When Do Banks Share Customer Information?

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Abstract

It has been a widely shared view among financial economists that information sharing across banks about borrowers reduces or fully eliminates information asymmetry in modern credit markets. Several analysts also argued that full information sharing would best serve the banks' long-term interest. I propose that the type of information sharing is endogenous to the market structure. No information sharing is the banks' dominant strategy if the fraction of bad borrowers is small and banks incur low marginal cost of funds and operation. Myopic banks would also prefer no information sharing. However, banks would choose full information sharing if the share of bad borrowers is substantial, or banks incur largely different marginal costs. In contrast to former studies I show—using a simple infinite horizon model with overlapping generations and with customers' strategic behavior—that banks' willingness to share information and the type of information sharing depends on institutions, banks' costs and market concentration rather than on demand or other market characteristics such as, regional diversity or local monopolies.

Borrowers with good credit records, on the other hand, would prefer information sharing only about bad customers to full or to no information sharing. Comparing mature private credit markets and newly emerging markets I demonstrate that banks face an "initial period effect" in emerging markets, but this effect does not have long-lasting consequences on banks' subsequent choice of information sharing.

JEL Classification Numbers: D81 Risk and uncertainty D82 Credit markets- Asymmetric information D92 Intertemporal firm choice G21 Banks G29 Financial institutions

Keywords: Risk and uncertainty, Credit markets – Asymmetric information, Intertemporal firm choice, Banks, Financial institutions

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1. Introduction

The fast development of private credit markets in recent decades raised a series of questions about the institutions necessary to support a well-functioning financial system. (Joseph Stiglitz and Andrew Weiss 1981, and Tullio Jappelli and Marco Pagano 2002). Jorge A. Padilla and Pagano (2000) show that moral hazard in borrower-lender relationship can be contained by information sharing. This should provide banks with strong incentives to share information about their customers but despite serious efforts of various third parties, including the World Bank, credit reporting institutions are slow to appear in emerging markets (Margaret J. Miller 2002). The question this paper addresses is under what conditions are banks interested in sharing full or partial information about customers in mature and emerging markets.

I shall discuss two related issues in this paper: (1) What is the optimum pricing strategy of the banks under a given information sharing arrangement? (2) What information sharing arrangement is the most beneficial to banks? Most studies on banks' competition and on information sharing apply a two-period price competition model—or its stationary extension—with myopic customer behavior. I shall assume strategic customer behavior and I show that strategic borrower behavior results in a different optimal information sharing strategy of the banks than what, for instance Bouckaert and Degryse (2006) described. I develop a simple *infinite horizon* model for oligopolistic private credit markets where banks arrive at the "current period" with unequal market shares.

My contribution to the existing literature on information sharing among banks is summarized in the following hypotheses:

1. Full information sharing may be the banks' dominant strategy in the long run, for they can charge higher interest rates than with any other form of information sharing (except with no information sharing at all), and sharing customer information keeps the mass and fraction of bad borrowers small. However, myopic banks or fully rational banks that operate in a market where the proportion of bad customers is currently small, and there is not a huge diversity among banks' operating costs will opt for no information sharing.
2. Borrowers with good credit records, on the other hand, would prefer information sharing only about bad customers to full or to no information sharing.
3. There is an "initial period effect" in emerging markets[1]—that is, banks will find their optimal interest rate in a completely different way in the first period than in subsequent periods—but this effect does not have a lasting impact on the long-term structure of the market or on the optimal choice of banks' information sharing. The choice of pricing strategy and information sharing will be based on the same principles in emerging as in mature markets, from the second period on.

The structure of the paper is as follows: I give a concise literature review in section 2. I describe the assumptions and notations in section 3. I outline the model of banks' competition in a mature market with different information sharing regimes in section 4, where I also address the specific features of the emerging private credit markets. Discussion and conclusions follow in section 5.

2. Literature review

This paper is a contribution to the literature on information sharing in imperfect markets.[2] The literature on information sharing between firms is very rich. But I have found only a few papers that address the issue of information transfer among economic actors when the same piece of private information can be "good news" or "bad news" depending on the actors' economic strength.[3] Susan Athey and Kyle Bagwell (2001) analyze collusive behavior in a price competition setting where agents have different market shares. They conclude that collusion requires that large agents relinquish market share. William Novshek and Hugo Sonnenshein (1982) conclude that full information sharing or no information sharing can equally support Nash equilibria in oligopolistic competition. My results are in line with what Novshek and Sonneshein attest. Esther Gal-Or (1985) asserts that no information sharing is the unique Nash equilibrium in Cournot competition if agents have private information about demand. This conclusion seems to have a limited relevance especially in private credit markets. Lode Li (1985) argues that no information sharing is the unique equilibrium if information sharing would be about a common parameter of the market or the agents' efficiency. Amir Ziv (1993) points to the fact that information sharing may be hampered by moral hazard if agents use private information strategically in competition. Finally, Xavier Vives (2002) argues that having private information is a much more powerful tool in oligopolistic competition than having large market share. I arrived at different conclusions than most of the authors mentioned above. Namely, I did not find information sharing and especially its form neutral to competition. I agree with Vives that private information may be more relevant than market share, but in case a large actor has private information he can use it in a completely different way than a small actor.

Previous work on information sharing in private credit markets is not extensive. Pagano and Jappelli (1993) analyze a market with regional monopolies that existed in the past in the US.

James Vercammen (1995) presents a moral hazard *cum* adverse selection approach to information sharing without explicitly addressing the banks' optimization problem. Padilla and Pagano (1997) also focus on reputation games driven by the borrowers' effort and welfare. Jan Bouckaert and Hans Degryse (2004) use a two period price competition model with borrowers' switching costs to show that banks' voluntary disclosure of customer information lessens the problem of adverse selection in loan markets and softens the banks' competition for market share in the initial period. The authors do not explicitly state but it obvious from their paper that they assume full information sharing even if the decision to share information is not necessarily symmetric among banks. Bouckaert and Degryse (2006) revise their previous analysis and argue that banks may disclose only positive information about their own clients in order to deter entry. Thomas Gehrig and Rune Stenbacka (2007) arrive at similar conclusions as Bouckaert and Degryse (2004), namely that information sharing among banks softens competition for market shares, but they focus on the negative welfare effects of lenders' information disclosure. They argue that information sharing hampers competition, consequently, a portion of good borrowers' benefit will be converted into lenders profit. Marquez (2002) arrives at a different conclusion when he shows that banks' merger—a *de facto* information sharing arrangement—alleviates the problem of adverse selection and results in lower interest rates than a fragmented market. Giovanni Dell'Ariccia (2001) delivers a similar conclusion. He shows—by using a multi-period spatial model—that the number of banks is endogenous when banks have asymmetric information about borrowers. He also demonstrates that—contrary to expectations—the more concentrated the loan market is the lower interest rates become.

Steven A. Sharpe (1990) and Ernst-Ludwig von Tadden (2004) use a two-period price competition model to show that high quality borrowers are informationally captured and remain with their original bank without information sharing. Their main conclusion is that information asymmetry softens competition for good borrowers. Sharpe (1990) extends the analysis to infinite periods in the framework of an overlapping generations model, but he assumes that banks offer the same stationary contract to each cohort of borrowers. That is, banks' optimizing strategy is fairly restricted and borrowers do not act strategically in Sharpe's model.

Joseph Farrell and Carl Shapiro (1988) present a dynamic price competition duopoly model (with switching costs) and they conclude that the two competitors change places in successive periods as "incumbent" and "entrant," and the incumbent serves only its old customers—who are locked in by switching costs—while the entrant serves the new customers.[4]

I propose a different approach than Farrell and Shapiro (1988). Information sharing rather than switching costs plays the role of a "lock-in device" in the current framework. Namely, if banks share full information, the banks' dominant strategy will be to poach good customers of other banks. But we need to see first whether it is in the banks' best interest to share full information.

My approach is closest to Drew Fudenberg and Jean Tirole (1998, 2000) and J. Miguel Villas-Boas (1999) who show that firms (banks) with smaller market shares will compete more aggressively for known customers of their rivals than larger companies (banks), especially in cases when firms (banks) cannot offer credible long-term contracts. Villas-Boas (1999) also discusses the impact of customer recognition on firms' pricing strategy in a dynamic setting and argues that more patience on the customers' and on the firms' side will soften competition in the market.

3. Assumptions and notations

3.1 *Customers*

A mass of N customers may borrow in the market in every period. I assume that the mass of all potential customers is fixed and continuous, and it is normalized to two in each period.[5] Each customer lives exactly for two periods.[6] Hence, half of the customers—with a mass of one—enter the market as new and half of them—also with a mass of one—leave the market as old in each period. Customers are characterized by their preferences, that I assume to be quasi-linear, by "reliability type"—type can be "good" or "bad"—and by their valuation, and their history. A fraction γ of the customers is "good type" and a fraction $(1-\gamma)$ is "bad type" in period t. Customers' type does not change over time. "Good" customers always repay the loan, while "bad" customers never repay.[7]

I make the following assumption about customers' choice of a bank: I assume that each new good borrower will choose one of two banks that operate in the market, based on his or her preference for the banks' services, and on the interest rates banks charge.[8] I shall also assume that borrowers' preferences do not change over time. I shall work with the assumption that customers' preferences for banks, denoted θ are uniformly distributed on the unit interval.[9]

Since bad borrowers know that they will not repay the loan their allocation across banks is random. I shall assume that bad borrowers go to banks according to the banks' market share in the market for new borrowers. This assumption is supported by empirical observations that the fraction of bad customers is almost identical across banks in most countries. (I could have assumed instead that half of bad customers go to one bank and half of them to the other bank. This would alter the formulas but not the substance of the analysis.) If banks share bad borrower information, the number of bad customers who borrow from bank k will be in period t: $s_t^y(k)(1-\gamma),\ k=1,2$, where $s_t^y(k),\ k=1,2$ denotes the market share of bank k in the market segment of "young" borrowers in period t. If banks do not share bad information, each bank will receive more bad customers from the pool of bad borrowers than with bad information sharing, for all bad borrowers unknown to a bank may borrow. Consequently, the number of all bad customers who can borrow in period t will be $(1-\gamma)$ if banks share bad information, while in case banks do not share information about bad customers, the number of bad customers who will be able to borrow at some bank becomes $2(1-\gamma)$.

I need to emphasize the crucial difference between a "young" or "old" customer on the one hand, and an unknown or known customer on the other. While all "young" customers are unknown to all banks, an old customer may be unknown to all those banks that have not served this customer yet, depending on the type of information sharing among banks. That is, if banks share information on a certain group of customers, then all old borrowers who belong to this group will be known to all banks. If banks do not share information, then an old customer will only be known to the bank that extended loan to this borrower.

Customers may borrow \$1 either from bank 1 or from bank 2, or they don't borrow in period t. I shall assume that all customers have high enough valuation for the loan so that all of them will be able to borrow. Since each customer can borrow just \$1 per period and all of them are capable of borrowing, for simplicity's sake I assume that customers have an identical net valuation v of the loan.[10] Thus, their total benefit from a \$1 loan is $1+v$. Customers' valuation does not change over time.[11] Then good customers, who borrow and repay in both periods, maximize total utility from two periods:

(1) $$u\left(R_t(k), R_{t+1}(j)\right) = v - R_t(k) - \theta_k + \delta\left(v - R_{t+1}(j) - \theta_j\right), \quad k=1,2; \quad j=2,1.$$

where $R_t(k)$ and $R_{t+1}(j)$ are the interest rates of bank *k* or bank *j* in period *t* and *t*+1, respectively, depending on whom the customer has borrowed from in that period, $\delta \in (0,1)$ is the discount factor, and θ_k, θ_j measure the customer's "distance" from that bank he or she actually borrowed from in period *t* and *t*+1. A bad customer will borrow and not repay in both periods if banks do not share information about bad borrowers. A bad customer's pay-off then becomes: $u^B = (1+\delta)(1+v)$. If banks share bad information, a bad customer can borrow either in the first or in the second period of his presence in the market. It is obvious that bad borrowers do not postpone to take the loan until the second period, for the discounted value of their benefit would be smaller than what they gain from borrowing and not repaying in the first period, which is $u^B = 1+v$.

Finally, I assume that customers do not incur switching costs others than what they may pay in terms of higher interest rates if they switch banks.

3.2 *Banks*

Two banks operate in the private credit market in period *t*.[12] Since banks can identify at least those customers who already borrowed from them, each bank is capable of distinguishing among known good, known bad and unknown borrowers. Consequently, banks can apply "behavioral price discrimination"—*á la* Fudenberg and Tirole (2000)—between known good and unknown borrowers. Obviously, banks will not serve known bad customers. Hence, bank *k*'s gross benefit from extending a \$1 loan to a known good customer in period *t* will be $(1+R_t^G(k))$, while it will be $(1+R_t^U(k))$ in case of an unknown borrower if the loan is repaid, where $R_t^G(k)$ and $R_t^U(k)$

are the interest rates that bank k will charge to known good and to unknown customers, respectively.

Banks' cost from selling loans consists of two components: the *loss* imposed upon them by borrowers who do not repay the loan plus the cost of funds and operation. I assume that bank k's marginal cost of funds and operation is constant at c_k. For simplicity's sake, I disregard banks' startup costs. I further assume that banks do not pay for the information they acquire about customers from a credit rating agency.[13]

Banks are represented by their history, strategy and payoff. Banks' history is the infinite past in mature markets. But the knowledge a bank accumulates about customers during two successive periods becomes almost useless after these customers exit the market. New generations of customers will enter the market and information about each generation is relevant only for two periods.

Bank k's history consists of the mass of unknown borrowers and the mass of known good customers this bank has served in periods before period t. The bank's strategy is a function that maps the bank's history into prices for unknown and for known good customers they serve in the current period, $\left(R_t^U(k), R_t^G(k)\right)$:

(2) $$\left(R_t^U(k), R_t^G(k)\right) = f_k\left(h_t(k)\right), \quad k = 1, 2,$$

where $h_t(k)$ is bank k's history up until period t.

Banks maximize profits from infinite periods by choosing interest rates for different groups of customers they are going to serve in each period. The bank's payoff from a certain strategy is the expected discounted profit from pursuing that strategy given the actions of its customers, and the strategy of other banks:

$$(3) \qquad \pi(k)=\sum_{t=0}^{\infty}\delta^t\pi_k\left(R_t^U(k),R_t^G(k)\middle|R_t^U(j\neq k),R_t^G(j\neq k)\right), \quad k=1,2; \quad j=2,1.$$

3.3 *The nature of competition in the market*

Banks jointly choose the system of information sharing if they can voluntarily agree on what type of information sharing to apply. If banks cannot agree on the type of information sharing, there will be either no information sharing among them at all, or the type of information sharing will be set by law. I shall only discuss the banks' optimal choice of information sharing. I do not deal with cases where information sharing is designed by the legislature.

Banks can join four different types of information sharing systems: (1) they can share information only about bad customers (a "black list"), or (2) only about good customers ("white list"), or (3) about all customers they serve ("full list"). Finally, (4) they can refuse to share any customer information.

What are the potential institutions of information sharing banks can rely on? One way of joining an information system for a bank is to submit its files on customers to credit bureaus without having financially compensated for these files. Then the bank can purchase sets of customer information from the credit bureaus. Such a credit reporting system has existed in the United States.

Theoretically, it would be possible for banks to buy and sell information directly to and from other banks. Moreover, banks could exchange information on a "one for one" basis, that is, bank *A* would disclose information about a certain number of its customers to bank *B* and it would get information on an equal number of customers from bank *B* in return. We do not see these direct transactions happening between banks. It would need an extensive analysis why a “free market” of customer information does not exist. Such a study is beyond the scope of this paper. I shall just briefly address the issue how banks would value customer information in an unregulated information market in the discussion section.

Each bank’s choice of the type of information sharing is conditioned on the amount of profits it can earn during infinite periods under different types of information sharing. Once all banks agreed to implement a certain type of information sharing, this system remains in place for the future. Banks simultaneously set the interest rates for new customers at each period before these customers decide from which bank to borrow. Then—as in Villas-Boas (1999)—each bank observes the interest rates charged to unknown borrowers by other banks before it decides on the interest rate it will charge to known good customers. Banks’ pricing rule is common knowledge among banks and borrowers. Banks have relevant information about their known customers when they offer the loan.

Customers learn the conditions of borrowing when they enter the market. Once a new customer learned the conditions of borrowing and signed a contract with a bank, there is no possibility of reneging on either side, nor can banks unilaterally alter the conditions of the loan.

Banks make simultaneous pricing decisions for unknown, and separately for known good customers in a mature market. But banks sell loans only to unknown customers in an emerging market in the “initial” period. After that period, they engage in a simultaneous price setting competition—as it happens in mature markets—for infinite periods. The question I shall ask: does this “initial period effect” have lasting consequences for the banks’ competitive strategies and for their choice of information sharing in transition markets?

I define market equilibrium as follows: banks set different interest rates for unknown and for known good customers that satisfy the Markov perfect equilibrium conditions. That is, interest rates are best responses to all other banks' choice, conditioned on the state variable of the mass of unknown customers each bank serves in period t and on the customers' type of being good or bad. Customers allocate themselves among banks and market(s) clear in each period.

The timing of the infinite horizon game among banks is as follows:

1. Nature had set γ and $1-\gamma$ in the infinite past. Borrowers' valuation v is also set when they enter the market.
2. Banks jointly decide what type of information sharing they apply.
3. Borrowers learn what form of information sharing between banks is in place.
4. Banks simultaneously set the interest rates for unknown customers.[14]
5. Banks observe the interest rates for unknown borrowers and simultaneously set the interest rates for known good customers.
6. Customers allocate themselves across banks accordingly and pay-offs occur.

4. Infinite horizon price competition among banks with and without information sharing in mature markets

After having outlined the modeling assumptions I present the models with different information sharing systems.

Let us start with the borrowers' problem. Since I assumed that bad borrowers allocate themselves according to banks' market share in the market for new customers, we only need to find the mass of good customers a bank will serve in period t. A "young" good customer with preference θ will choose bank k rather than bank j in period t if an only if:

(4)

$$\begin{aligned} &v - R_t^U(k) - \theta + \max\left\{\delta\left(v - R_{t+1}^G(k) - \theta\right); \delta\left(v - R_{t+1}^U(j) - (1-\theta)\right)\right\} \geq \\ &\geq v - R_t^U(j) - (1-\theta) + \max\left\{\delta\left(v - R_{t+1}^G(j) - (1-\theta)\right); \delta\left(v - R_{t+1}^U(k) - \theta\right)\right\}, \end{aligned}$$

which can also be written as:

(5)

$$R_t^U(k)+\theta+\min\left\{\delta\left(R_{t+1}^G(k)+\theta\right);\delta\left(R_{t+1}^U(j)+(1-\theta)\right)\right\}\leq$$
$$\leq R_t^U(j)+(1-\theta)+\min\left\{\delta\left(R_{t+1}^G(j)+(1-\theta)\right);\delta\left(R_{t+1}^U(k)+\theta\right)\right\},$$

where, again, θ denotes the customer's distance from her or his preferred bank, $R_t^U(k)$ and $R_t^U(j)$ are the interest rates charged to unknown customers in period *t*, while $R_{t+1}^G(k)$ and $R_{t+1}^G(j)$ are the interest rates charged to known good customers by bank *k* and bank *j* in period *t*+1, respectively.

The marginal customer between bank *k* and bank *j* will be the person, who is indifferent between choosing bank *k* in the first period, and choosing either bank *k* or bank *j* in the second period, depending on the her second period net benefit, or choosing bank *j* in the first period and making a choice between bank *j* or bank *k* in the next period, depending again on which choice will provide her with the largest net benefit. Notice, that in case a customer switches from one bank to another, she will pay the interest rate charged to unknown borrowers by her new bank, while the customers who stay with their original bank pay their original bank's interest rate for known good borrowers, if there is no information sharing about good borrowers.

I shall work backwards and describe the decision problem of those good customers who spend their second (last) period in the market. An old good customer with preference θ will choose her original bank *k* rather than bank *j* in period *t*+1 if and only if:

(6) $R_{t+1}^G(k)+\theta\leq R_{t+1}^U(j)+1-\theta$, or $\theta\leq\dfrac{R_{t+1}^U(j)-R_{t+1}^G(k)+1}{2},\quad k=1,2;\quad j=2,1.$

Hence, $\gamma\left(\frac{R_{t+1}^{U}(j)-R_{t+1}^{G}(k)+1}{2}\right)$ good customers will stay at bank k and pay the interest rate $R_{t+1}^{G}(k)$, while a mass of $s_{t+1}^{o}(j)=\gamma\left(s_{t}^{y}(k)-\left(\frac{R_{t+1}^{U}(j)-R_{t+1}^{G}(k)+1}{2}\right)\right)$ good customers will go and borrow from bank j as unknown, where $s_{t+1}^{o}(j)$ labels bank j's market share among "old" good customers who come to this bank from bank k in period t+1. (Obviously, bank k gets $s_{t+1}^{o}(k)=\gamma\left(s_{t}^{y}(j)-\left(\frac{R_{t+1}^{U}(k)-R_{t+1}^{G}(j)+1}{2}\right)\right)$ "old" good customers, who leave bank j in period t+1.)

The mass of those old good borrowers who stay with bank k cannot exceed $\gamma s_{t}^{y}(k)$, that is:

(7) $s_{t}^{y}(k)\geq\frac{R_{t+1}^{U}(j)-R_{t+1}^{G}(k)+1}{2}$, or $R_{t+1}^{G}(k)+\theta^{*}\geq R_{t+1}^{U}(j)+1-\theta^{*}$,

where θ^{*} denotes the marginal customer's "distance" from bank k. Equation (7) implies that in case it is satisfied with strict inequality, bank j will poach a fraction of bank k's good customers in the next period.

Let us turn to the decision problem of the new good customers in period t. The inequalities in (5) and (7) give the indifference condition for the marginal new good customer between banks k and j in her first period in the market. Since it follows from (7) that $\min\left\{\left(R_{t+1}^{G}(k)+\theta^{*}\right);\left(R_{t+1}^{U}(j)+1-\theta^{*}\right)\right\}=\left(R_{t+1}^{U}(j)+1-\theta^{*}\right)$, we get the following indifference condition for the marginal customer:

(8) $R_{t}^{U}(k)+\theta^{*}+\delta\left(R_{t+1}^{U}(j)+1-\theta^{*}\right)=R_{t}^{U}(j)+1-\theta^{*}+\delta\left(R_{t+1}^{U}(k)+\theta^{*}\right)$.

From (8) we have:

(9) $$s_t^y(k) = \theta^* = \frac{R_t^U(j) - R_t^U(k) + \delta\left(R_{t+1}^U(k) - R_{t+1}^U(j)\right)}{2(1-\delta)} + \frac{1}{2}, \quad k = 1, 2; \quad j = 2, 1.$$

Equation (9) gives the market share of bank *k* in the market segment of young customers in period *t*.

What happens to old good borrowers? If bank *k* sold private credit to all of its known good customers, markets would be in steady state. The interest rate bank *k* could charge to its known good borrowers would become:

(10) $$\overline{R}^G(k) = \overline{R}^U(j) + 1 - 2\overline{s}^y(k) = \overline{R}^U(k), \quad k = 1, 2; \quad j = 2, 1,$$

which directly follows from equations (7) and (9). Bank *k*'s profit on *all* of its known good customers then yields in period *t*+1: $\pi_{t+1}^G(k) = \gamma s_t^y(k)\left(R_{t+1}^U(j) + 1 - 2s_t^y(k) - c_k\right)$. But a uniform interest rate cannot be a bank's profit maximizing strategy if it can differentiate between unknown and known good borrowers. Thus, bank *k* sells to less than the whole mass of its known good customers, and it will find the interest rate by solving its profit maximization problem with regard to known good customers.

4.1 *Information sharing about bad borrowers ("black list")*

Banks know all bad customers who already borrowed, but they cannot distinguish between unknown good and unknown bad borrowers. There will be two separate but interrelated markets: one for unknown and one for known customers. Bank *k* will find the interest rate it charges to unknown customers from solving:

(11) $$\max_{R_t^U(k)} \left\{\pi_t^U(k) + \pi_t^U(j \neq k) + \delta\pi_{t+1}^U(j \neq k)\right\}, \quad k = 1, 2; \quad j = 2, 1,$$

where

(11a)

$$\pi_t^U(k) = \left(\gamma R_t^U(k) - (1-\gamma) - c_k\right) s_t^y(k) =$$
$$= \left(\gamma R_t^U(k) - (1-\gamma) - c_k\right)\left(\frac{R_t^U(j) - R_t^U(k) + \delta\left(R_{t+1}^U(k) - R_{t+1}^U(j)\right)}{2(1-\delta)} + \frac{1}{2}\right)$$

is bank k's profit from its new unknown borrowers in period t;

(11b) $$\pi_t^U(j \neq k) = \gamma\left(R_t^U(k) - c_k\right)\left(\max\left\{0; \left(s_{t-1}(j) - \frac{R_t^U(k) - R_t^G(j) + 1}{2}\right)\right\}\right)$$

is the bank's profit from old unknown customers in period t who borrowed at the other bank in period t–1; and

(11c) $$\pi_{t+1}^U(j \neq k) = \gamma\left(R_{t+1}^U(k) - c_k\right)\left(\max\left\{0; \left(s_t(j) - \frac{R_{t+1}^U(k) - R_{t+1}^G(j) + 1}{2}\right)\right\}\right)$$

is the bank's continuation profit from old unknown customers in period t+1.

Bank k's interest rate to be charged to its known good customers in period t obtains from:

(12) $$\max_{R_t^G(k)} \pi_t^G(k) = \max_{R_t^G(k)}\left\{\gamma\left(R_t^G(k) - c_k\right)\left(\min\left\{s_{t-1}^y(k); \left(\frac{R_t^U(j) - R_t^G(k) + 1}{2}\right)\right\}\right)\right\}.$$

If banks lose a fraction of known good customers to the other bank they compete with—and we have seen before that all banks will—then the interest rate bank k will charge to its known good borrowers becomes in period t:

(13) $R_t^G(k) = \dfrac{R_t^U(j) + 1 + c_k}{2}, \quad k = 1, 2; \quad j = 2, 1.$ (This result immediately follows from solving the first order condition of the profit maximization problem in (12).)

Substituting the result from (13) into $s_t^p(k)$—which is bank k's market share in the poaching market as defined above—obtains that the mass of those good customers who borrowed from bank j in period t–1, and go to bank k as unknown in period t will be:

(14)

$$s_t^p(k) = \gamma\left(\frac{R_{t-1}^U(k) - R_{t-1}^U(j)}{2(1-\delta)} + \left(\frac{\delta}{1-\delta} + \frac{1}{2}\right)\frac{R_t^U(j)}{2} - \left(\frac{\delta}{1-\delta} + \frac{1}{2}\right)\frac{R_t^U(k)}{2} + \frac{1}{4} + \frac{c_j}{4}\right),$$
$$k = 1, 2; \quad j = 2, 1.$$

After substituting (14) into (11), and solving for the first order condition of bank k's profit maximum on the market segment of unknown borrowers we get:

(15)

$$\frac{\partial\left(\pi_t^U(k) + \pi_t^U(j \neq k) + \delta\pi_{t+1}^U(j \neq k)\right)}{\partial R_t^U(k)} = \frac{\delta R_{t+1}^U(k)}{1-\delta} - \left(\frac{3+\delta}{2(1-\delta)}\right)R_t^U(k) + \frac{R_{t-1}^U(k)}{2(1-\delta)} - \frac{\delta R_{t+1}^U(j)}{2(1-\delta)}$$
$$+\left(\frac{3+\delta}{4(1-\delta)}\right)R_t^U(j) - \frac{R_{t-1}^U(j)}{2(1-\delta)} + \frac{3}{4} + \frac{1-\gamma}{2(1-\delta)\gamma} + \frac{c_j}{4} + \left(\frac{2+(1-\delta)\gamma}{4(1-\delta)\gamma}\right)c_k = 0,$$
$$k = 1, 2; \quad j = 2, 1.$$

The first order conditions give a fairly complex system of linear difference equations of second order for the interest rates banks charge to unknown customers in successive periods. I shall present the results only for steady state.[15] The equations (15) in steady state simplify to:

(16)

$$\overline{R}_B^U(k) = \frac{3(1-\delta)}{3-\delta} + \frac{2(1-\gamma)}{(3-\delta)\gamma} + \frac{1}{3-\delta}\left(\frac{4(2-\delta)^2}{(5-3\delta)\gamma} + 1 - \delta\right)c_k + \frac{1-\delta}{3-\delta}\left(1 + \frac{2(2-\delta)}{(5-3\delta)\gamma}\right)c_j,$$
$$k = 1, 2; \quad j = 2, 1,$$

where $\overline{R}_B^U(k)$ denotes bank k's equilibrium interest rate charged to unknown borrowers under bad information sharing. Since $\delta \in (0, 1)$ by assumption, the equilibrium interest rates give a unique Markov-perfect equilibrium for the banks' optimization problem in steady state. If the discount factor is very close to 1, then (16) becomes:

(17) $\overline{R}_B^U(k) = \frac{1-\gamma}{\gamma} + \frac{c_k}{\gamma}, \quad k = 1, 2.$

Substituting the result from (17) into (13) gives the interest rates banks will charge to known good customers in steady state:

(18) $\overline{R}_B^G(k) = \frac{1}{2\gamma} + \frac{\gamma c_k + c_j}{2\gamma}, \quad k = 1, 2; \quad j = 2, 1.$[16]

It can be seen from (17) and (18) that the more cost-efficient bank, say, bank *k* in case $c_k < c_j$, will charge a lower interest rate to its unknown borrowers, $\overline{R}_B^U(k) < \overline{R}_B^U(j)$, but the same bank will ask a *higher* interest rate from its known good customers, $\overline{R}_B^G(k) > \overline{R}_B^G(j)$, than the less efficient bank. It also holds that all banks set a *higher* interest rate to known than to unknown customers, $\overline{R}_B^U(k) < \overline{R}_B^G(k)$ if $\gamma > \frac{1+2c_k - c_j}{2+c_k}, \quad k = 1, 2; \quad j = 2, 1$, that is, if the fraction of good customers is larger than 1/2 in each cohort of borrowers. Consequently, both banks will "rip off" known good customers, but bank *k* (the larger bank) will be more driven to do so than bank *j* (the smaller bank).

If bank *k* can acquire funds less expensively than bank *j*, $c_k < c_j$, then its market share among unknown customers will exceed bank *j*'s market share by $\overline{s}^y(k) - \overline{s}^y(j) = \frac{c_j - c_k}{\gamma} > 0$. Bank *k* will have a larger market share also among known good borrowers than bank *j* by the amount of $\overline{s}^o(k) - \overline{s}^o(j) = \frac{(1+\gamma)(c_j - c_k)}{2}$, where $\overline{s}^o(k)$ is bank *k*'s market share among old good customers in equilibrium. This is a smaller difference than bank *k*'s advantage over bank *j* in the market for unknown customers, if $\gamma < 1$. Finally and surprisingly, bank *j*—the less efficient bank—rather than bank *k* will gain a larger market share in the poaching market by

(19) $$\bar{s}^{p}(j) - \bar{s}^{p}(k) = \frac{(3-\gamma)(c_j - c_k)}{4} > 0 .$$

It follows from the above analysis of interest rates and market shares that *banks with a larger market share will be more driven to charge a higher interest rate to known good customers and let some of them go to other banks than banks with a smaller market share.* In addition, equation (19) shows that *smaller banks will poach more good customers from larger banks than vice versa.*

Banks' profit with bad information sharing will consist of two parts: the first part is poaching profit that banks attain from good customers who switch banks in their second period. The second part is profit from own known good customers. Notice that banks earn zero profit on young unknown borrowers, for $\gamma \bar{R}_{B}^{U}(k) - (1-\gamma) - c_k = 0, \quad k = 1, 2$. Ultimately, total profit of the two banks in equilibrium will be:

(20)

$$\bar{\pi}_{B}(k) = \bar{\pi}^{u}(j \neq k) + \bar{\pi}^{G}(k) = \frac{1}{4\gamma}(1-\gamma)(1+c_k)(2\gamma - 1 + c_k - (2-\gamma)c_j) + \frac{1}{8\gamma}(1 + c_j - \gamma c_k)^2 ,$$
$$k = 1, 2; \quad j = 2, 1,$$

where $\bar{\pi}_{B}(k), \quad k = 1, 2$ labels the bank's equilibrium profit with bad information sharing. The equilibrium is unique at all sensible values of γ, c_k and c_j.

We can conclude this part of the analysis that banks with large market shares will not have a strong incentive to fiercely compete for good customers if banks share information only about bad borrowers. Since banks have different marginal costs, the equilibrium market shares will *not* equalize in steady state. Banks with lower marginal costs will have larger market shares than banks with higher marginal costs. Low-cost large banks will have a stronger incentive to charge a higher interest rate to known good borrowers than high-cost small banks, as I have shown before. Consequently, large banks lose some of their known good borrowers who go to smaller banks as unknowns, resulting in a loss of the large banks' market share, while the market share of small banks increases by poaching. But the difference in marginal costs sets a limit to the small banks' expansion and the large banks' contraction that prevents market shares to equalize.

4.2 *Full information sharing ("full list")*

With full information sharing there will be two separate markets: one for known and one for unknown borrowers.[17] In contrast to "bad information" sharing, known good customers cannot go to another bank as unknowns. Each bank will find the interest rate for unknown and for known borrowers separately. Also, customers choose from which bank to borrow when they are new independent of their choice when they will grow "old."

It is important to emphasize that—contrary to Fudenberg and Tirole (2000)—*banks will not charge different interest rates to own good borrowers and known good borrowers who borrowed from the other bank before if banks share full information. (Notice that such price discrimination is only feasible under full information sharing.)* In principle, it would be possible, but it is not in the banks' interest to price discriminate between own known good borrowers and the known good borrowers of the other bank under full information sharing. (See Proposition A1 and its proof in the Appendix.)

The marginal new good customer will be indifferent between choosing bank k or bank j if:

(21) $R_t^U(k) + \theta^* = R_t^U(j) + 1 - \theta^*, \quad k = 1, 2; \quad j = 2, 1$, from which immediately obtains:

(22) $s_t^y(k) = \dfrac{R_t^U(j) - R_t^U(k) + 1}{2}, \quad k = 1, 2; \quad j = 2, 1.$

Bank *k*'s market share among known good customers becomes in period *t*:

(23) $s_t^o(k) = \dfrac{R_t^G(j) - R_t^G(k) + 1}{2}, \quad k = 1, 2; \quad j = 2, 1.$

Banks find the interest rate they charge to unknown borrowers from solving:

(24) $\max_{R_t^U(k)} \pi_t^U(k) = s_t^y(k)\left(\gamma R_t^U(k) - (1-\gamma) - c_k\right),$

while the interest rate they charge to known good customers obtains from:

(25) $\max_{R_t^G(k)} \pi_t^G(k) = \gamma s_t^o(k)\left(R_t^G(k) - c_k\right).$

The first order conditions of (24) and (25) yield:

(26)

$$R_t^U(k) = \frac{R_t^U(j)}{2} + \frac{1 + c_k}{2\gamma}, \quad k = 1, 2; \quad j = 2, 1, \text{ and}$$

$$R_t^G(k) = \frac{R_t^G(j)}{2} + \frac{1 + c_k}{2}, \quad k = 1, 2; \quad j = 2, 1.$$

Both markets are in steady state from the start and the equilibrium interest rates become:

(27)

$$\overline{R}_F^U(k) = \frac{3 + 2c_k + c_j}{3\gamma}, \quad k = 1, 2; \quad j = 2, 1, \text{ and}$$

$$\overline{R}_F^G(k) = \frac{3 + 2c_k + c_j}{3}, \quad k = 1, 2; \quad j = 2, 1,$$

where $\overline{R}_F^U(k)$ and $\overline{R}_F^G(k)$ label, respectively, bank *k*'s interest rate to unknown and to known good borrowers with full information sharing.[18]

Equations (27) show that, in contrast to bad information sharing, banks will charge *higher interest rates* to unknown than to known borrowers. That is, borrowers will be rewarded for good behavior under full information sharing. But comparing the steady state interest rates in (17), (18) and (27) shows that the interest rates paid by unknown and by known good customers will be *higher* with full information sharing than the respective interest rates under bad information sharing if $\gamma > \frac{3(1+c_j)}{6+c_k+2c_j}$, which is an unexpected result. Consequently, banks will gain, but customers would lose with a full list, if the fraction of good borrowers exceeds 1/2.

Comparing banks' market share on the markets for unknown and for known borrowers implies that a bank with higher marginal costs will more zealously poach good customers of the other bank than the bank with lower marginal costs, as we have also seen this with bad information sharing. Notably, bank *k* will poach good customers of other bank if:

(28) $$c_k > \frac{\gamma\left(R_t^U(j) - R_t^G(j)\right)}{1-\gamma} - 1 .$$

It follows from (28) that the larger a bank's marginal cost c_k—and the smaller its market share—the more aggressively it will poach good customers of the other bank.

Full information sharing differs from a black list in another important respect, too. Notably, the pool of unknown good customers will be smaller, but the pool of known good customers will be larger with full than with bad information sharing. This hurts small banks more than large ones, for small banks—that are more eager to poach other banks' unknown good borrowers as we have seen before—lose a larger fraction of their poaching profit than large banks that would result from the difference between a higher interest rate to unknown and a lower rate to known good borrowers with bad information sharing.

The most intriguing question is which information sharing system would banks with different market shares support. Using the results from (27), banks' profit with full information sharing becomes:

$$(29)\quad \overline{\pi}_F(k) = \frac{\gamma}{2}\left(1+\frac{c_j - c_k}{3\gamma}\right)^2 + \frac{\gamma}{2}\left(1+\frac{c_j - c_k}{3}\right)^2, \quad k = 1, 2; \quad j = 2, 1,$$

where $\overline{\pi}_F(k), \quad k = 1, 2$ denotes bank *k*'s profit with full information sharing in steady state. Notice, that the equilibrium will always be unique, for $\overline{\pi}_F(k) > 0$. Comparing (20) and (29) shows that, banks attain *higher* expected profits with *full* than with bad information sharing if $\gamma > \frac{3(1+c_j)}{6+c_k+2c_j}$. Based on the analysis above, we can formulate the following proposition:

Proposition 1. *Fully rational banks will always prefer full information sharing to a black list if the fraction of good customers,* $\gamma > 1/2$. *But customers would be better off with bad rather than with full information sharing, for they pay higher interest rates with a full list than with a black list.*

Proof: *Comparing* $\overline{\pi}_B(k)$ *in* (20) *and* $\overline{\pi}_F(k)$ *in* (29) *shows that banks earn larger profits with full than with bad information sharing. Comparing the interest rates in* (17), (18) *and* (27) *that banks charge to unknown and to known borrowers under bad and under full information sharing, respectively, proves that both unknown and known good borrowers pay higher interest rates under full information sharing than with a black list. Q.e.d.*

The above result is surprising for one would expect that sharing full information triggers intensive competition among banks and stronger competition leads to lower interest rates to known good borrowers. But known good customers cannot leave their bank and go to another bank as unknowns. They are *informationally captured* by their original bank and banks use this opportunity to charge higher interest rates to known than to unknown clients. We can conclude this section that full information sharing softens rather than facilitates competition among banks. Consequently, customers *lose* while banks *gain* with a full list.[19] Banks would benefit from full information sharing, provided that all banks submit their customer files to a credit register or to credit bureaus, for they earn higher expected profits with a full than with a black list. We could observe this in several advanced countries, especially in the US, until recently. The question remains, why have some large banks been reluctant to share customer information in the US in recent years, and why is it so cumbersome to introduce a full list in several emerging markets? I address these issues in the next sections.

4.3 *No information sharing and information sharing only about good borrowers*

Any form of information sharing adds a cooperative element to the banks' competition. Based on conventional wisdom we would expect that banks will cooperate in order to attain higher profits. But I shall show that this is not always the best choice banks can make.

With no information sharing, old bad customers may go to a bank they have not yet banked with. Known good customers may also visit another bank as unknowns. Thus, good customers allocate themselves across banks as with "bad" information sharing. But the banking sector gets more bad customers now than with full or with bad information sharing. The fraction of bad customers who will patronize bank k in period t will be:

(30) $$s_t^y(k)(1-\gamma)+s_t^y(k)(1-\gamma)\left(1-s_{t-1}^y(k)\right)=s_t^y(k)(1-\gamma)\left(2-s_{t-1}^y(k)\right).$$

As can be seen from (30), the number of bad customers who visit bank *k* cannot be smaller now than with information sharing only about bad borrowers. Bank *k*'s profit from unknown borrowers becomes in period *t*:

(31)

$$\begin{aligned}\pi_t^U(k) + \pi_t^U(j \neq k) + \pi_{t+1}^U(j \neq k) &= s_t^y(k)\left(\gamma R_t^U(k) - c_k - (1-\gamma)\left(2 - s_{t-1}^y(k)\right)\right) \\ &+ \gamma\left(R_t^U(k) - c_k\right)\left(\max\left\{0;\, s_{t-1}^y(k) - \frac{R_t^U(k) - R_t^G(j) + 1}{2}\right\}\right) \\ &+ \delta\gamma\left(R_{t+1}^U(k) - c_k\right)\left(\max\left\{0;\, s_t^y(k) - \frac{R_{t+1}^U(k) - R_{t+1}^G(j) + 1}{2}\right\}\right) \\ &- \delta s_{t+1}^y(k)(1-\gamma)\left(1 - s_t^y(k)\right)\left(1 + c_k\right), \\ &k = 1, 2; \quad j = 2, 1.\end{aligned}$$

Bank *k*'s profit in (31) is a difference equation of third order because of the last term on the right-hand side. Solving the first order condition for steady state values yields:

(32)

$$\begin{aligned}\frac{\partial\left(\pi_t^U(k) + \pi_t^U(j \neq k) + \delta\pi_{t+1}^U(j \neq k)\right)}{\partial R_t^U(k)} &= \left(\frac{2\gamma - 1 - \delta}{2\gamma}\right)\overline{R}^U(k) + \frac{3\gamma - 2 - \delta(2-\gamma)}{2\gamma}\overline{R}^U(j) \\ &+ \frac{3+\delta}{4} + \frac{(1-\delta)(1-\gamma)}{2\gamma} + \frac{(1+\delta)c_j}{4} + \left(\frac{2 - (1+\delta)\gamma}{4\gamma}\right)c_k = 0.\end{aligned}$$

In case the discount factor is close to one, the equilibrium interest rates for unknown borrowers become:

(33) $$\overline{R}_N^U(k) = \frac{\gamma}{3(1-\gamma)} + \frac{(3\gamma-1)c_k}{6(1-\gamma)} - \frac{(3\gamma-2)c_j}{6(1-\gamma)}, \quad k = 1, 2; \quad j = 2, 1,$$

where $\overline{R}_N^U(k)$ denotes the equilibrium value of the interest rate bank *k* will charge to unknown customers under no information sharing. Bank's profit from unknown customers will be:

(34)

$$\overline{\pi}_N^U(k) =$$
$$\left(\frac{(2\gamma-1)(c_j-c_k)}{2\gamma}+\frac{1}{2}\right)\left[\frac{\gamma^2}{3(1-\gamma)}+\frac{(9\gamma-7)c_k}{6(1-\gamma)}-\frac{(3\gamma-2)c_j}{6(1-\gamma)}-(1-\gamma)\left(\frac{3}{2}-\frac{(2\gamma-1)(c_j-c_k)}{2\gamma}\right)\right]$$
$$+\frac{\gamma}{24(1-\gamma)^2}\left(\gamma+\frac{(9\gamma-7)c_k}{2}-\frac{(3\gamma-2)c_j}{2}\right)(1+(2\gamma-1)c_k-(4\gamma-3)c_j),$$
$$k=1,2;\quad j=2,1.$$

Interest rates charged to known good borrowers obtains as in (13):

$$(35)\quad \overline{R}_N^G=\frac{3-2\gamma}{6(1-\gamma)}+\frac{(9\gamma-1)c_k}{12\gamma}-\frac{(3\gamma-2)c_j}{12\gamma},\quad k=1,2;\quad j=2,1.$$

Comparing (33) and (35) shows that the interest rates banks charge to borrowers with no information sharing will *exceed* the interest rates and profits banks attain with a full list at small values of $1-\gamma$ and c. Profits with no information sharing will also be larger at low values of $1-\gamma$ and c_k, $k=1,2$, than banks' profit under full information sharing as can be seen from comparing (29) and (34). It also follows from from (33) and (35), the high-cost (smaller) bank will charge higher interest rates to all customers than the low-cost bank, and the difference between banks' market share becomes in equilibrium: $\frac{(2\gamma-1)(c_j-c_k)}{2(1-\gamma)}$, which is much larger than the difference $\frac{(c_j-c_k)}{6\gamma}$ between banks' market shares with full information sharing if $\gamma>3/5$. Based on the analysis, we can formulate the following proposition:

Proposition 2. *There exist (small) values of* γ *and* c_k, $k=1,2$*, when no information sharing becomes the banks' dominant strategy*. *At such values, all banks charge higher interest rates if they do not share information than under any other form of information sharing, but small banks lose, while large banks gain larger market shares than in case they share information.*

Good customers will lose the most with no information sharing because interest rates will be higher now than either with information sharing about bad borrowers or with full information sharing.

Proof: *Since full information sharing dominates information sharing about bad borrowers if* $\gamma > 1/2$*, it will suffice to show that at certain values of* γ *and* $c_k, k = 1, 2$ *banks earn larger profits without information sharing than with sharing full information. Assume that* $c_k \sim 0, k = 1, 2$. *Then* $\overline{R}_N^G(k) > \overline{R}_F^G(k)$ *if* $\gamma > 3/4$*, as can be seen from comparing* (35) *and* (27). *Consequently, banks earn larger profits on known good borrowers with no information sharing than with full information sharing. Comparing the first expression on the right-hand side of* (29) *and* (34) *shows that banks acquire larger profits from unknown borrowers without than with full information sharing if* $\gamma > 4/5$. *Q.e.d.*

Under the conditions outlined above, large banks would gain more than small ones if they do not share customer information, for their market share and profits will be much larger now than with a full list. In addition, no information sharing has a special appeal to large banks: the number of bad borrowers a bank receives will *fluctuate* period by period. That is, a bank with a large market share may receive a larger mass of bad customers in the current period, but the young bad borrowers of this bank will go to other banks in the next period. Thus, a bank that has more bad customers now can “poison” the customer base of its competitors during the next period.

Finally, it will not be feasible to the banks to choose information sharing only about good customers, for large and small banks cannot agree on such a system of information sharing.[20] We can formulate the following proposition.

Proposition 3. *Banks with different marginal costs (and market shares) cannot agree to implement information sharing only about good borrowers.*

Proof: *If banks shared only good information there would be two separate markets: one for unknown and one for known good clients. Bank k's profit from unknown borrowers would become in period t:*

(36) $\pi_t^U(k) = s_t^U(k)\left(\gamma R_t^U(k) - c_k - (1-\gamma)\left(2 - s_{t-1}^y(k)\right)\right),$

while bank k would earn the following profit from known good borrowers:

(37) $\pi_t^G(k) = s_t^o(k)\gamma\left(R_t^G(k) - c_k\right).$

Solving (*36*) *and* (*37*) *for equilibrium values yields the following interest rates:*

(38) $\overline{R}_G^U(k) = \frac{1}{\gamma} + \frac{(3\gamma-1)c_k}{\gamma(5\gamma-2)} + \frac{(2\gamma-1)c_j}{\gamma(5\gamma-2)}, \quad k = 1, 2; \quad j = 2, 1,$

where $\overline{R}_G^U(k)$ *denotes the interest rate bank k will charge to unknown customers with information sharing only about good borrowers. The interest rates charged to known good customers will be the same as in* (27)*:*

$\overline{R}_G^G(k) = \frac{3 + 2c_k + c_j}{3}, \quad k = 1, 2; \quad j = 2, 1$. *The interest rates charged to unknown customers with full information sharing (as given in* (27)*) will be larger than the interest rates in* (38) *if:*

(39) $\left(\frac{(3\gamma-1)}{\gamma(5\gamma-2)} - \frac{2}{3\gamma}\right)c_k + \left(\frac{(2\gamma-1)}{\gamma(5\gamma-2)} - \frac{1}{3\gamma}\right)c_j < 0.$

The (39) *condition can be simplified to:*

(40) $\frac{(1-\gamma)\left(c_j - c_k\right)}{3(5\gamma-2)} > 0.$

If $c_j > c_k$ *and* $\gamma > 2/5$*, the* (40) *condition will always be satisfied for bank k. But for bank j:* $\frac{(1-\gamma)(c_k - c_j)}{3(5\gamma - 2)} < 0$ *will hold. Thus, the more efficient bank will not want to switch from a full list to a white list, while the less efficient bank would prefer the white list to full information sharing. Consequently, the banks cannot agree to implement information sharing only about good borrowers. Q.e.d.*

The above result is different from what Bourckaert and Degryse (2006) assert that information sharing only about good customers may be the banks' optimal strategy. As their argument goes: banks could use information sharing only about good borrowers as a strategic device if they may assume that there are banks that are not aware of the mass or fraction of bad borrowers in the market.

We can conclude the analysis of mature markets that banks' optimum strategy is to share full information if the fraction of bad borrowers is substantial in the market, or banks incur largely different costs of funds. But in case the share of bad borrowers and the banks' marginal costs are small, no information sharing may become the banks' optimum strategy. Good customers lose more with no information sharing than with full information sharing, while they pay higher interest rates with full information sharing than with a black list.

4.4. *The initial period in emerging markets*

Banks will face an "initial period effect" in emerging markets. Banks would benefit from sharing information about all customers in an emerging market, but the magnitude of their benefit depends on the proportion of bad customers within the entire banking population.

Banks establish their market share in the initial period by selling only to unknown customers. Now it is important what kind of information sharing is in place or can be expected to emerge in the next period. Since most emerging markets implemented some form of a "black list," I assume that banks can expect bad information sharing to be in place, when they arrive at the second period.[21] Then banks' profit from unknown customers and their continuation profit will be in the initial period:

(41)

$$\pi_0^U(k) + \delta\pi_1^U(j \neq k) = \left(\gamma R_0^U(k) - (1-\gamma) - c_k\right)s_0^y(k) + \delta\gamma\left(R_1^U(k) - c_k\right)\left(\max\left\{0;\, s_0(j) - \frac{R_1^U(k) - R_1^G(j) + 1}{2}\right\}\right),$$

where the subscripts 0 and 1 denote the initial period and the subsequent period, respectively. Banks find the interest rate to be charged to all borrowers by solving the first order condition of the profit equation (41):

(42)

$$\frac{\partial\left(\pi_0^U(k) + \delta\pi_1^U(j \neq k)\right)}{\partial R_0^U(k)} = \frac{\delta R_1^U(k)}{1-\delta} - \frac{\delta R_1^U(j)}{2(1-\delta)} - \frac{R_0^U(k)}{1-\delta} + \frac{R_0^U(j)}{2(1-\delta)} + \frac{1}{2} + \frac{(1-\gamma)}{2(1-\delta)\gamma} + \frac{(1-\delta\gamma)c_k}{2(1-\delta)\gamma} = 0.$$

From the first order condition we get:

(43) $$R_0^U(k) = \delta R_1^U(k) + 1 - \delta + \frac{1-\gamma}{\gamma} + \frac{(1-\delta\gamma)(2c_k + c_j)}{3\gamma}, \quad k = 1, 2; \quad j = 2, 1.$$

Comparing (43) and the interest rates in (18)—that banks would charge to unknown borrowers in a mature market with a black list—shows that the initial interest rates will be much higher in an emerging market than in a mature market, mostly due to the lack of information about good borrowers. But this initial period effect will not have long lasting consequences. Banks start the same type of competition for customers in the second period as I described in the case of mature markets. Consequently, emerging markets will develop the same way as mature markets after the initial period.

5. Discussion and conclusions

We have found that myopic banks or banks operating in a market that consists of a small fraction of bad borrowers will not be interested to share customer information, provided that banks' marginal cost is low. Full information sharing would be in the banks' interest if they could expect to get more and more bad borrowers as the market expands, and different banks incur largely different marginal costs. In fact, this is the case in several emerging markets. Consequently, emerging markets would benefit more from full information sharing than mature markets, if all banks shared their customer files, and borrower information was reliable. Implementing full information sharing on a private credit market may also serve as a long-term strategic device that contains the mass and fraction of *future* bad borrowers on the market. Banks would always favor a full list to a black list for they can charge higher interest rates and earn higher profits with the former than with the latter.

We could also see that large banks have different incentives to information sharing than small banks. A large bank has less incentive to share information about its bad customers when it releases a large number of such customers to the market and "poisons" the customer base of other banks. This incentive becomes weaker when bad customers are at the smaller banks in a large number, and the large bank can expect many bad customers to come in the next period. Surprisingly, large banks would gain more than small banks from full information sharing in terms of profits, but not in market share.

An exciting issue of strategic information sharing is why do banks form or join a credit bureau at all? Would it not be more beneficial to banks to directly trade information among themselves? There may be cost saving effects of joining a credit bureau, but are there other considerations that render a joint information pool more desirable to banks than to deal with information transactions directly? If information sharing is a strategic decision—and we have seen it is—then a credit bureau may serve as an implicit contract among banks not to abuse private information in competition. This is a huge topic that should be addressed in a different paper.

Finally, I have shown that full information sharing or no information sharing—that banks would prefer most—have the most adverse consequences to good borrowers. Good borrowers pay the highest interest rates if banks do not share information, for good clients bear the burden of a larger mass of bad (and unknown) customers. But good borrowers would be better off with a black list than with a full list, for they would be informationally captured by full information sharing. Consequently, regulatory agencies could have an important role to play in shaping the institutions of emerging private credit markets. Emerging markets become mature markets after the first two initial periods and banks that survive will behave as their peers in mature markets.

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Appendix

Proposition A1. *It cannot be a bank's dominant strategy to charge different prices to own known good customers and to known good customers of the other bank if banks share full information*.

Proof: *Denote the interest rate* $\hat{R}_t^G(k)$ *that bank k charges to known good borrowers who migrate from bank j to bank k in period t. Then the marginal unknown good customer will be the person for whom:*

(A1)

$$R_t^U(k) + \theta^* + \delta \min\left\{\left(R_{t+1}^G(k) + \theta^*\right); \left(\hat{R}_{t+1}^G(j) + 1 - \theta^*\right)\right\} =$$
$$= R_t^U(j) + 1 - \theta^* + \delta \min\left\{\left(R_{t+1}^G(j) + \theta^*\right); \left(\hat{R}_{t+1}^G(k) + \theta^*\right)\right\}.$$

Applying the same argument as in (7) *we have:*

(A2)

$$s_t^y(k) = \frac{R_t^U(j) - R_t^U(k) + \delta\left(\hat{R}_{t+1}^G(k) - \hat{R}_{t+1}^G(j)\right)}{2(1-\delta)} + \frac{1}{2}, \quad k = 1, 2; \quad j = 2, 1.$$

Bank k's profit from unknown borrowers will be in period t:

(A3) $\pi_t^U(k) = \left(\gamma R_t^U(k) - c_k - (1-\gamma)\right) s_t^y(k), \quad k = 1, 2$,

while the bank's profit from own known good customers becomes:

(A4) $\pi_t^G(k) = \gamma\left(R_t^G(k) - c_k\right)\left(\frac{\hat{R}_t^G(j) - R_t^G(k) + 1}{2}\right), \quad k = 1, 2; \quad j = 2, 1$,

and profit from known good customers of the other bank obtains:

(A5) $\hat{\pi}_t^G(k) = \gamma\left(\hat{R}_t^G(k) - c_k\right)\left(s_{t-1}^y(j) - \frac{\hat{R}_t^G(k) - R_t^G(j) + 1}{2}\right), \quad k = 1, 2; \quad j = 2, 1$.

The first order condition of (A3) *yields:*

(A6) $$\frac{R_t^U(j)}{2} - R_t^U(k) + \frac{\delta\hat{R}_{t+1}^G(k)}{2} - \frac{\delta\hat{R}_{t+1}^G(j)}{2} + \frac{1-\delta}{2} + \frac{1-\gamma}{2\gamma} + \frac{c_k}{2\gamma} = 0, \quad k = 1, 2; \quad j = 2, 1.$$

From the first order condition of (A4) *we have:*

(A7) $$\frac{\hat{R}_t^G(j)}{2} - R_t^G(k) + \frac{1+c_k}{2} = 0, \quad k = 1, 2; \quad j = 2, 1.$$

Finally, the first order condition of (A5) *gives:*

(A8) $$\frac{R_{t-1}^U(k) - R_{t-1}^U(j)}{2} + \frac{(1-\delta)R_t^G(j)}{2} + \frac{\delta\hat{R}_t^G(j)}{2} - \hat{R}_t^G(k) + \frac{c_k}{2} = 0.$$

Solving the system of equations in (A6)–(A8) *for steady state values and* $\delta \sim 1$ *yields:*

(A9)

$$\overline{R}^U(k) = \frac{14c_k}{15\gamma} + \frac{c_j}{15\gamma}, \quad k = 1, 2; \quad j = 2, 1;$$

$$\overline{\hat{R}}^G(k) = \frac{(1+\gamma)c_k}{5\gamma} - \frac{(1-\gamma)c_j}{5\gamma}, \quad k = 1, 2; \quad j = 2, 1;$$

$$\overline{R}^G(k) = \frac{1}{2} + \frac{(6\gamma-1)c_k}{10\gamma} + \frac{(1+\gamma)c_k}{10\gamma}, \quad k = 1, 2; \quad j = 2, 1.$$

Comparing $\overline{R}^U(k)$ *in* (A9) *with* $\overline{R}^U(k)$ *in equation* (27) *shows that banks charge higher interest rates to unknown borrowers and earn higher profits from these customers without than with price discrimination between own known good customers and known good customers of the other bank.*

Since $\overline{\hat{R}}^G(k) < \overline{R}^G(k)$, *as can be seen from* (A9), *it will suffice to show that* $\overline{R}^G(k)$ *will be smaller with than without price discrimination between own known good customers and known good customers of the other bank at any reasonable values of* γ. $\overline{R}^G(k)$ *in* (A9) *will be smaller than* $\overline{R}^G(k)$ *in equation* (27) *if:*

(A10) $\gamma > \frac{3(1-c_k)}{15+2c_k+7c_j}$.

Since γ *is decreasing in* c_k *and in* c_j, *the upper bound of the right-hand side of* (A10) *is 0.2. That is, in case the fraction of good borrowers exceeds 20 percent of the banking population in each period,* $\overline{R}^G(k)$ *in* (A9) *will be smaller than* $\overline{R}^G(k)$ *in equation* (27). *Consequently, banks earn lower profits on known good customers with than without price discrimination. Q.e.d.*

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[1] The paper covers only a small portion of the research we have done about emerging credit card markets. The members of the research team (principal investigator: Akos Rona-Tas, Department of Sociology, University of California San Diego) conducted interviews with bank officials in eleven countries, including China, Vietnam, South Korea and eight Central and East European countries. In addition, they collected information from Visa, from Fair Isaac, and from other organizations in the US. We were especially interested in newly emerging private credit markets in post-communist countries that we labeled “transition markets.”

[2] Novshek and Sonnenschein (1982), Vincent Crawford and Joel Sobel (1982), Richard Clarke (1983), and Gal-Or (1985) present models of information sharing in two-stage games but their

focus has been the noisy nature of information. Lawrence Ausubel (1991) discussed the case of the US credit card market without engaging deeply in the analysis of information sharing.

[3] Paul Milgrom (1981) discusses strategic settings when information can be good or bad news.

[4] I use the term "new customer" for borrowers who just entered the market. An old customer may also be "new" to a bank if she or he has not borrowed from this bank yet, but we shall label such a client "unknown borrower."

[5] This assumption could have been easily relaxed by saying that the market population is increasing with a λ rate. In order to keep the model simple, I shall assume that the size of the market population does not change over time.

[6] I made the simplest assumption possible to keep the analysis tractable. I could have assumed that customers live for $T > 2$ periods. Such a generalization would have had two important implications: (1) Customers' options to act strategically would have been more numerous than in case customers live only for two periods. (2) The number of periods would have had an additional impact on the customer base if that number was larger than the number of banks that operate in the market. Old bad customers who already went to all banks would drop out from the market before they "decease." Until the number of periods is not larger than the number of banks, I could have changed the share of customers who exit the market at the end of each period from 1 to $2/T$. Consequently, the share of surviving customers would have been $2(T - 1)/T$. To simplify the analysis, I assume that $T = 2$, and the number of banks is not smaller than the number of periods customers live through.

[7] Bad customers may also have an interest to repay in the first period, while they will refuse to repay in the second period if they act strategically, and banks share bad information, but I shall disregard this possibility in order to simplify the analysis. It could also be argued that even

"good" customers may not repay their dues—especially in the last period of their presence in the market—either because of strategic considerations or because they are not capable of repaying. I do not deal with the extreme case that good customers who would be able to finance their debt refuse to repay, and I also disregard the issue of customers' repayment probability in this paper for I intend to outline a benchmark case where further analysis can start from. I have written another paper (xxx, 2008) where good borrowers repay with probability $p < 1$ in the second period. The results are not substantially different from what I present in this paper.

[8] The current approach could be easily extended to $K > 2$ banks by assuming that each customer will choose those two banks out of K banks that are closest to her preferences for banking services. It gives $\binom{K}{2}$ possible choices to each borrower. Then the customer will select her bank based on her preference θ and on the interest rates banks charge to borrowers. Since each bank will compete with all other banks in a "pair-wise competition," the interest rate it can set will be affected by the interest rates and costs of all banks. A reviewer of an earlier version suggested that I should restrict the analysis to the case of $K = 2$, for all conclusions will also hold in the more general case, and this is why I discuss the important features of steady state for two banks.

[9] I could have assumed—as in Fudenberg and Tirole (2000)—that customers are distributed between two banks by the density function $f_{i,j}(\theta)$, but it would just have complicated the analysis without adding new insights.

[10] One of the referees of a former version of this paper wrote that it would render the model more realistic if I allowed for different customer valuations. But in case if all customers can borrow, valuation will not affect the banks' market share or the interest rates banks will charge. Consequently, I shall retain the original assumption.

[11] I do not address moral hazard in this paper. On this issue see, for instance, Sharpe (1990), Padilla and Pagano (2000), Dell'Ariccia (2000), and Marquez (2002).

[12] See also endnote 10. I assume that no bank will drop out from the market and I also disregard mergers between banks.

[13] In reality, there is a moderate amount charged by the credit bureau to banks for each record they acquire, but I shall ignore this cost.

[14] It would also be conceivable that a bank serves only its known good borrowers in period *t* and then leaves the market in period *t*+1. I shall disregard this possibility.

[15] A special case occurs when banks have identical constant marginal cost *c*. It can be shown that the interest rate charged to unknown customers becomes in steady state: $\overline{R}^U(k) = \frac{3(1-\delta)}{3-\delta} + \frac{2(1-\gamma)}{(3-\delta)\gamma} + \left(\frac{4(1+(1-\delta)\gamma)}{(3-\delta)\gamma}\right)c, \quad k = 1, 2$, and the interest rate charged to known good borrowers will be $\overline{R}^G(k) = \frac{\overline{R}^U(k)}{2} + \frac{1+c}{2}$, where $\overline{R}^U$ and $\overline{R}^G$ stand for the equilibrium values of the interest rates. If the discount factor $\delta \sim 1$, we get: $\overline{R}^U(k) = \frac{1-\gamma}{\gamma} + \frac{2c}{\gamma}, \quad k = 1, 2$, and $\overline{R}^G(k) = \frac{1}{2\gamma} + \frac{(2+\gamma)c}{\gamma}, \quad k = 1, 2$.

[16] To see that the above results are fairly general it can be easily obtained that the equilibrium interest rates for unknown customers with *K* banks and with $\delta \sim 1$ become:

$\overline{R}^U(k) = \frac{1-\gamma}{\gamma} + \frac{c_k}{\gamma}, \quad k = 1, 2, ..., K$. Banks charge the following interest rates to known good borrowers:

$\overline{R}^{G}(k)=\frac{1-\gamma}{2\gamma}+\frac{\sum_{j\neq k} n_{k,j}c_j}{2\gamma}+\frac{1+c_k}{2}=\frac{1+\gamma c_k+\sum_{j\neq k} n_{k,j}c_j}{2\gamma}$, $\forall k$, $\forall j\neq k$, where $n_{k,j}$ is the fraction of those customers who borrow either from bank k or from bank j. $\overline{R}^{G}(k)>\overline{R}^{U}(k)$ will hold if: $\gamma>\frac{1+2c_k-\sum_{j\neq k} n_{k,j}c_j}{2+c_k}$. Since the right-hand side of this inequality increases with c_k, the former constraint on marginal costs will only be relevant if the fraction of good borrowers becomes small. ("Small" means $\gamma\leq 1/2$ here.) Should this case occur no bank would be able to stay in the market.

[17] The market for unknown customers and for known good borrowers would be interconnected if banks applied price discrimination between own known good customers and the migrating known good customers of the other bank. But we prove in the Appendix (see Proposition A2) that such price discrimination cannot be the banks' dominant strategy.

[18] If banks have identical marginal costs, the interest rates bank k will charge to its unknown and to its known good customers in period t becomes, respectively: $\overline{R}^{U}(k)=\frac{1+c}{\gamma}$, and $\overline{R}^{G}(k)=1+c,\ \ k=1,2$.

[19] I note here that full information sharing can impose additional harm on customers if banks become "overly confident" by having access to the files of all borrowers, and they "over-lend" customers because of competition, as it has happened, for instance, in the US sub-prime loan market just recently.

[20] With regard to a white list, banks can "only agree to disagree." See Robert J. Aumann (1976).

[21] I need to mention here that I ignored the possibility that small banks form a coalition against one or more large banks. Small banks would be fairly successful in doing so if their joint market share is not substantially smaller than the market share of the large bank. If small banks jointly have a larger market share than the large bank, they may become the dominant player if they collude.