ("strategic repayment"). We consider the case where 1. interest rates inside the consortium are low and 2. borrowers with a partial history inside the consortium are not "rationed" by the inside banks. This means that borrowers that have had contracts with members of the consortium will prefer to repay within the consortium, and that they will ask for/receive credit *only* from banks within the consortium[13].

The number of creditworthy borrowers in each group is equal to all high type borrowers on each segment, plus those lucky low-type borrowers, who have succeed on all their contracts in the consortium. To calculate the number of borrowers in each category, note that the length of segment (2) is $n - m + 1$, and borrowers there need to have m success for second period credit. The length of segments 1 and 3 is $m - 1$ each.

Creditworthy borrowers:

- For category (1) this includes borrowers with m successful contracts in the con-

[13] One may wonder why low-type borrowers care about the interest rates, given that they will not repay anything with probability 1 (given our simplifying assumption). In our model, a lower interest rate means a higher demand for loans from the high-type borrowers. Since low-type borrowers mimic the high-type borrowers, they will ask for/ receive a similar amount. Moreover, it is quite likely that the private benefits from "being in business" are increasing in the amount of funding they can get.

sortium, includes: $(n-m+1)\frac{B}{N}\lambda$ high type borrowers and

$$B_m = (n-m+1)\frac{B}{N}\lambda;$$

For category (2), with i $(1 \leq i \leq m-1)$ successful contracts in the consortium, this includes equal number of borrowers from segment 2 and 3 (we will refer to borrowers with i success contract as i type borrowers):

$$B^i = \frac{2B}{N}\Big[\lambda + (1-\lambda)\Big(1 - \frac{i}{m}\Big)\Big].$$

The total number of borrowers is therefore $\sum_{j=1}^{m} B_j = \frac{B}{N}(n-m+1)\lambda + \sum_{i=1}^{m-1} 2\frac{B}{N}(1-\lambda)\Big(1-\frac{i}{m}\Big) = \frac{B}{N}(n+\lambda(m-1))$.

Banks have already had lending relationships with some of the borrowers, and they have observed their success or failure (default). In the current period:

- the number of banks in the consortium, n, is chosen;
- information on first-period credit histories is exchanged among inside lenders;
- banks choose the quantity to lend;
- interest rates are determined.

We are looking for an equilibrium where

1. The consortium size is bigger than the number of banks borrowers have contracted with $(n > m)$;
2. All other borrowers (that is, borrowers with 1 or more success histories and no default) are served in the consortium.

This is equivalent to saying that a) the equilibrium interest rate for borrowers with at least a contract in the consortium is below that set by outside banks, and b) banks will have enough capacity to lend to all these borrowers.

More formally, the above equilibrium condition means inside banks should make the same profits on funds lent to any type:

$$\lambda^i R^i - \bar{R} = \lambda_j R^j - \bar{R}$$

thus

$$R^i = \frac{\lambda_1}{\lambda^i} R_1$$

for any $1 \leq i \leq m$. The probability that a borrower with i successful repayments (and no default) in the consortium is a high-type borrower is $\lambda_i = \frac{\lambda}{\lambda+(1-\lambda)\left(1-\frac{i}{m}\right)} = \frac{\lambda m}{m-i+\lambda i}$.

If the equality did not hold, banks would always be able to increase their profits by shifting their funds to the more profitable type.

The interest rate for type i can therefore be expressed as a function of the interest rate for the borrowers that have had only one contract inside the consortium:

$$R^i = \frac{\lambda_1}{\lambda^i} R_1$$

for any $1 \leq i \leq m$.

Each inside bank i chooses D_i so as to solve the following maximization problem:

$$\text{Max} D_i \Big(\lambda_1 R_1 - \bar{R} \Big)$$

s.t

$$\sum_{j=1}^{m} B_j (k - sR^j) = \sum_{l=1}^{n} D_l$$

Interest rates will be determined from the constraint, and therefore will be given by

$$R_1 = \frac{k \sum_{j=1}^{m} B_j - \sum_{l=1}^{n} D_l}{s\lambda_1 \sum_{j=1}^{m} \frac{B_j}{\lambda_j}}$$

Thus the maximization problem reduces to

$$\text{Max} D_i \Big(\frac{k \sum_{j=1}^{m} B_j - \sum_{l=1}^{n} D_l}{s \sum_{j=1}^{m} \frac{B_j}{\lambda_j}} - \bar{R} \Big).$$

In a symmetric equilibrium, each bank will choose total deposits equal to

$$D_i = \frac{1}{n+1} \Big(k \sum_{j=1}^{m} B_j - \bar{R} s \sum_{j=1}^{m} \frac{B_j}{\lambda_j} \Big)$$

The equilibrium interest rate for borrowers that have had a success story within the consortium is equal to

$$R_1 = \frac{\frac{1}{n+1}\sum_{j=1}^m B_j + \frac{n}{n+1}\bar{R}s\sum_{j=1}^m \frac{B_j}{\lambda_j}}{s\lambda_1 \sum_{j=1}^m \frac{B_j}{\lambda_j}}$$

The profit margin for the funds lent by the inside banks is equal to

$$\lambda_1 R_1 - \bar{R} = \frac{1}{n+1}\frac{k\sum_{j=1}^m B_j - \bar{R}s\sum_{j=1}^m \frac{B_j}{\lambda_j}}{s\sum_{j=1}^m \frac{B_j}{\lambda_j}}$$

Expected profits per bank:

$$\Pi^{inside} = D^*(\lambda_1 R_1 - \bar{R}) = \frac{\left(k\sum_{j=1}^m B_j - \bar{R}s\sum_{j=1}^m \frac{B_j}{\lambda_j}\right)^2}{s(n+1)^2\sum_{j=1}^m \frac{B_j}{\lambda_j}}.$$

We have that $\frac{B_m}{\lambda_m} = \frac{B}{N}(n-m+1)$. For $j = 1, ..., m-1$ we have $\frac{B_j}{\lambda_j} = 2\frac{B}{N}\frac{\left(\lambda+(1-\lambda)\left(1-\frac{j}{m}\right)\right)^2}{\lambda}$.
Therefore $\sum_{j=1}^m \frac{B_j}{\lambda_j} = \frac{B}{N}(n-m+1) + \sum_{j=1}^{m-1} 2\frac{B}{N}\frac{\left(\lambda+(1-\lambda)\left(1-\frac{j}{m}\right)\right)^2}{\lambda}$.

Proof of Proposition 4.3

The per-bank inside profit Π^{inside} is $\Pi^{inside} = D^*(\lambda_1 R_1 - \bar{R}) = \frac{\left(k\sum_{j=1}^m B_j - \bar{R}s\sum_{j=1}^m \frac{B_j}{\lambda_j}\right)^2}{s(n+1)^2\sum_{j=1}^m \frac{B_j}{\lambda_j}}$.

Its derivative with respect to the number of banks in the consortium n is:

$$\begin{aligned}
\frac{\partial \Pi_b}{\partial n} &= \frac{1}{(n+1)^4} \times \frac{1}{\left(s\lambda_1\sum_j \frac{B_j}{\lambda_j}\right)^2} \times \Big[(k\lambda\frac{B}{N} - s\bar{R}\frac{B}{N})(n+1)^2 s\lambda_1 \sum_{j=1}^m \frac{B_j}{\lambda_j} \\
&- \Big((n+1)^2 s\lambda_1 \frac{B}{N} + 2(n+1)s\lambda_1\sum_{j=1}^m \frac{B_j}{\lambda_j}\Big)\Big(k\sum_{j=1}^m B_j - s\bar{R}\sum_{j=1}^m \frac{B_j}{\lambda_j}\Big)\Big] - c\frac{B}{N}\lambda \\
&= \frac{1}{(n+1)^3} \times \frac{1}{\left(\sum_j \frac{B_j}{\lambda_j}\right)^2}\Big[k\Big(\lambda\frac{B}{N}(n+1)\sum_{j=1}^m \frac{B_j}{\lambda_j} - (n+1)\frac{B}{N}\sum_{j=1}^m B_j - 2\sum_{j=1}^m B_j \sum_{j=1}^m \frac{B_j}{\lambda_j}\Big) \\
&+ 2s\bar{R}\Big(\sum_{j=1}^m \frac{B_j}{\lambda_j}\Big)^2\Big] - c\frac{B}{N}\lambda
\end{aligned}$$

The derivative is negative because:

$$\lambda\frac{B}{N}(n+1)\sum_{j=1}^{m}\frac{B_j}{\lambda_j}-(n+1)\frac{B}{N}\sum_{j=1}^{m}B_j=(n+1)\Big(\frac{B}{N}\Big)^2((m-1)(-\lambda-1)+2\sum_{j=1}^{m-1}\Big(\lambda+(1-\lambda)\Big(1-\frac{j}{m}\Big)\Big)^2)$$
$$=(n+1)(1-\lambda)(m-1)\Big(\frac{B}{N}\Big)^2\Big(-1+(1-\lambda)\frac{2m-1}{3m}\Big)<0$$

and

$$2\sum_{j=1}^{m}\frac{B_j}{\lambda_j}\Big(-k\sum_{j=1}^{m}B_j+s\bar{R}\sum_{j=1}^{m}\frac{B_j}{\lambda_j}\Big)<0.$$

The per-bank profit is decreasing in n if $n>m$.

Proof of Proposition 4.4

Suppose we have n banks in the credit bureau. They will ask for credit reports about all borrowers in the bureau if the cost of a credit report c is low.

The per-bank profit is:

$$\begin{aligned}\Pi_b=&D^*(\lambda_1R_1-\bar{R})-\text{ report costs}-\text{ entry fee}\\ =&\frac{\Big(k\sum_{j=1}^{m}B_j-\bar{R}s\sum_{j=1}^{m}\frac{B_j}{\lambda_j}\Big)^2}{s(n+1)^2\sum_{j=1}^{m}\frac{B_j}{\lambda_j}}-c\sum_{j=1}^{m}B_j-F,\end{aligned}$$

where c is the price of a credit report, $\sum_{j=1}^{m}B_j=\frac{B}{N}(\lambda n+m-1)$, F is the entrance fee. $\frac{B_m}{\lambda_m}=\frac{B}{N}(n-m+1)$. For $j=1,...,m-1$ we have $\frac{B_j}{\lambda_j}=2\frac{B}{N}\frac{\Big(\lambda+(1-\lambda)\Big(1-\frac{j}{m}\Big)\Big)^2}{\lambda}$. Therefore $\sum_{j=1}^{m}\frac{B_j}{\lambda_j}=\frac{B}{N}(n-m+1)+\sum_{j=1}^{m-1}2\frac{B}{N}\frac{\Big(\lambda+(1-\lambda)\Big(1-\frac{j}{m}\Big)\Big)^2}{\lambda}$.

(Note:

$$\sum_{j=1}^{m-1}\Big(\lambda+(1-\lambda)\Big(1-\frac{j}{m}\Big)\Big)^2=\lambda(m-1)+(1-\lambda)^2\frac{(m-1)(2m-1)}{6m}.)$$

The per-bank profit needs to be above the profits they would get as an outside bank:

$$\Pi^0=\frac{B}{N}\frac{N-n-m+1}{N-n}\Big(\lambda m+(1-\lambda)\frac{m-1}{2}\Big)\frac{(\lambda_0k-s\bar{R})^2}{s\lambda_0(m+1)^2}.$$

where $\lambda_0 = \frac{\lambda}{\lambda+(1-\lambda)\left(1-\frac{1}{m}\right)} = \frac{\lambda m}{m-1+\lambda}$.

The independent agency maximizes $n(c\sum_{j=1}^m B_j + F)$, provided that $\Pi \geq \Pi^{out}$.

At the limit, $\Pi^{independent} = \Pi^{out}$, so $n(c\sum_{j=1}^m B_j+F) = n\times\Big[\frac{\left(k\sum_{j=1}^m B_j - \bar{R}s\sum_{j=1}^m \frac{B_j}{\lambda_j}\right)^2}{s(n+1)^2\sum_{j=1}^m \frac{B_j}{\lambda_j}} - \frac{B}{N}\frac{N-n-m+1}{N-n}\left(\lambda m + (1-\lambda)\frac{m-1}{2}\right)\frac{(\lambda_0 k - s\bar{R})^2}{s\lambda_0(m+1)^2}\Big]$.

Proof of Proposition 4.5

We have that

$$\Pi_{independent} = n(\Pi_b - \Pi^{out}).$$

Note that

$$\frac{\partial \Pi_i}{\partial n} = n\frac{\partial \Pi_b}{\partial n} + \Pi_b - n\frac{\partial \Pi_{out}}{\partial n} - \Pi_{out}$$

Π_i and Π_b are continuous and differentiable functions of n.

First, suppose that there is an internal value of n ($0 < n_b < N$) where Π_b is maximized. We have $\frac{\partial \Pi_b}{\partial n}|_{n_b} = 0$ and $\frac{\partial^2 \Pi_b}{\partial n^2}|_{n_b} < 0$. Since $\Pi_b - n\frac{\partial \Pi_{out}}{\partial n} - \Pi_{out} > 0$, there will be a local solution n_i to $\frac{\partial \Pi_i}{\partial n} = n_i\frac{\partial \Pi_b}{\partial n} + \Pi_b - n_i\frac{\partial \Pi_{out}}{\partial n} - \Pi_{out} = 0$ which is necessarily higher: $n_i > n_b$. If $\Pi_i(n_i)$ is the global maximum, then we have shown that in equilibrium there will be more banks in an independent credit bureau than in a lender-owned one.

If there are several local maxima for Π_i, suppose there is a global maximum at $n'_i < n_i$. That would imply that $n'_i(\Pi_b(n'_i) - \Pi_{out}(n'_i)) > n_i(\Pi_b(n_i) - \Pi_{out}(n_i)) > n_b(\Pi_b(n_b) - \Pi_{out}(n_b))$. However, we know that $n'_i < n_b$, $\Pi_b(n'_i) < \Pi_b(n_b)$ (n_i is a global maximum for Π_b), and $-\Pi_{out}(n'_i) < -\Pi_{out}(n_b)$ (Π_{out} is decreasing in n). Therefore as long as $\Pi_b(n_i) - \Pi_{out}(n_i) > 0$ (as long as a credit bureau exists), we cannot have a global maximum for Π_i below n_i, and as $n_i > n_b$, coverage is higher with an independent credit bureau than with a bank-owned credit bureau.

Suppose next that we have a corner solution, i.e. Π_b has the highest value at 0 or N. If the highest value is at zero, then an independent credit bureau, if it exists, can only have higher coverage than what obtains under an attempt at a lender-owned credit bureau. If the highest value is at N, then $\frac{\partial \Pi_i}{\partial n}|_N \geq 0$, therefore $\frac{\partial \Pi_b}{\partial n}|_N \geq 0$. Then we can show as above that Π_i cannot have a global maximum below N.