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Information Sharing Among Banks About Borrowers: What Type Would They Support?

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What Type Would They Support?

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Information Sharing Among Banks About Borrowers: What Type Would They Support?

Iván Major

Abstract

I address the following issue in this paper: how does information sharing among banks about borrowers affect banks' competition, and ultimately, the interest rate borrowers pay for the loan they take? One would expect that full information sharing among banks reduces lenders' risk and results in lower lending rates than any other arrangement. This may be the reason why regulators of the banking industry would like to see full information sharing in most countries. I shall show below that the regulators' expectation is usually not fulfilled. Full information sharing will result in higher lending rates than any other form of information sharing under fairly general conditions.

Despite its lucrative features, banks are not always keen on supporting full information sharing. Information sharing only about bad borrowers is the fully rational banks' dominant strategy if the proportion of bad borrowers is substantial. Myopic banks would opt for no information sharing if the proportion of bad borrowers is large. Fully rational banks would only choose full information sharing if the share of bad borrowers is small.

Borrowers with good credit records, on the other hand, would prefer information sharing only about bad customers rather than full or no information sharing, for they pay lower interest rates under a black list than with any other form of information sharing or with no information sharing.

Keywords: Risk and uncertainty; Credit markets; Asymmetric information; Firms' inter-temporal choice; Banks; Financial institutions

JEL classification: D81, D82, D92, G21

Az adósinformáció megosztása a bankok között: melyik típusú adóslista a legvonzóbb a bankok számára?

Major Iván

Összefoglaló

Tanulmányom arra a kérdésre keresi a választ, hogy miként befolyásolja a bankok közötti versenyt és végső soron a hitelfelvevők által fizetett kamatlábat a bankok közötti információ-megosztás az ügyfeleikről? Azt várnánk, hogy a bankok közötti teljes információmegosztás csökkenti leginkább a hitelezés kockázatát, és így alacsonyabb kamatlábakat eredményez, mint bármely más információ-megosztási rendszer. Ez lehet a fő indoka annak, hogy a pénzpiacok szabályozó intézményei a világ legtöbb országában – így Magyarországon is – a teljes lista bevezetését szorgalmazzák. A tanulmányban bizonyítom, hogy a szabályozók várakozása általában nem teljesül. A bankok közötti teljes információmegosztás – meglehetősen általános feltételek teljesülése esetén – magasabb hitelkamatlábak kialakulásához vezet, mint a többi információmegosztási rendszer vagy annak teljes hiánya.
A teljes listának a bankok számára vonzó tulajdonságai ellenére a pénzintézetek mégsem minden esetben támogatják azt. Amennyiben a „rossz” adósok aránya a hitelfelvevők körében jelentős, a profitjukat hosszú távon maximalizáló bankok az ún. „negatív listát” részesítenék előnyben. Amennyiben a bankok „rövidlátó” módon viselkednek – tehát a rövid távú profitjuk maximalizálásában érdekeltek – és a „rossz” adósok aránya a hitelfelvevő népesség körében magas, akkor az információmegosztás hiányát részesítik előnyben minden másfajta rendszerrel szemben. A profitjukat hosszú távon maximalizáló bankok csak abban az esetben támogatják a teljes lista bevezetését, ha a rossz adósok aránya alacsony.

Tárgyszavak: kockázat, hitelpiacok, asszimmetrikus információmegosztás, bankok, pénzintézetek

JEL kódok: D81, D82, D92, G21

INFORMATION SHARING AMONG BANKS ABOUT BORROWERS: WHAT TYPE WOULD THEY SUPPORT?

1. INTRODUCTION

The main issue of this paper is as follows: how does information sharing among banks about borrowers affect banks' competition, and ultimately, the interest rate borrowers pay for the loan they take? Information sharing about customers is an important specific feature of the banking industry. Namely, banks can access information not only about their own customers but about the customers of other banks, too. This fact has a huge impact on how banks operate in the financial market, how do they deal with lending risk and how do they price the loan they extend to borrowers. Some form of information sharing among banks about borrowers' credit history is mandatory in most countries. One of the four possible types of information sharing regimes may be in place in a country: banks may share information about all customers (a "full list"), only about non-paying customers (a "black list"), only about good borrowers (a "white list"), or they may not share any borrower information at all.

One would expect that full information sharing among banks reduces lenders' risk and results in lower lending rates than any other arrangement. This may be the reason why regulators of the banking industry would like to see full information sharing in most countries. I shall show below that the regulators' expectation is usually not fulfilled. Full information sharing will result in higher lending rates than any other form of information sharing or the lack of it under fairly general conditions.

Despite its lucrative features, it may not always be in the banks' interest to support a full list as I shall demonstrate. For instance, myopic banks with different market shares—that is, banks of different sizes that maximize short-term profits during two periods at maximum—may have conflicting interests with regard to information sharing. We could witness this fact in Britain where four major banks launched a comprehensive information sharing scheme in 2006, but Barclays Bank Ltd., the largest competitor in the market refused to join (Prosser, 2006). Similar developments occurred in the US financial market in the early 2000s where larger banks have been reluctant to share customer information with the credit bureaus and with competitors (Lazarony, 2000).[1]

[1] In the late 1990s, with the concentration of retail lending, credit reporting in the United States started to change that required regulatory intervention Hunt (2002). I leave the analysis of these changes to a later paper.

The question this paper addresses is under what conditions would banks support full or partial information sharing about customers in private credit markets. I shall show that fully rational banks—that is, banks that maximize long-term profits—would only gain from full information sharing, if the fraction of bad borrowers is relatively low. But in case the fraction of bad borrowers is substantial, information sharing only about bad borrowers will be the banks' dominant strategy.

However, the deepest conflict lies between the interest of borrowers on the one hand, and the banks' interest on the other, rather than among banks of different sizes. I shall show that, contrary to common wisdom, information sharing about all customers is not in the interest of borrowers with good credit records. They would prefer information sharing only about bad borrowers to any other form of information sharing, for bad information sharing among banks would result in the lowest interest rates borrowers pay.

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 most papers on the subject outlined. I develop a simple *three period* model of oligopolistic private credit markets where banks serve unknown and known customers of different vintage.

I shall discuss three related issues in this paper. The first question asks what the optimum pricing strategy of the banks will be under a given information sharing arrangement. The second question focuses on the issue what type of information sharing is the most beneficial to banks. Finally, I shall address the issue which type of information sharing is most beneficial to borrowers. My contribution to the existing literature on information sharing among banks is as follows:

1. *Known* good customers of a bank pay *higher interest rates than* the bank's *unknown* borrowers with information sharing only about bad customers (under a "black list"). The opposite is true under full information sharing: banks charge lower interest rates to their known good customers than to unknown borrowers.
2. The interest rates known good and unknown borrowers pay with a full list *will be higher* than the respective interest rates under a black list. Consequently, good borrowers would prefer a black list to full information sharing among banks.
3. 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, and sharing customer information keeps the mass and fraction of bad borrowers small. However, myopic banks may opt for no information sharing if they serve a large fraction of bad borrowers in the current period, for these bad borrowers will go to other banks and depreciate the customer base of those banks in the subsequent period.

My findings that interest rates are higher under full information sharing than under other information sharing regimes, and known good borrowers pay more than unknown borrowers under a black list are important both from a positive as well as from a normative perspective. On the positive side, they may contribute to explain why a large variety of different information sharing arrangements is in place in real credit markets.[2] On the normative side, the main result of the paper could help to explain why mandated information sharing—imposed by parliaments or governments—is sometimes supplemented by voluntary information sharing agreements among banks.

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 the private credit market with different information sharing regimes in section 4. Discussion and conclusions follow in section 5.

2. LITERATURE REVIEW

The literature on information sharing among firms is very rich. But 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. [3] They show that adverse selection of borrowers can be contained with information sharing among banks. Padilla and Pagano (1997) also focus on reputation games driven by the borrowers' effort and welfare. The authors prove that moral hazard on the borrowers' part can be controlled by full information sharing. Jappelli and Pagano (2002) argue that full information sharing eliminates adverse selection in bank lending. Padilla and Pagano (2000) show that moral hazard in borrower-lender relationship can also be contained by information sharing. This should provide the regulators and the banks with strong incentives to share information about customers but despite serious efforts of various third parties, including the World Bank, credit reporting on borrowers is slow to appear in a large number of countries (Miller, 2003). Bouckaert and 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 is obvious from their paper that they assume full information sharing even if the decision to share information is not necessarily symmetric among banks. They argue that banks will induce borrowers to switch between banks in the second period, and it

[2] See, for instance, Miller (2003).
[3] Ausubel (1991) discussed the case of the US credit card market without engaging deeply in the analysis of information sharing.

ultimately relaxes competition among the banks during the first period. 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. Gehrig and Stenbacka (2007) arrive at similar conclusions as Bouckaert and Degryse (2004), namely that information sharing among banks softens competition for market shares. They develop a two period price competition model *á la* Bertrand. The authors conclude that banks will not viciously compete for good borrowers *in the first period* if borrowers face positive switching costs whenever they change banks, and banks share customer information. The authors focus on the negative welfare effects of lenders' information disclosure. They argue that information sharing hampers competition. Consequently, a fraction of good borrowers' benefit will be converted into lenders profit through higher interest rates. I try to further develop the argument of Gehrig and Stenbacka and show that different information sharing schemes have different effects on customers' and on banks' behavior and ultimately on interest rates borrowers pay even without switching costs. 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. 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.

Sharpe (1990) and von Thadden (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 result is that information asymmetry softens competition for good borrowers. My conclusion is different in this paper: information sharing rather than the lack of it softens competition among banks, for information asymmetry among banks is the basis for a poaching market to evolve. Sharpe (1990) then 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.

Farrell and 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. 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 my paper.

I derive market shares of competing banks similar to Fudenberg and Tirole (1998, 2000) and to 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 case firms (banks) cannot offer credible long-term contracts. But the above papers do not discuss information sharing and its impact on competition, what is the main focus of my paper.

3. ASSUMPTIONS AND NOTATIONS

3.1 THE NATURE OF COMPETITION IN THE MARKET

Banks can operate under four different types of information sharing systems as I already described in the introduction. Each bank's preference for the type of information sharing is conditioned on the amount of profits it can earn during three periods under different types of information sharing. Once all banks operate under a certain type of information sharing, this system remains in place for the future. Why is the banks' view about the type of information sharing relevant if the actual form of information sharing is usually mandated by law in most countries? Banks' opinion is important for they can largely influence the legislative process before the legal regulation about information sharing is enacted by parliament or by government.

I assume that 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 are aware of 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.

I define market equilibrium as follows: banks set interest rates for unknown borrowers and for known good customers. 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. Interest rates satisfy the

Markov perfect equilibrium conditions in steady state of the market. I define steady state as follows: the market is in steady state if neither the interest rates nor the banks' market shares change in different segments of the credit market from one period to the other. That is, $R_t(k) = R_{t+1}(k) = \overline{R}(k)$ and $s_t(k) = s_{t+1}(k) = \overline{s}(k)$, where $R_t(k)$ and $R_{t+1}(k)$ denote the interest rates bank k charges to a customer; $s_t(k)$ and $s_{t+1}(k)$ label bank k's market shares in period t and t+1, respectively, while $\overline{R}(k)$ is this bank's interest rate, and $\overline{s}(k)$ is the bank's market share in equilibrium (in steady state).

The timing of the dynamic game among banks is as follows:

1. The proportion of good and bad customers γ and $1-\gamma$, respectively is known to banks and it does not change over time. Borrowers' valuation v is also set when they enter the market.
2. Borrowers know the type of information sharing among banks when they enter the credit market.
3. Banks simultaneously set the interest rates for unknown customers.[4]
4. Banks observe the interest rates for unknown borrowers and simultaneously set the interest rates for known good customers.
5. Customers allocate themselves across banks accordingly and pay-offs occur.

3.2 CUSTOMERS

A mass of N customers borrows in the market in each period. I assume that the mass of all borrowing customers is normalized to two during one period. Each customer lives for exactly two periods.5 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. Each customer can borrow $1 per period. For simplicity's sake, I assume that customers have an identical net valuation v of the loan.6 Each customer must place the amount of ψ as

[4] 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.
[5] The main conclusions of the paper do not depend on the fact that customers are present for two rather than for $t > 2$ periods in the market, provided that t is smaller than the number of banks. (Otherwise bad customers would drop out from the market even without any form of information sharing).
[6] I could have assumed different customer valuations, but in case all customers can borrow at uniform interest rates for the same group of customers, valuation will not affect the banks' market share or the interest rates banks will charge. Consequently, I shall retain the original assumption.

collateral at the bank when she borrows that she can recover upon repayment. But a customer would lose this amount if she did not repay the loan with interest.[7]

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.

Lemma 1: *A borrower is a "good type" if* $\delta^G \psi - (1+R_t) \geq 0 \rightarrow \delta^G \geq \frac{(1+R_t)}{\psi}$, *where* $\delta^G \psi$ *is the discounted value of the collateral the borrower had to pay when she took the loan,* R_t *is the interest rate a customer pays in period t, and* $(1+R_t)$ *is the total amount of the borrower's repayment obligation. That is, a good customer discounts future gains and losses with a large enough discount factor* δ^G *(with a small discount rate* r^G*) so that her benefit from repaying the loan exceeds the benefit of non-repayment. A borrower will be a "bad type" if* $\delta^B \psi - (1+R_t) < 0 \rightarrow \delta^B < \frac{(1+R_t)}{\psi}$. *Hence, good customers will always repay the loan, while bad customers never repay.*

The assumption that bad customers never repay is fairly restrictive. If banks did not share borrower information, or they shared information only about good customers, this would be a rational choice for bad borrowers since they can borrow and not repay in the initial period, then go to another bank and borrow without repayment in the second period. In case banks share full or bad information, bad customers can make a strategic choice whether to repay the loan or not in their first period. Consequently, the fraction of defaulting customers can be endogenously derived from the banks' profit maximization problem. The financial market would be deeper if a fraction of bad customers repays the loan in the first period. But the deepening of the market will equally affect the banks' customer base with bad and with full information sharing. Consequently, the conclusions about the impact of different information sharing schemes on interest rates would not change. Therefore I retain the original assumption that bad customers never repay, for it renders the analysis more tractable.

I make the following assumption about customers' choice of a bank: each new good borrower will choose one of two banks that operate in the market, based on his or her

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[7] I do not address moral hazard in this paper. I use collateral only as a separating device between "good" and "bad" customers, and I do not discuss its other implications. On moral hazard in bank lending see, for instance, Sharpe (1990), Padilla and Pagano (1997), and Padilla and Pagano (2000), Dell'Ariccia (2000), and Marquez (2002). On the role of collateral see, for instance, Stiglitz and Weiss (1981).

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 evidence that the fraction of bad customers is almost identical across banks in most countries. (I could have assumed instead that half of the bad customers go to one bank and half of them to the other bank. This would have altered 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" unknown 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 are unknown to the bank they borrow from. 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 from some bank becomes $2(1-\gamma)$.

Good customers, who borrow and repay in both periods, maximize total utility over two periods:

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

where v is the customers' valuation of the loan, $R_t(k)$ 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, $\delta^G \in (0, 1)$ is the discount factor, θ_k and θ_j measure the customer's "distance" from that bank he or she actually borrowed from in period *t* and *t*+1.

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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. Then the customer decides which bank to go to in her first period and in her second period in the market. I shall show in section 4.1 that the main conclusions of the analysis would also hold if more than two banks compete in the market.

9 I could have assumed—as in Fudenberg and Tirole (2000)—that customers are distributed between banks *k* and *j* by the density function $f_{k,j}(\theta)$. The market shares of bank *k* and *j* would then become $F_{k,}j(\theta^*)$ and $1-F_{k,j}(\theta^*)$ instead of θ^* and $1-\theta^*$, respectively, where θ^* denotes the preference of the marginal customer between bank *k* and *j* and $F_{k,}j(\theta^*)$ is the cumulative density function, but it would have not modified either the analysis or any of the conclusions.

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: $u^B = (1+\delta^B)(1+v)$. 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 their decision to take the loan until the second period, for the discounted value of their benefit would be lower than what they gain from borrowing and not repaying in the first period, which is $u^B = 1+v$. Since only good customers can borrow in both periods if banks share information about customers, the relevant discount factor will be δ^G. I shall denote the discount factor δ to make the formulas simpler. I also assume that good customers and the banks work with the same discount factor.

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.

3.3 BANKS

Two banks of different sizes operate in the private credit market in period *t*.[10] 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* inflicted upon them by borrowers who do not repay the loan plus the *cost of funds and operation*. I assume that banks have identical marginal cost of funds and operation and it is constant at *c*.[11] For simplicity's sake, I disregard banks' start-up costs. I further assume that banks do not pay for the information they acquire about customers from a credit rating agency.[12]

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[10] I assume that no bank will drop out from the market and I also disregard the possibility of mergers between banks.
[11] The assumption about the banks' identical marginal cost simplifies the analysis without affecting its main conclusions. If I assumed different marginal costs it would have resulted in the banks' diverging market shares. I shall briefly mention this possibility in the paper when it becomes relevant.
[12] 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.

Banks are represented by their history, strategy and payoff. Banks' history would be 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. This is why I shall develop a three period model with overlapping generations.

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

4. LONG-TERM PRICE COMPETITION AMONG BANKS WITH AND WITHOUT INFORMATION SHARING

After having outlined the modeling assumptions I present the models with different information sharing systems. It would be convenient but it is not feasible to compile a general model of banks' competition with different regimes of information sharing. We need four different models to describe the banks' competition with different information sharing systems because the demand for loans of the different types of borrowers will be derived in different ways under the four possible regimes. We start the analysis with "black listing" then we turn to full list. No information sharing and information sharing only about good borrowers will then follow.

4.1 INFORMATION SHARING ONLY 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. 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 unknown good customers a bank will serve in period t.

Let us start with the borrowers' problem. First, I describe the decision problem of those good customers who spend their second (last) period in the market.

Lemma 2: *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*:

(4) $v-\left(R^G_{t+1}(k)+\theta\right)\geq v-\left(R^U_{t+1}(j)+1-\theta\right)$, or $R^G_{t+1}(k)+\theta\leq R^U_{t+1}(j)+1-\theta$, *from which we have*: $\theta\leq\dfrac{R^U_{t+1}(j)-R^G_{t+1}(k)+1}{2}, \quad k=1,2; \quad j=2,1,$

where $R^U_{t+1}(k)$ and $R^U_{t+1}(j)$ *are the interest rates charged to unknown customers in period t+1, while* $R^G_{t+1}(k)$ and $R^G_{t+1}(j)$ *are the interest rates charged to known good customers by bank k and bank j in period t+1, respectively*.

Lemma 2 states that an old good customer stays at her original bank and pays the interest rate charged to known good borrowers if her consumer surplus is not smaller than what she could have attained had she switched banks and paid the interest rate charged to unknown borrowers by the new bank.

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

The mass of those "old" and known good borrowers who stay with bank k cannot exceed $\gamma s_t^y(k)$, that is bank k's market share among young unknown good borrowers:

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

θ^* denotes the marginal young customer's "distance" from bank k which equals bank k's market share $s_t^y(k)$ in the market segment of young customers, for we assumed that θ is uniformly distributed on the unit interval.[13] Equation (5) 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 "young" unknown good customers in period t.

Lemma 3: *A young unknown good customer with preference θ will choose bank k rather than bank j in period t if an only if*:

(6)
$$\begin{aligned} &v-R_t^U(k)-\theta+\max\left\{\delta\left(v-R_{t+1}^G(k)-\theta\right);\delta\left(v-R_{t+1}^U(j)-(1-\theta)\right)\right\}\geq \\ &\geq v-R_t^U(j)-(1-\theta)+\max\left\{\delta\left(v-R_{t+1}^G(j)-(1-\theta)\right);\delta\left(v-R_{t+1}^U(k)-\theta\right)\right\}, \end{aligned}$$

which can also be written as:

(7)
$$\begin{aligned} &R_t^U(k)+\theta+\min\left\{\delta\left(R_{t+1}^G(k)+\theta\right);\delta\left(R_{t+1}^U(j)+(1-\theta)\right)\right\}\leq \\ &\leq R_t^U(j)+(1-\theta)+\min\left\{\delta\left(R_{t+1}^G(j)+(1-\theta)\right);\delta\left(R_{t+1}^U(k)+\theta\right)\right\}, \end{aligned}$$

where, again, θ denotes the customer's "distance" in the preference space of all customers from bank k, $R_t^U(k)$ 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 the other, she will pay the interest rate charged to

[13] Had θ had a distribution other than uniform, bank k's market share in the market segment of young borrowers would become: $s_t^y(k)=F\left(\theta^*\right)$, where $F(.)$ denotes the cumulative density function of θ.

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. 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 equation (5) that $\min\{(R_{t+1}^G(k)+\theta^*);(R_{t+1}^U(j)+1-\theta^*)\}=(R_{t+1}^U(j)+1-\theta^*)$, we get the following indifference condition for the marginal new good customer:

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

After rearranging equation (8) we have:

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

which is bank k's market share in the market segment of young unknown borrowers.

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

How will old good borrowers, known to their original bank, choose the bank to borrow from in the second period? Before answering this question, I describe an important result in the following lemma.

Lemma 4: *If banks sold private credit to all of their known good customers, markets would be in steady state from the start. The interest rate bank k could charge to its known good borrowers becomes*:

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

which directly follows from equations (5) *and* (9). (*The upper bar stands for steady state values of the variables.*)

As shown in equation (10), banks would charge the same interest rate to their unknown and to their known good customers. Bank k's profit on *all* of its known good customers then would become in each period: $\overline{\pi}^G(k)=\gamma\overline{s}^y(k)\left(\overline{R}^U(k)-c\right)$.

However, a uniform interest rate cannot be a bank's profit maximizing strategy if it can distinguish between unknown and known good borrowers. (See Proposition A1 and its proof in the Appendix.) 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. Bank k's market share among known (or "old") good customers will be in period t: $s_t^o(k) = \gamma\left(\frac{R_t^U(j) - R_t^G(k) + 1}{2}\right)$.

After having found the banks' market shares in all segments of the private credit market, let us turn to the banks' optimization problem. Bank k will find the interest rate it charges to unknown customers from solving its profit maximization exercise:

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

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

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

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

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

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

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

Lemma 5: *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) $$s_t^p(k) = \gamma\left(\frac{R_{t-1}^U(k) - R_{t-1}^U(j)}{2(1-\delta)} + \frac{\delta R_t^U(j)}{2(1-\delta)} - \frac{(1+\delta)R_t^U(k)}{4(1-\delta)} + \frac{1+c}{4}\right),$$
$k = 1, 2; \quad j = 2, 1.$

The above result immediately obtains if we plug the result from equation (13) *into* $s_t^p(k)$ *as defined above, which is bank k's market share in the poaching market.*

After substituting the result from (14) into equation (11) that gives bank k's profit from unknown customers, we get the first order condition of profit maximum in the market segment of unknown borrowers:

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

The first order conditions give a fairly complex system of linear difference equations of third order on the interest rates banks charge to unknown customers in successive periods. But solving equation (15) for the equilibrium value of $\overline{R}(j) = R_{t+1}(j) = R_t(j) = R_{t-1}(j), \quad j = 2, 1$ yields the following, less complex difference equation:

(15a) $$R_{t+1}^U(k) - \left(\frac{3+\delta}{2\delta}\right)R_t^U(k) + \frac{R_{t-1}^U(k)}{2\delta} + C = 0, \quad k = 1, 2,$$ where C stands for the constant terms in (15). I show in the Appendix that equation (15a) has a unique solution that is stable and it converges to steady state. (See Proposition A2 in the Annex.) Therefore, I shall present the results only for steady state.

Lemma 6: *Equation* (15) *simplifies to the following interest rates in steady state*:

(16) $$\overline{R}_B^U(k) = \frac{(2+\gamma-3\delta\gamma)}{2(2-\delta)\gamma} + \frac{\left(1+(1-\delta)\gamma\right)c}{(2-\delta)\gamma}, \quad k = 1, 2,$$

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 solution for the banks' optimization problem in steady state.*

Lemma 7: *The interest rate known good borrowers pay will be*:

(17) $$\overline{R}_B^G(k) = \frac{2+5\gamma-5\delta\gamma}{4(2-\delta)\gamma} + \frac{(2+6\gamma-3\delta\gamma)c}{4(2-\delta)\gamma}.$$

The above result obtains from substituting the $\overline{R}_B^U(k)$ *from equation* (16) *into equation* (13).

The interest rates bank k charges to unknown customers $\left(\overline{R}_B^U(k)\right)$ and to known good borrowers $\left(\overline{R}_B^G(k)\right)$ will be a monotonous and decreasing function of $\gamma \in [0, 1]$ under a black list. That is, unknown and known good borrowers pay a lower interest rate with a larger than with a smaller fraction of good borrowers in the entire borrowing population. This conclusion is in line with intuition. A more interesting result is that $\overline{R}_B^U(k)$ and $\overline{R}_B^G(k)$ also monotonously decrease with $\delta \in (0, 1)$ at any reasonable values of γ.[14] At $\delta \to 0$, the interest rate unknown borrowers pay will be:

(16a) $$\overline{R}_B^U(k) = \frac{2+\gamma}{4\gamma} + \frac{(1+\gamma)c}{2\gamma},$$

while known good customers pay the following interest rate:

(17a) $$\overline{R}_B^G(k) = \frac{2+5\gamma}{8\gamma} + \frac{(1+3\gamma)c}{4\gamma}.$$

If $\delta \to 1$, (16) becomes:

(16b) $$\overline{R}_B^U(k) = \frac{1-\gamma}{\gamma} + \frac{c}{\gamma}, \quad k = 1, 2.$$

Substituting (16b) into (13) gives the interest rates banks will charge to known good customers in steady state at $\delta \sim 1$.

(17b) $$\overline{R}_B^G(k) = \frac{1}{2\gamma} + \frac{(1+\gamma)c}{2\gamma}, \quad k = 1, 2.$$

Since interest rates decrease in δ, unknown and known good borrowers will pay the lowest interest rate at $\delta \sim 1$. That is, a thriftier banking population will pay lower interest rates to banks than if borrowers heavily discount their future benefit.

Another important result of the previous analysis obtains if we compare equations (16a) and (16b), and (17a) and (17b), respectively, as formulated in Proposition 1 below.

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[14] The condition will be as follows: $\overline{R}^U(k)$ and $\overline{R}^G(k)$ decrease in δ if $\gamma > \frac{2(1+c)}{5+2c}$. Since $c \in [0, 1]$ and γ is increasing with c in the inequality, $\overline{R}^U(k)$ and $\overline{R}^G(k)$ will decrease in δ if $\gamma \geq \frac{4}{7}$, that is, the share of good customers is larger than 57 per cent in the total banking population at the extreme.

PROPOSITION 1. *Banks set a higher interest rate to known good than to unknown customers under information sharing only about bad customers,* $\overline{R}_B^U(k) < \overline{R}_B^G(k)$ *if* $\gamma > \frac{2(1+c)}{3+2c}$ *when* δ *is close to zero, and* $\overline{R}_B^U(k) < \overline{R}_B^G(k)$ *if* $\gamma > \frac{1+c}{2+c}$ *when* δ *approaches* 1.

Proof. The proof immediately follows from comparing interest rates in equations (16a) *and* (16b), *and in* (17a) *and* (17b), *respectively.*

It can be easily seen that the first inequality results in a larger γ than the second one. Consequently, banks can charge a higher interest rate to known good than to unknown customers at a lower fraction of good borrowers if customers are thrifty. In case customers discount future benefits to a large extent, banks need a larger fraction of good borrowers to be able to charge higher interest rates to known good than to unknown customers.

As the former proposition demonstrates, banks will "rip off" known good customers.[15] The intuition behind this result is straightforward. If banks do not share information about good customers—which implies that good borrowers of a bank cannot credibly prove to other banks that they repaid their loan before—then each bank is a monopolist in its market segment of old good borrowers. Consequently, banks can and will charge the monopoly rate to their old good customers. The monopoly rate is only constrained by the customers' valuation and by the interest rate other banks ask from unknown borrowers. The higher the banks price their loan to old good borrowers the larger fraction of these borrowers go and borrow at other banks as unknowns. Meanwhile, banks compete for unknown borrowers who can be new or old. Thus, the market is larger and competition is fiercer in the market segment of unknown customers than in the monopolistic segment of a bank's market. More vicious competition exerts a downward pressure on interest rates banks can ask from unknown customers. In other words, old good borrowers are "informationally captured" by

[15] If banks operated with different marginal costs, the more cost-efficient bank would charge a *lower* interest rate to its unknown customers than the less efficient one: $\overline{R}_b^U(k) = \frac{1-\gamma}{\gamma} + \frac{c_k}{\gamma} < \frac{1-\gamma}{\gamma} + \frac{c_j}{\gamma} = \overline{R}_b^U(j)$ if $c_k < c_j$. But the low-cost bank would ask a *higher* interest rate from its known good borrowers than the high-cost bank: $\overline{R}_b^G(k) = \frac{1}{2\gamma} + \frac{\gamma c_k + c_j}{2\gamma} > \frac{1}{2\gamma} + \frac{c_k + \gamma c_j}{2\gamma} = \overline{R}_b^G(j)$. It means that the more efficient—and usually larger—bank would "rip off" its known good customers even more eagerly than the less efficient and smaller one.

their original bank because these customers cannot carry their good reputation over to other banks.[16]

We have seen before that the interest rates borrowers pay will be the lowest when the discount factor is close to 1. I shall assume that $\delta \sim 1$ when I compare banks' market shares and profits under different systems of information sharing.

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 $\gamma \overline{R}_B^U(k) - (1-\gamma) - c = \gamma\left(\frac{1-\gamma}{\gamma} + \frac{c}{\gamma}\right) - (1-\gamma) - c = 0$. Total profit of the two banks in equilibrium will be:

(18)

$$\overline{\pi}_B(k) = \overline{\pi}_B^U(j \neq k) + \overline{\pi}_B^G(k) = \left(\frac{(2\gamma-1)(1-\gamma)(1+c)}{4\gamma}\right) + \frac{(1+(1-\gamma)c)^2}{8\gamma},$$

$k = 1, 2; \quad j = 2, 1,$

where $\overline{\pi}_B(k)$ labels the bank's total equilibrium profit with bad information sharing. Equilibrium profit is unique at all feasible values of γ and c.[17]

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[16] If bank *k* operated with a lower unit cost than bank *j*, that is, $c_k < c_j$ would hold, then its market share among unknown customers would exceed bank *j*'s market share by $\overline{s}^y(k) - \overline{s}^y(j) = \frac{c_j - c_k}{\gamma}$. 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, bank *j*, the less efficient bank, will gain a larger market share than bank *k* in the poaching market by: $\overline{s}^p(j) - \overline{s}^p(k) = \frac{(3-\gamma)(c_j - c_k)}{4}$.

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, smaller banks will poach more good customers from larger banks than vice versa.

[17] As mentioned above in footnote 8, the results are fairly general and could be easily extended to $K > 2$ banks. Bank *k*'s market share in the market segment of unknown young borrowers would then become: $s_t^y(k) = \frac{\sum_{j \neq k} n_{k,j} R_t^U(j) - R_t^U(k) + \delta\left(R_{t+1}^U(k) - \sum_{j \neq k} n_{k,j} R_{t+1}^U(j)\right)}{2(1-\delta)} + \frac{1}{2}$, where $n_{k,j}$ is the fraction of those customers who borrow either from bank *k* or from bank *j*. Bank *k*'s market share on

We can conclude this part of the analysis that banks will not have an incentive to fiercely compete for good customers if they share information only about bad borrowers, for those customers are informationally captured by their original bank. Consequently, known good borrowers will pay a higher interest rate for the loan they acquire than unknown customers. Competition will be more vicious for young unknown borrowers and on the poaching market, for it makes sense for a certain group of a bank's customers to switch to another bank during their second period in the market. In fact, we can witness fiercer competition for unknown customers in several countries where black listing is in place: banks offer a low "introductory rate" to new customers, while interest rates sneak upwards later when these customers will have already settled at the bank.

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.[18] 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 in the current framework—contrary to Fudenberg and Tirole (2000)—banks will not charge different interest rates to own good borrowers and known good borrowers who borrowed from another bank before if banks share full information. In principle, it would be feasible, but it is not in the banks' interest to price discriminate between own known good borrowers and the known good borrowers of the

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the poaching market would be: $\sum_{j\neq k} \max\left(0;\, s_{t-1}(j,k) - n_{k,j}\left(\frac{R_t^U(k) - R_t^G(j) + 1}{2}\right)\right)$. It can be easily obtained that the equilibrium interest rates for unknown customers with K banks and with $\delta \sim 1$ would be: $\overline{R}_B^U(k) = \frac{1-\gamma}{\gamma} + \frac{c}{\gamma},\quad k = 1, 2, \ldots, K$. Banks would charge the following interest rates to known good borrowers: $\overline{R}_B^G(k) = \frac{1 + \left(\gamma + \sum_{j\neq k} n_{k,j}\right)c}{2\gamma},\ \forall k,\ \forall j \neq k$. These interest rates are basically identical to what we obtained with two banks.

[18] 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 I prove in the Appendix (see Proposition A2) that such price discrimination cannot be the banks' dominant strategy.

other bank under full information sharing. (See Proposition A2 and its proof in the Appendix.)

Lemma 8: *The marginal new (unknown) good customer will be indifferent between choosing bank k or bank j if*:

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

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

Lemma 9: *Bank k's market share among known good customers becomes in period t*:

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

Finally, there won't be a poaching market if banks share full information. Banks find the interest rate they charge to unknown borrowers by solving:

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

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

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

The first order conditions of (22) and (23) yield:

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

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

Lemma 10: *Both markets are in steady state from the start and the equilibrium interest rates become*:

(26) $$\overline{R}_F^U(k) = \frac{1+c}{\gamma}, \quad k = 1, 2, \text{ and}$$

(27) $$\overline{R}_F^G(k) = 1 + c, \quad k = 1, 2,$$

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

Comparing equations (26) and (27) shows that, in contrast to bad information sharing, banks will charge *lower interest rates* to known than to unknown borrowers whenever $\gamma < 1$. That is, borrowers will be rewarded for good behavior under full information sharing. This result is in line with intuition. Although banks cannot act as monopolists in either of the two market segments—they must compete for customers in both markets—known good customers cannot go to another bank and borrow as unknowns. And this fact softens competition among banks for unknown customers. But it doesn't mean that good customers are better off with full than with bad information sharing. If we compare the steady state interest rates in (16b) and (17b) and in (26) and (27) it shows that the interest rates paid by unknown customers will *always* be *higher* with full information sharing than under bad information sharing. Known good borrowers will also pay higher interest rates under a full list than with a black list if $\gamma > \frac{1+c}{2+c}$, which is an unexpected result. (I discuss the intuition behind this outcome below.) Consequently, banks will gain, but customers will lose with a full list even at relatively low values of γ (that is, at a relatively small fraction of good borrowers).

Full information sharing differs from a black list from 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.[19]

The most intriguing question is which information sharing system would banks support. Using the results from (26) and (27), banks' profit with full information sharing becomes:

$$\text{(28)} \quad \bar{\pi}_F(k) = \bar{\pi}_F^U(k) + \bar{\pi}_F^G(k) = \frac{1}{2}\left(\gamma\left(\frac{1+c}{\gamma}\right) - (1-\gamma) - c\right) + \frac{\gamma}{2}(1+c-c) = \gamma, \quad k = 1, 2; \quad j = 2, 1,$$

where $\bar{\pi}_F(k), \quad k = 1, 2$ denotes bank k's profit from unknown and from known good borrowers with full information sharing in steady state. Notice, that the equilibrium will always be unique. Comparing (18) and (28)—that is, comparing respective market shares and interest rates net of marginal cost—shows that, banks attain *higher* expected profits with *full* than with bad information sharing. Based on the analysis above, we can formulate the following proposition:

PROPOSITION 2. *Fully rational banks will always prefer full information sharing to a black list if the fraction of good customers,* $\gamma > \frac{1+c}{2+c}$. *In case* $\gamma < \frac{1+c}{2+c}$, *banks will share information only about bad borrowers.*

[19] If banks operated with different marginal costs, consequently, with different market shares, the lack of the poaching market would hurt 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—would lose more in terms of poaching profit than large banks.

Customers, however, would be better off with bad than with full information sharing, for they pay higher interest rates with a full list than with a black list if $\gamma > \frac{1+c}{2+c}$. (See proof in the Appendix.)

The result about interest rates is surprising for one would expect that sharing full information triggers intensive competition among banks and stronger competition unequivocally leads to lower interest rates to all borrowers. But with full information sharing, known good customers cannot leave their bank and go to another bank as unknowns, nor can young unknown customers remain and borrow as unknowns in their second period in the market. Banks will know that a good customer spends her last period in the market, while unknown borrowers cannot be but young. Hence, banks use this information to charge higher interest rates to known *and* to unknown borrowers than with bad information sharing. In addition, since the two market segments are fully separated under a full list, the interest rates charged by a bank's competitors in one market segment do not have a dampening effect on this bank's interest rate on the other market segment as was the case under a black list. 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.[20]

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 section.

[20] 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, but also in several Eurozone countries recently.

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. Hence, good customers allocate themselves across banks the same way as with "bad" information sharing. But the banking sector faces 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:

$$s_t^y(k)(1-\gamma)+s_t^y(k)(1-\gamma)\left(1-s_{t-1}^y(k)\right)=s_t^y(k)(1-\gamma)\left(2-s_{t-1}^y(k)\right). \tag{29}$$

As can be seen from equation (29), the number of bad customers who visit bank *k* cannot be smaller now than with information sharing only about bad borrowers. If two banks operate in the market, equation (29) becomes:

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

From now on, I shall use this equation.

Bank *k*'s profit and its continuation profit from unknown borrowers becomes in period *t*:

$$\begin{aligned}\pi_t^U(k)+\pi_t^U(j\neq k)+\delta\pi_{t+1}^U(j\neq k) &= s_t^y(k)\left(\gamma R_t^U(k)-c-(1-\gamma)\right)-\left(1-s_{t-1}^y(k)\right)(1-\gamma)(1+c)\\ &+\gamma\left(R_t^U(k)-c\right)\left(\max\left\{0;\ s_{t-1}^y(j)-\frac{R_t^U(k)-R_t^G(j)+1}{2}\right\}\right)\\ &+\delta\gamma\left(R_{t+1}^U(k)-c\right)\left(\max\left\{0;\ s_t^y(j)-\frac{R_{t+1}^U(k)-R_{t+1}^G(j)+1}{2}\right\}\right)\\ &-\delta\left(1-s_t^y(k)\right)(1-\gamma)(1+c),\qquad k=1,2;\quad j=2,1.\end{aligned} \tag{31}$$

Bank *k*'s profit in (31) is a difference equation of third order. Solving the first order condition for steady state values yields:

$$(32)\ \frac{\partial\left(\overline{\pi}^{U}(k)+(1+\delta)\overline{\pi}^{U}(j\neq k)\right)}{\partial \overline{R}_{N}^{U}(k)}=-\frac{(2-\delta)\gamma \overline{R}^{U}(k)}{2(1-\delta)}+\frac{\left(1+(1-\delta)\gamma\right)c}{2(1-\delta)}+\frac{(2+(1-\delta)\gamma)(1-\gamma)}{4(1-\delta)}=0\,.$$

In case the discount factor is close to one, the equilibrium interest rates for unknown borrowers will be the same as in (16b):

$$(33)\qquad \overline{R}_{N}^{U}(k)=\frac{1-\gamma}{\gamma}+\frac{c}{\gamma},\quad k=1,2,$$

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.

Known good customers pay the same interest rate as with a black list: $\overline{R}_{N}^{G}(k)=\frac{1}{2\gamma}+\frac{(1+\gamma)c}{2\gamma},\quad k=1,2$. Bank's profit from unknown customers will obviously be smaller than under a black list for banks lose more on bad borrowers with no information sharing than with a black list. Consequently, banks' profit with no information sharing is always lower than with bad or with full information sharing.

PROPOSITION 3. *No information sharing cannot be a bank's dominant strategy if banks are fully rational and maximize long-term profits.*

Proof. *The proof immediately follows from Proposition 2, and from the fact that banks' profit will be lower with no information sharing than with a black list because of a larger fraction of bad customers who are able to borrow in both periods. Q.e.d.*

As we have just seen, fully rational banks would never opt for no information sharing, but myopic banks may do so. No information sharing has a special appeal to 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.[21] We can formulate the following proposition.

PROPOSITION 4. *Banks with different marginal costs (and market shares) will not choose to implement information sharing only about good borrowers.* See proof of Proposition 4 in the Appendix.

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

We can conclude that banks' optimum strategy is to share full information if the fraction of bad borrowers is not substantial in the market. 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.

5. DISCUSSION AND CONCLUSIONS

We have found that full information sharing would be in the banks' interest if the fraction of good borrowers is sufficiently large. 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 also 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.

The analysis can be extended in several directions. First, if banks operated with different marginal costs then large banks would have different incentives to information sharing than small ones. Large banks would gain more than small banks from full information sharing in terms of profits, if the fraction of good borrowers is large in the private credit market. But in case banks can expect a substantial fraction of bad borrowers, large banks will opt for bad information sharing. The conflicting interest of banks with different sizes may partly explain that we do not see full information sharing schemes in many of the emerging markets. These countries usually implement a black list on a mandatory basis instead.

Secondly, I only focused on issues similar to the problem of adverse selection. Allowing for a positive probability of good customers' default, that is, incorporating moral hazard in the analysis would render the issue of systemic risk in bank lending also tractable.

Thirdly, I have shown that with endogenously derived default decisions of borrowers a fraction of "bad" customers will also have an interest to act strategically and repay their loan with interest in the first period. Bad customers' incentive to repay equally holds for full and for bad information sharing, but it does not apply if there is no information sharing among banks or they only share good information. Fewer defaults result in a deeper financial market and lower interest rates for repaying borrowers.

However, finally, a deeper market does not alter the fact that full information sharing leads to higher interest rates than a black list. I have shown that full information sharing has the most negative consequences to good borrowers. Good borrowers would be better off with a black list than with a full list for they must pay a higher interest rate with full information sharing than under a black list. If governments put a larger weight on consumer welfare than on banks' profits, they will choose a scheme of bad information sharing rather than a full list. It follows from the above argument that regulatory agencies could have an important role to play in shaping the private credit markets.

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APPENDIX

PROPOSITION A1. Fully rational banks will not charge a uniform interest rate to unknown and to known good customers with bad information sharing.

Proof. With a uniform interest rate bank k maximizes the following profit, including continuation profit in period t:

(A1) $$\pi_t(k) = s_t^y(k)\big(\gamma R_t(k) - c - (1-\gamma) + \delta s_t^y(k)\gamma\big(R_{t+1}(k) - c\big)\big) + s_{t-1}^y(k)\gamma\big(R_t(k) - c\big).$$

The first order condition by $R_t(k)$ *yields:*

(A2) $$\frac{R_{t-1}(j) - R_{t-1}(k)}{2(1-\delta)} + \frac{R_t(j)}{2} - R_t(k) - \frac{\delta R_{t+1}(j)}{2(1-\delta)} + 1 + \frac{1-\gamma}{2(1-\delta)\gamma} + \frac{c}{2(1-\delta)\gamma} = 0.$$

Solving (A2) for steady state values gives:

(A3) $$\overline{R}(k) = \left(\frac{2(1-\delta)}{3-2\delta}\right)\overline{R}(j) + \left(\frac{2(1-\delta)}{3-2\delta}\right) + \frac{1-\gamma}{(3-2\delta)\gamma} + \frac{c}{(3-2\delta)\gamma}.$$

Assuming that $\delta \sim 1$ *obtains:*

(A4) $$\overline{R}(k) = \frac{1-\gamma}{\gamma} + \frac{c}{\gamma}, \quad k = 1, 2,$$

which is the same interest rate banks would charge to unknown customers with price discrimination. Bank k's profit in steady state becomes:

(A5) $$\overline{\pi}(k) = \frac{(1-\gamma)(1+c)}{2}.$$

Profits with price discrimination will be in steady state:

$$\overline{\pi}_B(k) = \overline{\pi}^u(j \neq k) + \overline{\pi}^G(k) = \frac{(2\gamma-1)(1-\gamma)(1+c)}{4\gamma} + \frac{\big(1+(1-\gamma)c\big)^2}{8\gamma}, \quad k = 1, 2$$

as presented in equation (18) above. Comparing profits with uniform pricing as given in equation (A5) and profits with price discrimination between unknown and known good borrowers as in equation (18) above shows that the former is smaller than the latter one if $\gamma > \frac{-\left(1-c^2\right) + \sqrt{1-c^2}}{c^2} \sim \frac{1}{2}$. *Q.e.d.*

PROOF OF PROPOSITION 2: Comparing $\overline{\pi}_B(k)$ *in (18) and* $\overline{\pi}_F(k)$ *in (28) shows that banks earn larger profits with full than with bad information sharing if* $\gamma > \frac{1+c}{2+c}$ *for the following reasons:*

- *Banks earn zero profits on young unknown customers under a black list:* $\overline{\pi}_B^U(k) = \overline{s}^y(k)\left(\gamma \overline{R}^U(k) - c\right) = \overline{s}^y(k)\left(\gamma\left(\frac{1-\gamma}{\gamma} + \frac{c}{\gamma}\right) - (1-\gamma) - c\right) = 0, \quad k = 1, 2.$

- *Banks' profit in the poaching market with information sharing only about bad customers becomes:* $\overline{\pi}_B^p(k) = \overline{s}^p(k)\gamma\left(\overline{R}_B^U(k) - c\right) = \left(\frac{2\gamma-1}{4\gamma} + \frac{(1+\gamma)c}{4\gamma}\right)\gamma\left(\overline{R}_B^U(k) - c\right) = \left(\frac{2\gamma-1}{4\gamma} + \frac{(1+\gamma)c}{4\gamma}\right)(1-\gamma)(1+c)$ *, while banks' profit on unknown customers under a full list will be:* $\overline{\pi}_G^U(k) = \overline{s}^y(k)\left(\gamma \overline{R}_G^U(k) - (1-\gamma) - c\right) = \frac{\gamma}{2}$*. Since unit profit on the poaching market under a black list is* $(1-\gamma)(1+c)$*, while it is* γ *in the market for unknown borrowers under a full list, it immediately obtains that* $(1-\gamma)(1+c) < \gamma$ *if* $\gamma > \frac{1+c}{2+c}$*. Now we just need to show that* $\overline{s}^p(k) = \left(\frac{2\gamma-1}{4\gamma} + \frac{(1+\gamma)c}{4\gamma}\right) < \frac{1}{2}$*. After rearranging we get:* $1 - \frac{1}{c} < \gamma$*. Since* $c \le 1$*, the former inequality will always hold.*

- *The interest rate banks charge to known good borrowers —consequently, unit profit—will be higher under a full list than under a black list if* $\gamma > \frac{1+c}{2+c}$*, as I have shown above. Banks' market share in the market segment of known good customers with a black list is* $\overline{s}^o(k) = \frac{1-2\gamma}{4\gamma} + \frac{(1-\gamma)c}{4\gamma} + \frac{1}{2}$*, while it is* $\overline{s}^o(k) = \frac{1}{2}$ *under a full list. Thus, banks serve more known good borrowers under a full list than under a black list if* $\frac{1-2\gamma}{4\gamma} + \frac{(1-\gamma)c}{4\gamma} + \frac{1}{2} < \frac{1}{2}$*, which simplifies to* $\gamma > \frac{1+c}{2+c}$.

We can conclude that banks will earn larger profits with full information sharing than with information sharing only about bad borrowers under fairly general conditions.

Finally, comparing the interest rates in (16) and (17), and in (26) 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.

PROPOSITION A2. The solution of the difference equation $R_{t+1}^{U}(k)-\left(\frac{3+\delta}{2\delta}\right)R_t^{U}(k)+\frac{R_{t-1}^{U}(k)}{2\delta}+C=0$*, is unique and stable and it converges to steady state.*

PROOF: The characteristic equation of the above difference equation is given by $m^2-\left(\frac{3+\delta}{2\delta}\right)m+\frac{1}{2\delta}=0$*. Since* $\frac{1}{4}\left(\frac{3+\delta}{2\delta}\right)^2-\frac{1}{2\delta}>0$ *holds for any value of* $\delta>0$*, equation has a unique solution in real numbers.*[22] *The solution of the difference equation is stable and converges to steady state if the solution of the characteristic equation is smaller than unity. It can be seen that this condition is met if* $\delta<2$*. Q.e.d.*

PROPOSITION A3. 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 bank k charges to known good borrowers who migrated from bank j $\hat{R}_t^{G}(k)$ *in period t. Then the marginal unknown good customer will be the person for whom:*

(A6)

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

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

(A7)

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

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

(A8) $\pi_t^{U}(k)=\left(\gamma R_t^{U}(k)-c-(1-\gamma)\right)s_t^{y}(k),\quad k=1,2$,

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

(A9) $\pi_t^{G}(k)=\gamma\left(R_t^{G}(k)-c\right)\left(\frac{\hat{R}_t^{G}(j)-R_t^{G}(k)+1}{2}\right),\quad k=1,2;\quad j=2,1$,

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

(A10) $$\hat{\pi}_t^{G}(k)=\gamma\left(\hat{R}_t^{G}(k)-c\right)\left(s_{t-1}^{y}(j)-\frac{\hat{R}_t^{G}(k)-R_t^{G}(j)+1}{2}\right),\quad k=1,2;\quad j=2,1.$$

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[22] See, for instance, Sydsaeter and Hammond (1995), p. 751.

The first order condition of (A8) yields:

(A11) $$\frac{R_t^U(j)}{2} - R_t^U(k) + \frac{\delta\hat{R}_{t+1}^G(k)}{2} - \frac{\delta\hat{R}_{t+1}^G(j)}{2} + \frac{1-\delta}{2} + \frac{1-\gamma}{2\gamma} + \frac{c}{2\gamma} = 0, \quad k = 1, 2; \quad j = 2, 1.$$

From the first order condition of (A9) we have:

(A12) $$\frac{\hat{R}_t^G(j)}{2} - R_t^G(k) + \frac{1+c}{2} = 0, \quad k = 1, 2; \quad j = 2, 1.$$

Finally, the first order condition of (A10) gives:

(A13) $$\frac{R_{t-1}^U(k) - R_{t-1}^U(j)}{2} + \frac{(1-\delta)R_t^G(j)}{2} + \frac{\delta\hat{R}_t^G(j)}{2} - \hat{R}_t^G(k) + \frac{c}{2} = 0.$$

Solving the system of equations in (A11)–(A13) for steady state values and $\delta \sim 1$ *yields:*

(A14)

$$\left.\begin{aligned} \overline{R}^U(k) &= \frac{c}{\gamma}; \\ \overline{\hat{R}}^G(k) &= \frac{2c}{5\gamma}; \\ \overline{R}^G(k) &= \frac{5+7c}{10} \end{aligned}\right\} \quad k = 1, 2.$$

Comparing $\overline{R}^U(k)$ *in equation (A14) with* $\overline{R}^U(k)$ *in equation (26) 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 $\overline{\hat{R}}^G(k) < \overline{R}^G(k)$ *if* $\gamma > \frac{4c}{5+7c}$, *that is, if* $\gamma > \frac{1}{3}$ *when* $c \sim 1$ *at the extreme, as can be seen from (A14), 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.* $\overline{R}^G(k)$ *in (A14) will be smaller than* $\overline{R}^G(k)$ *in equation (27) if* $\frac{5+7c}{10} < 1+c$. *This condition will be satisfied at any values of c. Consequently, banks earn lower profits on known good customers with than without price discrimination. Q.e.d.*

PROOF OF PROPOSITION 4: 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:

(34) $\pi_t^U(k) = s_t^y(k)\left(\gamma R_t^U(k) - (1-\gamma) - c\right) - \left(1 - s_{t-1}^y(k)\right)(1-\gamma)(1+c),$

as with no information sharing, while bank k would earn the following profit from known good borrowers:

(35) $\pi_t^G(k) = s_t^o(k)\gamma\left(R_t^G(k) - c\right)$, *where* $s_t^o(k) = \dfrac{R_t^G(j) - R_t^G(k) + 1}{2}$.

Solving (34) and (35) for equilibrium values with $\delta \sim 1$ *yields the following interest rates:*

(36) $\overline{R}_G^U(k) = \dfrac{1-2\gamma}{\gamma} + \dfrac{(2-\gamma)c}{\gamma}, \quad k = 1, 2$,

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):*

(37) $\overline{R}_G^G(k) = 1 + c, \quad k = 1, 2$.

The interest rates charged to unknown customers with a black list, as given in equation (16b) will be higher than the interest rates in (36) if: $\gamma > -\dfrac{1-c}{c}$. *This condition will always be satisfied. Since banks receive more bad customers with a "white list" than with a black list, their profit from unknown borrowers will be lower in the former case than in the latter. Banks' profit from known good customers will be identical with full information sharing and with a white list. But we have seen that full information sharing dominates information sharing only about bad borrowers under fairly general conditions. Consequently, full information sharing also dominates information sharing only about good borrowers. Q.e.d.*