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INFORMATION SHARING IN BANKING:
A COLLUSIVE DEVICE?

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Information Sharing in Banking: A Collusive Device?*

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Abstract: We show that information sharing among banks may serve as a collusive device. An informational sharing agreement is an a-priori commitment to reduce informational asymmetries between banks in future lending. Hence, information sharing tends to increase the intensity of competition in future periods and, thus, reduces the value of informational rents in current competition. We contribute to the existing literature by emphasizing that a reduction in informational rents will also reduce the intensity of competition in the current period, thereby reducing competitive pressure in current credit markets. We provide a large class of economic environments, where a ban on information sharing would be strictly welfare-enhancing.

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1. Introduction

Credit bureaus and credit registers play an important role in communicating credit histories of borrowers to lenders, and, thus, as is widely asserted, contribute to more efficiency in credit markets¹. Recent contributions in the literature have substantiated this view by presenting models with socially beneficial implications of information sharing (Japelli and Pagano (1999), Pagano and Japelli (1993), as well as Pagano and Padilla (1997), (1999). While this literature is largely concerned with the cost of lending and the probability of defaults of funded projects, it raises remarkably little concern about potential anti-competitive implications of information exchange among lenders.

To the extent that information exchange coordinates informational asymmetries in the future this literature tends to separate strategic concerns about future lending from current lending decisions. We show that this property may significantly reduce the intensity of competition in the present lending markets. Without information sharing the prospective of future informational rents on the existing clientele will enhance current competition among lenders.

The intertemporal collusion-enhancing effect of information sharing resembles the mechanism presented by Petersen and Rajan (1995), who argue that the bank's willingness to lend in the initial stage of a dynamic banking relationship increases with the concentration of the lending market. Petersen and Rajan demonstrate that credit market competition imposes constraints on the ability of borrowers and lenders to intertemporally share the surplus from investment projects so that lenders in a more competitive lending market may be forced to initially charge higher interest rates than lenders with more market power. However, issues related to information exchange between lenders are completely outside their analysis.

Virtually all the recent literature on information exchange in credit markets stresses the value of communication among lenders in reducing default probabilities of borrowers in situations of limited strategic interaction among lenders. We show that the supposedly

beneficial consequences of information sharing are a consequence of the lack of potential competition in those models. Typically in this literature, informational advantages are arbitrarily assigned at an initial stage of the lending market interaction between rival banks. By enriching the market structure to allow for potential local interaction of rival lenders in each period, we show that information sharing should rather be viewed as a device facilitating collusion since it reduces the competitiveness of current lending markets drastically. We provide a model in which the future gains associated with information sharing are more than offset by the losses of current competitiveness independently of the time preferences held by borrowers and lenders in the credit market.²

Pagano and Padilla (1997), in particular, demonstrate that information sharing may render credit markets viable, which are not in the absence of information exchange. They show this result in a two-period model, in which banks are informational monopolists in both periods. Banks observe the true risk classes of their clientele but not those of their competitors'. Hence, in the absence of information sharing banks can extract all the project returns accruing to borrowers, thus reducing the incentives for entrepreneurs to invest in project-specific and ability-enhancing technologies that increase repayment probabilities. Binding *ex ante* agreements to share information at the end of period 1 commit the banks to compete in the credit market in stage 2 under conditions of symmetric information. This implies a commitment to more effective competition and, thus, to share period-2 surplus with the entrepreneurs. Accordingly, information sharing will increase the incentives into development of entrepreneurial ability and thereby the repayment probabilities. In particular, Pagano and Padilla prove that credit markets may operate under a regime of information sharing, while it would collapse without communication.

We show that this argument breaks down when lenders are symmetrically informed initially. Like Pagano and Padilla we consider constellations in which banks will become informational monopolists at stage 2. However, we generalize their framework by allowing banks to compete for clients in period 1. In this situation the prospect of future rents intensifies competition in period 1. Using the standard Hotelling framework we find that

¹ For a systematic characterization of these institutions in an international context we refer to Jappelli and Pagano (1999).

² Discount factors are assumed identical across borrowers and lenders.

lenders' overall profits are highest if they can commit to share information. At the same time entrepreneurial incentives to increase repayment probabilities are lowest under information sharing. Hence, we interpret information sharing in credit markets as a potentially collusive device. Thus, policy conclusions regarding information exchange between lenders should be drawn quite carefully as the welfare implications are sensitive to the precise nature of the strategic mechanisms whereby banks can create informational advantages relative to their rivals.

Finally, our analysis is related to a large body of literature on information sharing.³ Prominent examples of this literature include Shapiro (1986) and Gal-Or (1985, 1986), which focus on the incentives for oligopolists to exchange private information concerning common market conditions or firm-specific efficiency. These models are two-stage games of the following character. Prior to the actual observation of the private information the firms have to make binding commitments whether to reveal their private information or to keep it private. At the second stage market competition (based on Cournot and Bertrand competition) takes place. This literature generally finds that the direction of the ex ante incentives for information exchange depends on the nature of market competition (Bertrand or Cournot) and on the type of uncertainty (uncertainty concerning common demand conditions or firm-specific costs). This literature tends to agree, however, that information sharing increases social surplus in most cases. Hence, concerns about collusive conduct by information sharing agreements are not explicitly addressed in those economic environments.

The model of a banking duopoly is introduced in section 2. Section 3 presents the subgame perfect equilibrium. The role of information sharing is discussed in Section 4. Section 5 presents further comments and section 6 concludes. Most of the technical details and the mathematical proofs are delegated to the Appendix.

³ See Raith (1996) for a comprehensive survey.

2. Horizontally Differentiated Banking Duopoly

Consider a market with two lenders, which we henceforth label banks A and B. These banks are located at the endpoints of a Hotelling line segment $[0,1]$. Borrowers, or entrepreneurs, are uniformly distributed on this line. They incur proportional travel costs of t per unit distance. Their addresses are private information.⁴ Since entrepreneurs are lacking any funds of their own, they need to apply for external finance at one of the two banks. All agents are assumed to be risk-neutral.

There are two types of entrepreneurs, and both types are uniformly distributed along the Hotelling line. Only talented entrepreneurs can generate positive cash flows. They have access to a project that yields a return of v with probability p and 0 with $1-p$. Untalented entrepreneurs never generate any cash flow but they derive positive utility from controlling a project.⁵ The proportion of talented entrepreneurs is $0 < m < 1$.

Projects can be repeated sequentially. We assume that the returns are conditionally independent from one period to another. Moreover, talented entrepreneurs can strategically select the success probability p of their venture by private ability-enhancing investments at the stage prior to the market phase at a cost $C(p)$, which is increasing and convex in p . We assume that all the good projects are always fraught with uncertainty, and, consequently, it is prohibitively expensive to achieve certain success.

Banks initially have no specific information about borrowers' types and addresses. They only know the general pool characteristics. In period 1 they compete for lenders by announcing lending rates R_1^i . At the end of the period they observe their borrowers' types, and whether each of these borrowers was successful or not. This information is private information of the bank and may be communicated under an information sharing regime. Without information sharing, however, competition at stage 2 takes place under conditions of asymmetric information across banks. Accordingly, banks will charge different prices to

⁴ This model can be interpreted straightforwardly in the geographical sense. For most purposes, however, the location on the line could be interpreted as some other unobserved characteristic that affects lenders choice between banks.

⁵ Hence, under limited liability, they will undertake projects even when they expect insolvency with certainty.

clients with different histories and announce lending rates (R_2^i, \tilde{R}_2^i) for existing good-type borrowers and new borrowers, respectively. While in general banks may also wish to discriminate between successful and unsuccessful talented borrowers, we will consider only such situations, where successful entrepreneurs can finance the second period projects entirely out of their period 1 cash flow, and, hence, do not require second period finance.

In summary, the market extends over three periods. Initially, at the investment stage, period 0, entrepreneurs engage in project-specific investments that will affect repayment probabilities p in both periods 1 and 2. The credit market opens twice. In period 1 banks compete for borrowers by announcing lending rates R_1^i . At stage 2 banks announce lending rates (R_2^i, \tilde{R}_2^i) and at the end of the second period cash flows are realized and the market winds down.

We will assume that entrepreneurs are protected under limited liability. Moreover, we assume that the period-end information available to banks is verifiable and thus can be used to enforce the contractual arrangements immediately.

In order to simplify the analysis we assume that in case of success entrepreneurs generate a cash flow sufficient for repayment of the period 1 loan and for funding the period 2 project. Hence, we assume that v is sufficiently large.⁶

Finally, we will assume that the intensity of competition in the banking sector is high enough such that in period 2 uninformed banks will not try to compete for their rival's clientele.⁷ When t is low enough, uninformed banks cannot compensate the risk of erroneously funding untalented clients of their rival and opt to withdraw from that market segment altogether as shown below.

For the sake of comparability, our setup resembles the model of Pagano and Padilla (1997) with the exception that we start with a symmetric distribution of information at the beginning of stage 1. As in their model, banks will end up with asymmetric information at

⁶ See Proposition 3.2 for the precise condition.

the end of period 1. The banks enjoy superior information about the past performance of their clients, which strengthens the competitive position in period 2. This difference will have far-reaching consequences for the banking equilibrium as the next section develops in detail.

3. Credit Market Equilibrium

The equilibrium in this multi-stage credit market has to be determined by backward induction. Thus, initially we solve for the price game in period 2 for given period 1 interest rates and given repayment probabilities of entrepreneurs, and subsequently, we then determine the period-1 lending rates. Finally, we characterize the investment incentives of the entrepreneurs and consequently the overall systemic default rate.

Equilibrium in period 2

For given period-1 lending rates, (R_1^A, R_1^B) , borrowers will split into a clientele for bank A and a clientele for bank B. The respective demands for loans are determined by some critical lender $k = k((R_1^A, R_2^A), (R_1^B, R_2^B))$, where k is determined by

$$kt + pR_1^A + d(1-p)pR_2^A = (1-k)t + pR_1^B + d(1-p)pR_2^B .^8$$

Since the payoff functions for the project holders are monotonic in distance the addresses lower than k will apply for a loan from bank A and the addresses above k will apply for loans from B in period 1. Accordingly, at the end of the first period bank A will acquire an informational monopoly for the addresses below k and bank B has an informational monopoly above k , meaning that banks have learnt the degree of talent for each of their clients.

Accordingly, as banks acquire project-specific knowledge only with respect to their own period-1 customers competition in period 2 is asymmetric. In general, banks would

⁷ See Proposition 3.1. for the precise condition.

compete actively both for known and unknown clients in stage 2. In the latter case, however, they need to worry about the untalented clients, whom they cannot discriminate from talented ones, while their rival can. Thus generally pricing is not trivial. However, as we will show below, it does not pay for the uninformed bank to conquer customers from its informed rival if the transportation costs are sufficiently low, i.e. if the lending market competition is sufficiently intense. In this case banks will enjoy an endogenously determined informational monopoly in period 2.

Consequently, for a given k defining the customer bases for the two banks in period 1 we have

Proposition 3.1 (Informational Monopoly in Period 2) *In period 2 the lending rate equilibrium is determined by the monopolistic outcomes $(R_2^A, R_2^B) = (v - k\mathbf{t}, v - (1 - k)\mathbf{t})$, if*

$\mathbf{t} \leq \min\left(\frac{v}{2k}, \frac{v}{2(1-k)}, \left(\frac{1 - m\mathbf{p}}{m(1-\mathbf{p})} - \mathbf{p}\right)R_0\right)$ and $m \leq \frac{R_0}{\mathbf{p}(1-\mathbf{p})v}$. Moreover, both banks refrain from competing for unknown types.

Proof: See Appendix.

In period 2 banks enjoy an informational advantage relative to their competitors. They can discriminate among different types belonging to their local clientele and thus face an actuarially fair cost of funding of $\frac{R_0}{\mathbf{p}}$, while competitors face a cost of funding which

exceeds $\frac{R_0}{m\mathbf{p}} > \frac{R_0}{\mathbf{p}}$.⁹ Proposition 3.1 demonstrates that the wedge created by the implicit

cost of funding can be so large that the competitors are effectively not constrained by

⁸ Each side consists of transportation costs, period 1 costs which only arise in the case of success and period 2 costs, which only arise after failure in period 1 and success in period 2.

⁹ $\frac{R_0}{\frac{m(1-\mathbf{p})}{1-m\mathbf{p}}\mathbf{p}}$ is the actuarially fair refunding rate for the unscreened pool at a given location in period

2. In addition, however, banks need to take into account that they attract untalented entrepreneurs from the whole region served by the competitor in period 1.

competition. This occurs when the talented entrepreneurs are sufficiently scarce and competition is sufficiently intense so that the differentiation (transportation cost) parameter t is sufficiently small. Intuitively, in period 2 there are two effects whereby the degree of differentiation might impact on the bank's incentives to capture customers from those served by the rival in period 1. Firstly, with more differentiation the rival bank will make a higher profit since it enjoys stronger market power. For that reason an increased degree of differentiation will increase the incentives to capture some fraction of the rival's period-1 customers. Secondly, a higher degree of differentiation in the sense of a higher transportation cost will make it harder to capture the rival's former customers, because with a higher degree of differentiation the interest rate differential must increase to offset the increased differentiation threshold. These two effects operate in different directions. One interpretation of Proposition 3.1 is that it offers a sufficient condition, expressed in terms of the competitiveness of the lending market, for latter effect to dominate relative to the former one.

Equilibrium in period 1

Since entrepreneurs rationally anticipate period-2 prices, the critical entrepreneur can be determined as

$$k = \frac{1}{2} + \frac{p}{2t(1 - \alpha p(1 - p))} (R_1^B - R_1^A).^{10}$$

It can be seen that period-1 demand reacts more sensitively to lending rate differentials when α becomes large. In this case, borrowers are more concerned about future lock-in. Accordingly, price competition in period 1 is intensified.

Banks maximize discounted expected profits, which consist of period-1 profits from talented successful entrepreneurs and of period-2 profits from talented entrepreneurs that have been unsuccessful in period 1. In light of Proposition 3.1 the objective functions relevant for the lending rate decisions made in period 1 are

¹⁰ This follows from $kt + pR_1^A + \alpha(1 - p)p(v - kt) = (1 - k)t + pR_1^B + \alpha(1 - p)p(v - (1 - k)t)$.

$$G^A = k(\mathbf{m}\mathbf{p}R_1^A - R_0) + \mathbf{d}(1-\mathbf{p})\mathbf{m}(\mathbf{p}(v - k\mathbf{t}) - R_0)k$$

as well as

$$G^B = (1-k)(\mathbf{m}\mathbf{p}R_1^B - R_0) + \mathbf{d}(1-\mathbf{p})\mathbf{m}(\mathbf{p}(v - (1-k)\mathbf{t}) - R_0)(1-k).$$

Under the assumptions of Proposition 3.1 we can characterize the subgame perfect lending rate equilibrium in period 1.

Proposition 3.2 (Lending Rate Equilibrium in Period-1) *The credit market has a unique symmetric subgame perfect lending rate equilibrium in period 1 characterized by*

$$R_1^A = R_1^B = \frac{\mathbf{t}}{\mathbf{p}} + \frac{R_0}{\mathbf{m}\mathbf{p}} - \mathbf{d}(1-\mathbf{p})(v - \frac{R_0}{\mathbf{p}}) \text{ as long as } v > \frac{\mathbf{t} + \left(\frac{1}{\mathbf{m}} + \mathbf{d}(1-\mathbf{p})\right)R_0 + \mathbf{p}}{\mathbf{p}(1 + \mathbf{d}(1-\mathbf{p}))}.$$

Proof: See Appendix.

From Proposition 3.2 we can conclude that the period-1 lending rate equilibrium structurally incorporates two components. Firstly, there is a standard period-1 oligopoly premium, the fair cost of funding (for uninformed lenders). Secondly, and in addition to the standard component, the equilibrium exhibits a price discount that reflects the value of the prospective informational monopoly in period 2.

This result highlights the crucial role of future profits on market conduct in period 1. As \mathbf{c} or v increase, or equivalently, as period-2 profits grow, current competition intensifies and current lending rates fall. If $\mathbf{t} < \mathbf{d}\mathbf{p}(1-\mathbf{p})v$ banks incur losses from the loans granted in period 1.¹¹ Under the prospect of future informational rents they price current loans aggressively to compensate the period-1 losses by period-2 revenues. Such an effect cannot operate in the setting of Pagano and Padilla (1997), since they assume that an informational monopoly already prevails in period 1. Hence, in this sense effective competition never takes place in the absence of information sharing in their analysis.

¹¹ Since in this paper we assume low values of \mathbf{t} and high values of v , this condition is quite likely to be met.

Despite the losses in period 1 banks will always find it profitable to lend, as the following Result reassures.

Proposition 3.3 (Banks' equilibrium profits) *Equilibrium profits of the banks are given*

$$\text{by } G^A = G^B = \frac{mt}{2} \left(1 - \frac{d(1-p)p}{2} \right) > 0.$$

Proof: Straightforward and omitted.

From Proposition 3.3 we can draw the interesting conclusion that equilibrium profits do not depend on v . This feature is the consequence of two effects that exactly offset each other. On the one hand, high values of v imply high future informational rents, but, on the other hand, high values of v simultaneously induce high discounts in period-1 lending. We can also observe that equilibrium profits are monotonically declining in d . Accordingly, banks' profits are largest in the absence of future competition.

Entrepreneurial investment incentives

So far our analysis has been restricted to exogenously given probabilities of project success. Typically, project success is the outcome of investments into developing entrepreneurial ability as outlined in Section 2. Entrepreneurs make these investments in order to maximize expected discounted profits while taking into account that their needs for external funds are financed by debt contracts.

Consider a talented entrepreneur located at $0 \leq l \leq \frac{1}{2}$.¹² In equilibrium such a projectholder will belong to bank A's clientele. When facing the equilibrium debt contracts characterized above the expected discounted payoff of the entrepreneur located at l is given by

$$U^l(\mathbf{p}) = p(v - R_1^A) + d \left((1-p)p(v - R_2^A) + p^2(v - R_0) \right) - lt - C(\mathbf{p}).$$

¹² This is without loss of generality.

The first term captures the expected surplus accruing to the projectholder in period 1. The next terms denote the expected discounted surplus in period 2, during which a talented entrepreneur who failed in period 1 needs external debt finance while a talented entrepreneur who was successful in period 1 makes use of internal funds to finance the project in period 2. Finally, transport costs and investment costs are subtracted. Proceeding in a standard way, the investment incentives of the entrepreneur are determined by the first-order condition:

$$v - R_1^A + \mathbf{d}(v - R_2^A) + 2\mathbf{d}\phi(R_2^A - R_0) = C'(\mathbf{p}) .$$

Accordingly, the expected discounted marginal surplus accrued in periods 1 and 2 should equal the marginal disutility of private effort.¹³

For quadratic cost functions $C(\mathbf{p}) = \frac{\xi}{2}\mathbf{p}^2$ the optimal investment level can be readily determined.

Proposition 3.4 (entrepreneurial repayment investments) *With quadratic cost functions the equilibrium repayment probabilities \mathbf{p}^* of entrepreneurs are determined by*

$$\mathbf{p}^* = \frac{v - R_1^A + \mathbf{d}(v - R_2^A)}{\mathbf{g} - 2\mathbf{d}(R_2^A - R_0)} \text{ when } \mathbf{g} - 2\mathbf{d}(R_2^A - R_0) \geq 0 \text{ and } \mathbf{p}^* = 1 \text{ otherwise.}$$

Proof: straightforward and omitted

While repayment incentives are always decreasing in the first period repayment rate R_1^A and the cost parameter ξ , they are decreasing for the second period repayment rate R_2^A only when $\mathbf{p} \leq \frac{1}{2}$. Less intuitively, the repayment incentives are increasing for $\mathbf{p} > \frac{1}{2}$. In the latter case repayment probabilities and repayment rates are high; thus entrepreneurs can avoid paying the period-2 repayments by increasing the investments into entrepreneurial

¹³ Note also that the investment incentives do not depend on the location of an entrepreneur.

ability. Hence, high repayment rates in period 2 provide effective incentives for generating a high repayment rate in period 1.

4. The Role of Information Sharing

We can now discuss the role of information sharing. We view the information sharing agreement as a very long-term decision, which requires the design of irreversible institutional arrangements to take place prior to the entrepreneurs' investment decisions. For instance, the information and communication infrastructure of credit bureaus as well as their human capital has to be set up in accordance with such a framework. While there are variations empirically in the type and amount of information communicated by credit bureaus (see e.g. Japelli, Pagano, 1999), we follow Pagano and Padilla (1997) and assume that banks exchange information only about the borrowers' types. We shall relax this assumption in section 5. We shall also abstract from issues related to strategic information transmission in the communication process by assuming that the information exchanged is verifiable. Thus, information sharing renders banks' homogeneous information structures at the beginning of period 2. Consequently, in the presence of an arrangement for information sharing competition takes place under conditions of symmetric information in both periods. This being the case, the equilibrium in the repeated credit market is then readily established.

Proposition 4.1 (Complete Information Sharing) *Under an information sharing agreement in the credit market, equilibrium lending rates are determined by*

$\hat{R}_1^A = \hat{R}_1^B = \frac{t}{p} + \frac{R_0}{mp}$ and $\hat{R}_2^A = \hat{R}_2^B = \frac{t}{p} + \frac{R_0}{p}$. Furthermore, banks' equilibrium profits are

$$\hat{G}^A = \hat{G}^B = \frac{mt}{2}(1 + \alpha(1 - p)).$$

Proof: Under information sharing the banks compete in the standard Hotelling way in period 2. With information sharing this subgame is not affected by period-1 actions. Hence, also the period-1 interaction is a standard Hotelling game. ♦

An immediate implication of Proposition 4.1 is that equilibrium profits under information sharing always exceed duopoly profits in the absence of information sharing. This conclusion we formulate in

Corollary 4.2 *Under the conditions of Proposition 3.2, for any α , and independently of the respective repayment probabilities \hat{p} and p^* , banks' profits under information sharing are higher than in its absence, i.e. $\hat{G}^i > G^{*i}, i = A, B$.*

It is interesting to observe that this result holds independently of entrepreneurs' investment incentives. In other words, even if investment incentives were not affected, information sharing would increase overall profits. When investment incentives are affected information sharing will tend to reduce entrepreneurs' repayment incentives, because it raises funding costs and reduces surplus.

Corollary 4.3 *Under the conditions of Proposition 3.2, the repayment probabilities under information sharing are lower than those without information exchange, i.e. $\hat{p} < p^*$.*

Proof: See Appendix.

Corollaries 4.2 and 4.3 reveal the collusion-enhancing character of information sharing agreements in our framework. Information sharing is a commitment not to exploit the period-2 informational monopoly. This commitment reduces the aggressiveness of period-1 pricing and, thus, increases overall profits for any discount factor α .

In the framework of Pagano and Padilla (1997) information sharing does not affect period-1 competition, and hence, by reducing period-2 lending rates, it generates positive investment incentives for entrepreneurs. In fact, they consider constellations with market breakdown in the absence of information sharing. We argue that in many cases ex-ante competition may already be sufficient to prevent market breakdowns. In these situations information sharing may, however, reduce the intensity of competition. In these cases information sharing agreements have a potentially strong collusive character.

So far we have followed Pagano and Padilla in our assumption that banks will communicate the true type of their customers under information sharing. Of course, one might also be interested in the case, where banks share less than full information about their borrowers. This is the focus of the next section.

5. Partial Information Sharing

Credit registers typically communicate black or white information only, i.e. information about past defaults and arrears or information about the credit standing and the characteristics of borrowers, i.e. line of credit, assets etc.¹⁴. In our framework we cannot distinguish between default (black) information and information about successes (white information), since the respective information partitions are perfect complements. In each case, however, only partial information is shared, since the information about good types that were unsuccessful in period 1 cannot be communicated.¹⁵ Accordingly, in the case of partial information sharing competitors remain imperfectly informed about the types of individual projects belonging to their rivals.

So when banks communicate about their clients' failures (or successes) at the end of stage 1, they will still maintain their informational advantage about the talented but unsuccessful clients. Accordingly, for low enough transportation costs (or product differentiation) Proposition 3.1 can be invoked, which establishes conditions under which banks can maintain their informational monopoly in period 2. Hence, in our very stylized model partial information sharing does not affect equilibrium conduct at all.

6. Conclusion

This paper challenges the general view in the literature about the social desirability of information exchange among banks. We show that information exchange may reduce the competitiveness of lending markets and, thus, provide worse repayment incentives for entrepreneurs. The crucial feature of our model, which distinguishes it from the existing

¹⁴ See Japelli, Pagano (1999) for a cross-country comparison of different regimes of information sharing.

¹⁵ Note that banks only care about customers that failed in period 1, since successful entrepreneurs do not require further loans.

literature, is that we consider banking markets that are initially informationally symmetric among competitors, while the existing literature concentrates on markets with arbitrary a priori heterogeneity of information that drastically affects strategic interaction. So the existing literature concentrates on potentially positive consequences of informational exchanges in fundamentally segmented banking markets, while we concentrate on competitive banking markets, in which each informational advantage has to result from strategic actions. Hence, in our framework future informational rents may be a strong stimulus to current competition. This stimulus is destroyed by information exchange.

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Appendix

Proof of Proposition 3.1:

In period 2 only untalented and talented but unsuccessful entrepreneurs will apply for credit. In the pool of its existing customer base the bank will only lend to talented entrepreneurs, who were unsuccessful in period 1. The bank does not, however, know the types of its rival's period-1 clients. Hence, relative to its rival's customers it charges a lending rate \tilde{R}_2^i that reflects the risk of incorporating untalented entrepreneurs into the lending programmes. Consequently, period-2 profits consist of two elements, profits derived from lending to the known clientele and profits that arise from lending to former customers of the rival.

Let us without loss of generality analyze bank A's strategies against bank B's clients for a given critical $k \leq \frac{1}{2}$. The profits in period 2 to bank A from lending to former customers of B

is

$$(A1) \quad \tilde{G}_2^A = (1 - \mathbf{mp}) \left[\max\{\tilde{k}^A - k, 0\} \frac{\mathbf{m}(1 - \mathbf{p})}{1 - \mathbf{mp}} \mathbf{p} \tilde{R}_2^A - (1 - k)R_0 \right].$$

Note that this is non-negative if

$$(A1') \quad \tilde{R}_2^A \geq \frac{1 - k}{\tilde{k}^A - k} \frac{1 - \mathbf{mp}}{\mathbf{m}(1 - \mathbf{p})} \frac{R_0}{\mathbf{p}} \geq \frac{1}{\mathbf{m}(1 - \mathbf{p})} \frac{R_0}{\mathbf{p}}.$$

Bank B earns profits of

$$(A2) \quad G_2^B = \mathbf{m}(1 - \mathbf{mp})(1 - \tilde{k}^A)(\mathbf{p}R_2^B - R_0),$$

since it will lend only to talented and initially unsuccessful entrepreneurs. The critical lender

\tilde{k}^A is determined by $\tilde{k}^A = \frac{1}{2} + \frac{\mathbf{p}}{2\mathbf{t}}(R_2^B - \tilde{R}_2^A)$. Assuming an interior solution for \tilde{k}^A , the

first-order conditions with respect to the lending rate decisions in period 2 read as

$$(A3) \quad \begin{pmatrix} 1 & -\frac{1}{2} \\ -\frac{1}{2} & 1 \end{pmatrix} \begin{pmatrix} R_2^A \\ R_2^B \end{pmatrix} = \frac{1}{P} \begin{pmatrix} t\left(\frac{1}{2}-k\right) + \frac{R_0}{2} \frac{1-mP}{m(1-P)} \\ \frac{t}{2} + \frac{R_0}{2} P \end{pmatrix}.$$

Solving the system of equations defined by the reaction functions in (A3) shows that the equilibrium lending rates are given by

$$(A4) \quad \begin{pmatrix} \tilde{R}_2^A \\ R_2^B \end{pmatrix} = \frac{1}{P} \begin{pmatrix} t\left(1-\frac{4}{3}k\right) + \left(\frac{2}{3} \frac{1-mP}{m(1-P)} + \frac{1}{3}P\right)R_0 \\ t\left(1-\frac{2}{3}k\right) + \left(\frac{1}{3} \frac{1-mP}{m(1-P)} + \frac{2}{3}P\right)R_0 \end{pmatrix}$$

implying that $\tilde{k}^A = \frac{1}{2} + \frac{1}{2t} \left(\frac{2}{3}kt - \frac{1}{3} \left(\frac{1-mP}{m(1-P)} \right) R_0 \right)$, provided $\tilde{k}^A \geq k$. Otherwise bank A

selects a corner solution and prefers not to compete for its rivals period-1 customers in period

2. A high enough degree of product differentiation, i.e. $t \geq \frac{\left(\frac{1-mP}{m(1-P)} - P\right)R_0}{6\left(1-\frac{5}{3}k\right)}$, turns out to

be a sufficient condition for an interior solution. In this case the equilibrium payoffs in period 2 are

$$\tilde{G}_2^A = \left(\frac{1}{2} - \frac{5}{3}k - \frac{1}{P} \left(\frac{1-mP}{m(1-P)} - P \right) R_0 \right) \left(m(1-P) \left(t \left(1 - \frac{2}{3}k \right) + \left(\frac{2}{3} \frac{1-mP}{m(1-P)} + \frac{1}{3}P \right) R_0 \right) - (1-mP)R_0 \right)$$

and

$$G_2^B = \left(\frac{1}{2} + \frac{1}{3}k - \frac{1}{6t} \left(\frac{1-mP}{m(1-P)} - P \right) R_0 \right) \left(t \left(1 - \frac{2}{3}k \right) + \left(\frac{1}{3} \frac{1-mP}{m(1-P)} + \frac{2}{3}P - 1 \right) R_0 \right) > 0,$$

respectively.

If product differentiation is sufficiently small, i.e.

$$(A5) \quad t < \frac{\left(\frac{1 - m\mathbf{p}}{m(1 - \mathbf{p})} - \mathbf{p} \right) R_0}{6 \left(1 - \frac{5}{3}k \right)},$$

bank A will choose not to compete for bank B's clients. Analogously, bank B will select a corner solution if

$$(A6) \quad t < \frac{\left(\frac{1 - m\mathbf{p}}{m(1 - \mathbf{p})} - \mathbf{p} \right) R_0}{6 \left(1 - \frac{5}{3}(1 - k) \right)}.$$

When both conditions (A5) and (A6) are met, say when $t < \left(\frac{1 - m\mathbf{p}}{m(1 - \mathbf{p})} - \mathbf{p} \right) R_0$,¹⁶ and when

$\frac{1}{m(1 - \mathbf{p})} \frac{R_0}{\mathbf{p}} \geq v$, because of (A1') competition essentially reduces to local monopolies in

period 2. Bank A's period-2 profit function is $G_2^A = m(1 - \mathbf{p})\mathbf{p} \max\{(v - kt)v, (v - R_2^A t)R_2^A\}$.

Likewise, bank B's period-2 profit function is $G_2^B = m(1 - \mathbf{p})\mathbf{p} \max\{(v - (1 - k)t)v, (v - R_2^B t)R_2^B\}$.

Since $\max(v - R_2^i t)R_2^i = \frac{v^2}{4t}$ it follows that bank A will select a corner solution $R_2^A = v - tk_1$

when $t < \frac{v}{2k_1}$ and bank B will select a corner solution $R_2^B = v - t(1 - k_1)$ when

$$t < \frac{v}{2(1 - k_1)}. \quad \blacklozenge$$

¹⁶ Remember $k \leq 1/2$.

Proof of Proposition 3.2:

Under conditions of period-2 monopoly (Result 3.1) and under the condition that successful entrepreneurs generate enough cash flow to finance period-2 investments through retained earnings, overall profits are:

$$\begin{pmatrix} G^A \\ G^B \end{pmatrix} = \begin{pmatrix} k(\mathbf{mp}R_1^A - R_0) + \mathbf{d}\mathbf{p}(1-\mathbf{p})(v - kt - \frac{R_0}{\mathbf{p}})k \\ (1-k)(\mathbf{mp}R_1^B - R_0) + \mathbf{d}\mathbf{p}(1-\mathbf{p})(v - (1-k)t - \frac{R_0}{\mathbf{p}})(1-k) \end{pmatrix}$$

The critical borrower is determined by $kt + \mathbf{p}R_1^A + (1-\mathbf{p})\mathbf{d}\mathbf{p}R_2^A = (1-k)t + \mathbf{p}R_2^B + (1-\mathbf{p})\mathbf{d}\mathbf{p}R_2^B$, which in the case of period-2 monopolistic pricing implies

$$k = \frac{1}{2} + \frac{\mathbf{p}}{2t(1-\mathbf{d}\mathbf{p}(1-\mathbf{p}))} (R_1^B - R_1^A).$$

The first-order conditions for profit maximization in period 1 are:

$$\begin{pmatrix} R_1^A \\ R_1^B \end{pmatrix} = \begin{pmatrix} 2(1+\mathbf{d}\mathbf{g}(1-\mathbf{p})t) & -(1+2\mathbf{d}\mathbf{g}(1-\mathbf{p})t) \\ -(1+2\mathbf{d}\mathbf{g}(1-\mathbf{p})t) & 2(1+\mathbf{d}\mathbf{g}(1-\mathbf{p})t) \end{pmatrix}^{-1} \begin{pmatrix} \frac{t}{\mathbf{p}} + \frac{R_0}{\mathbf{mp}} - \mathbf{d}(1-\mathbf{p})(v - \frac{R_0}{\mathbf{p}}) \\ \frac{t}{\mathbf{p}} + \frac{R_0}{\mathbf{mp}} - \mathbf{d}(1-\mathbf{p})(v - \frac{R_0}{\mathbf{p}}) \end{pmatrix}$$

where $\mathbf{g} = \frac{\mathbf{p}}{2t(1-\mathbf{d}\mathbf{p}(1-\mathbf{p}))}$. Straightforward calculations yield Proposition 3.2.

The condition on v follows directly from $v > R_1^* + 1$. In this case after repayment in period 1, sufficient funds remain to fund the period-2 project internally. ♦

Proof of Corollary 4.3:

Because market size (i.e. the mass of borrowers) is fixed under the conditions of Proposition 3.2, Corollary 4.2 implies that banks capture a larger portion of the projects' surpluses under information sharing. Since entrepreneurial incentives are strictly monotonic as functions of the entrepreneurs' share of the surplus, the projectholders will invest less resources under information sharing. ♦