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 asymmetry between banks in future lending. Hence, information sharing agreements tend to increase the intensity of competition in future periods and, thus, reduce 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 is strictly preferred by society.

Keywords: information sharing, collusion, imperfectly competitive credit markets
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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 markets. 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 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 it 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 exhange 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 the beginning of the lending market. 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 collusive device since it reduces the competitiveness of current lending markets drastically. We provide a model in which the gain from future competitiveness are more than compensated by the losses of current competitiveness independently of the time preferences held by borrowers and lenders in the credit market.[1]

Pagano and Padilla (1997), in particular, demonstrate that information sharing may render credit markets viable, which are not in its absence. They show this result in a two-period model, in which banks are information 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 surplus from 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, which would collapse without communication.

We show that this argument collapses when lenders are symmetrically informed initially. Like Pagano and Padilla we consider constellations in which banks will become informational monopolists at stage 2. However, contrary to their framework, we allow 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 lenders` overall profits are highest if they can commit to share information. At the same time entrepreneurial incentives to reduce repayment probabilities are lowest under information sharing. Hence, we interpret information sharing in credit markets as a potentially collusive device. Policy implications should be drawn quite carefully with respect to the nature of the strategic environment.

[1] Discount factors are assumed identical across borrowers and lenders.

Finally, our analysis is related to a large body of literature on information sharing.[2] 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 supported 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.

2. **Spatial Banking Duopoly**

Consider a market with two lenders, which we henceforth label banks A and B. They are situated at the end points of a Hotelling line segment [0,1]. Borrowers, or entrepreneurs, are uniformly distributed on this line. They incur proportional travel costs of τ per unit distance traveled. Their addresses are private information.[3] 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.

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[2] See Raith (1996) for a comprehensive survey.

[3] 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.

Entrepreneurs are of two types, 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 cash flow of v with probability π and 0 with $1-\pi$. Untalented entrepreneurs never generate any cash-flow but derive positive utility from controlling a project.[4] The proportion of talented entrepreneurs is $0<\mu<1$.

Projects can be repeated sequentially. In this case the returns are conditionally independent from one period to another. Moreover, talented entrepreneurs can strategically select the success probability π of their venture by some private investment at the stage prior to the market phase at a cost $C(\pi)$, which is increasing and convex in π.

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 clients with different histories and announce lending rates $(R_2^i, \breve{R}_2^i)$ for existing lenders and new lenders respectively. While in general banks may also wish to discriminate between successful and unsuccessful borrowers, we will consider only such situations, where successful lenders 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 specific investments that will affect repayment probabilities π in both periods 1 and 2. The credit market opens twice. In period 1 banks compete for lenders by announcing lending rates R_1^i. At stage 2 banks announce lending rates $(R_2^i, \breve{R}_2^i)$ and at the end of the period cash-flows are realized and the market winds down.

[4] Hence, under limited liability, they will undertake projects even when they expect insolveny with certainty.

We will assume that entrepreneurs are protected under limited liability. Moreover, banks period-end information 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 sufficient cash-flow for repayment of the period 1 loan and for funding the period 2 project. Hence, we assume that v is sufficiently large.[5]

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.[6] When τ is low enough, uninformed banks cannot compensate the risk of erroneously funding untalented clients of their rival and opt to withdraw from that market 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 the end of period 1. They enjoy superior information about the past performance of their clients, which strengthens the competitive position in period 2. This difference in detail will have far-reaching consequences for the banking equilibrium as the next section develops in detail.

3. Banking Equilibrium

Equilibrium is determined by backward induction. So we have to solve for the price game in period 2 for given period 1 interest rates and given repayment probabilities of entrepreneurs, and then determine period 1 prices. Last we characterize entrepreneurs' investment incentives and consequently the overall systemic default rate.

equilibrium in period 2

[5] See Result 3.2 for the precise condition.

[6] See Result 3.1. for the precise condition.

For given period interest rates (R_1^A, R_1^B), in period 1 lenders 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

$$k\tau + \pi R_1^A + \delta(1-\pi)\pi R_2^A = (1-k)\tau + \pi R_1^B + \delta(1-\pi)\pi R_2^B \quad .[7]$$

Since lenders payoff functions 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, bank A has 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 client.

Accordingly, competition in period 2 is asymmetric. Typically, banks would compete actively, both for known and unknown clients in stage 2. In the latter case, however, the 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, when transportation costs are sufficiently low, competition does not pay for the uninformed bank. In this case banks enjoy an informational monopoly.

Result 3.1. (Informational Monopoly in Period 2)

When $\tau \le \min\left(\frac{v}{2k}, \frac{v}{2(1-k)}, \left(\frac{1-\mu\pi}{\mu(1-\pi)} - \pi\right) R_0\right)$ *for given k, banks equilibrium price quotes are determined by the monopolistic outcomes* $(R_2^A, R_2^B) = (v - k\tau, v - (1-k)\tau)$. *Moreover, both banks refrain from competing for unknown types, i.e.* $(\breve{R}_2^A, \breve{R}_2^B) = (v, v)$.

Proof: see appendix.

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,

[7] 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.

with more differentiation the rival bank will make a higher profit since it enjoys more 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 cutomers, 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 Result 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

$$k = \frac{1}{2} + \frac{\pi}{2\tau(1-\delta\pi(1-\pi))}(R_1^B - R_1^A).$$ [8]

It can be seen that period-1 demand reacts more sensitively to price differentials when δ 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.

$$G^A = k(\mu\pi R_1^A - R_0) + \delta(1-\pi)\mu(\pi(v - k\tau) - R_0)k$$

$$G^B = (1-k)(\mu\pi R_1^B - R_0) + \delta(1-\pi)\mu(\pi(v-(1-k)\tau) - R_0)(1-k)$$

This subgame has a unique Nash-equilibrium.

[8] This follows from $k\tau + \pi R_1^A + \delta(1-\pi)\pi(v - k\tau) = (1-k)\tau + \pi R_1^B + \delta(1-\pi)\pi(v-(1-k)\tau)$.

Result 3.2 (Period-1 Prices)

Under the assumptions of Result 3.1 and when $v > \frac{\tau + \left(\frac{1}{\mu} + \delta(1-\pi)\right)R_0 + \pi}{\pi\left(1+\delta(1-\pi)\right)}$ *the credit market game has a unique symmetric Nash-equilibrium in period-1 prices with* $R_1^A = R_1^B = \frac{\tau}{\pi} + \frac{R_0}{\mu\pi} - \delta(1-\pi)(v - \frac{R_0}{\pi})$.

Proof: see appendix.

Accordingly, equilibrium prices consist of a standard period-1 oligopoly premium, the fair cost of funding (for uninformed lenders), and 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 δ or v increase, or equivalently, as period-2 profits grow, current competition intensifies and current lending rates are dropping. If $\tau < \delta\pi(1-\pi)v$ banks are even loosing money on period 1 loans.[9] Under the prospect of future informational rents they are price current loans aggressively to compensate the period-1 losses by period-2 revenues.

It is this effect that cannot operate in the setting of Pagano and Padilla (1997), since they assume that the condition of informational monopoly already obtains in period 1. Hence, effective competition never takes place in the absence of information sharing in their analysis.

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

Result 3.3 (banks' equilibrium profits)

Equilibrium profits of the banks are given by $G^A = G^B = \frac{\mu\pi\tau}{2}\left(\frac{1}{\pi} - \frac{\delta(1-\pi)}{2}\right) > 0$.

Proof: straightforward and omitted

Interestingly, equilibrium profits do not depend on *v*. This is the consequence of two effects that exactly offset each other. On one hand high values of *v* imply high future informational rents and on the other hand they induce high discounts in period-1 lending.

Also note that equilibrium profits are monotonically declining in δ. Accordingly, banks' profits are largest in the absence of future competition.

entrepreneurial investment incentives

Entrepreneurs maximize expected discounted profits. Consider an entrepreneur located at $0 \le l \le \frac{1}{2}$.[10] In equilibrium he will belong to bank A's clientele. So his expected payoff is

$$U(l) = \pi(v - R_1^A) + \delta(1-\pi)\pi(v - R_2^A) - l\tau - C(\pi) \ .$$

Accordingly, his investment incentives are determined by:

$$v - R_1^A - \delta(1-2\pi)(v - R_2^A) - C'(\pi) = 0 \ .$$

Result 3.4 (entrepreneurial repayment investments)

In equilibrium repayment probabilities π^* *of entrepreneurs are determined by the condition*

$$v - \frac{\tau}{\pi^*} - \frac{R_0}{\mu\pi^*} + \delta(1-\pi^*)v - \delta(1-2\pi^*)(v - \frac{\tau}{2})v = C'(\pi^*) \ .$$

Proof: straightforward and omitted

[9] Since in this paper we assume low values of τ and high values of *v*, this condition is quite likely to be met.
[10] This is without loss of generality.

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 that has to be made well before entrepreneurs' investment decisions. For instance, the information and communication infrastructure of credit bureaus as well as their human capital has to be set up first. While there is some variation 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 do exchange information about the borrowers types. We shall relax this assumption in section 5. We shall also abstract from incentives issues in the communication process and assume that the information exchanged is verifiable. Thus information sharing renders banks' information structures homogenous at the beginning of period 2. Competition takes place under symmetric information in both periods. Equilibrium in the repeated credit market is readily established.

Result 4.1 (Complete Information Sharing)

Under an information sharing agreement equilibrium prices in the credit market are determined by $\hat{R}_1^A = \hat{R}_1^B = \frac{\tau}{\pi} + \frac{R_0}{\mu\pi}$ *and* $\hat{R}_2^A = \hat{R}_2^B = \frac{\tau}{\pi} + \frac{R_0}{\pi}$. *Furthermore, banks' equilibrium profits are* $\hat{G}^A = \hat{G}^B = \frac{\mu\tau}{2}\left(1+\delta(1-\pi)\right)$.

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

An immediate implication of Result 4.1 is that equilibrium profits under information sharing always exceed duopoly profits in the absence of information sharing.

Corollary 4.2

Under the conditions of Result 3.2, for any δ, *and independently of the respective repayment probabilities* $\hat{\pi}$ *and* π^*, *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 note 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 Result 3.2, the repayment probabilities under information sharing are lower than in its absence, i.e. $\hat{\pi} < \pi^{*}$.

Proof: see appendix.

Corollaries 4.2 and 4.3 reveal the collusive 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 δ.

In the framework of Pagano and Padilla (1997) information sharing does not affect period-1 competition, and hence, by reducing period-2 lending rates, 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 suffice to prevent market breakdown. 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 followed Pagano and Padilla in our assumption that banks will communicate the true type under information sharing, one might also consider the realistic case, when 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, i.e. line of credit, assets etc.[11]

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.[12] Accordingly, in the case of partial information sharing competitors remain imperfectly informed about their rivals' clientele.

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) Result 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 difference to the existing literature is that we consider banking markets that are initially levelled among competitors, while the existing literature concentrates on markets with 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 competitive actions. Hence, in

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

our framework future informational rents may be a strong stimulus to current competition. This stimulus is destroyed by information exchange.

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

Appendix

Proof of Result 3.1:

In period 2 only untalented and talented but unsuccessful entrepreneurs will apply for credit. While banks will only lend to their talented customers they do not know the types of their rival's clients. Hence they charge lending rates $\breve{R}_2^i$ that reflect the risk of lending to untalented entrepreneurs. Hence, 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 analyze bank A's strategies against bank B's clients for a given critical $k \leq \frac{1}{2}$. The profits from lending to this clientele is $\breve{G}_2^A = (1-\mu\pi)\frac{\mu(1-\pi)}{1-\mu\pi}\pi \max\{\breve{k}^A - k, 0\}\breve{R}_2^A - (1-\pi)R_0$. Bank B earns profits of $G_2^B = \mu(1-\pi)(1-\breve{k}^A)\left(\pi R_2^B - R_0\right)$ since it will lend only to talented and initially unsuccessful entrepreneurs. The critical lender $\breve{k}^A$ is determined by $\breve{k}^A = \frac{1}{2} + \frac{\pi}{2\tau}\left(R_2^B - \breve{R}_2^A\right)$. Accordingly, the firms' first order conditions read

$$\begin{pmatrix} 1 & -\frac{1}{2} \\ -\frac{1}{2} & 1 \end{pmatrix}\begin{pmatrix} R_2^A \\ R_2^B \end{pmatrix} = \frac{1}{\pi}\begin{pmatrix} \tau\left(\frac{1}{2} - k_1\right) + \frac{R_0}{2}\frac{1-\mu\pi}{\mu(1-\pi)} \\ \frac{\tau}{2} + \frac{R_0}{2}\pi \end{pmatrix}$$

Straightforward calculations show equilibrium lending rates as

$$\begin{pmatrix} \breve{R}_2^A \\ R_2^B \end{pmatrix} = \frac{1}{\pi}\begin{pmatrix} \tau\left(1 - \frac{4}{3}k_1\right) + \left(\frac{2}{3}\frac{1-\mu\pi}{\mu(1-\pi)} + \frac{1}{3}\pi\right)R_0 \\ \tau\left(1 - \frac{2}{3}k_1\right) + \left(\frac{1}{3}\frac{1-\mu\pi}{\mu(1-\pi)} + \frac{2}{3}\pi\right)R_0 \end{pmatrix}$$

implying $\breve{k}^A = \frac{1}{2} + \frac{1}{2\tau}\left(\frac{2}{3}k_1\tau - \frac{1}{3}\left(\frac{1-\mu\pi}{\mu(1-\pi)}\right)R_0\right)$, provided $\breve{k}^A \geq k_1$. Otherwise bank selects a corner solution and prefers to remain inactive in period 2. The condition for an interior solution is a sufficiently high degree of product differentiation, i.e. $\tau \geq \frac{\left(\frac{1-\mu\pi}{\mu(1-\pi)} - \pi\right)R_0}{6\left(1 - \frac{5}{3}k_1\right)}$. In this case the equilibrium payoffs in period 2 are

$$\breve{G}_2^A = \left(\frac{1}{2} - \frac{5}{3}k_1 - \frac{1}{\pi}\left(\frac{1-\mu\pi}{\mu(1-\pi)} - \pi\right)R_0\right)\left(\mu(1-\pi)\left(\tau\left(1 - \frac{2}{3}k_1\right) + \left(\frac{2}{3}\frac{1-\mu\pi}{\mu(1-\pi)} + \frac{1}{3}\pi\right)R_0\right) - (1-\mu\pi)R_0\right)$$

and $G_2^B = \left(\frac{1}{2} + \frac{1}{3}k_1 - \frac{1}{6\tau}\left(\frac{1-\mu\pi}{\mu(1-\pi)} - \pi\right)R_0\right)\left(\tau\left(1 - \frac{2}{3}k_1\right) + \left(\frac{1}{3}\frac{1-\mu\pi}{\mu(1-\pi)} + \frac{2}{3}\pi - 1\right)R_0\right) > 0$, resp.

If product differentiation is sufficiently small, i.e. $\tau < \frac{\left(\frac{1-\mu\pi}{\mu(1-\pi)} - \pi\right)R_0}{6\left(1 - \frac{5}{3}k_1\right)}$ bank A will choose not to compete for bank B's clients. Analogously, bank B will select a corner solution if $\tau < \frac{\left(\frac{1-\mu\pi}{\mu(1-\pi)} - \pi\right)R_0}{6\left(1 - \frac{5}{3}(1-k_1)\right)}$.

When both conditions are met, say when $\tau < \left(\frac{1-\mu\pi}{\mu(1-\pi)} - \pi\right)R_0$,[13] competition essentially reduces to local monopolies in period 2. Bank A's period-2 profit function is $G_2^A = \mu(1-\pi)\pi \max\{(v - k\tau)v, (v - R_2^A\tau)R_2^A\}$. Likewise, bank B's period-2 profit function is $G_2^B = \mu(1-\pi)\pi \max\{(v - (1-k)\tau)v, (v - R_2^B\tau)R_2^B\}$.

[13] Remember $k_1 \leq 1/2$.

Since $\max(v - R_2^i\tau)R_2^i = \dfrac{v^2}{4\tau}$ it follows that bank A will select a corner solution $R_2^A = v - \tau k_1$ when $\tau < \dfrac{v}{2k_1}$ and bank B will select a corner solution $R_2^B = v - \tau(1-k_1)$ when $\tau < \dfrac{v}{2(1-k_1)}$. ♦

Proof of Result 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:

$$\begin{pmatrix} G^A \\ G^B \end{pmatrix} = \begin{pmatrix} k(\mu\pi R_1^A - R_0) + \delta\mu\pi(1-\pi)(v - k\tau - \dfrac{R_0}{\pi})k \\ (1-k)(\mu\pi R_1^B - R_0) + \delta\mu\pi(1-\pi)(v - (1-k)\tau - \dfrac{R_0}{\pi})(1-k) \end{pmatrix}$$

The critical borrower is determined by $k\tau + \pi R_1^A + (1-\pi)\delta\pi R_2^A = (1-k)\tau + \pi R_2^B + (1-\pi)\delta\pi R_2^B$, which in the case of period-2 monopolistic pricing implies

$$k = \frac{1}{2} + \frac{\pi}{2\tau(1-\delta\pi(1-\pi))}\left(R_1^B - R_1^A\right).$$

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

$$\begin{pmatrix} R_1^A \\ R_1^B \end{pmatrix} = \begin{pmatrix} 2(1+\delta\gamma(1-\pi)\tau) & -(1+2\delta\gamma(1-\pi)\tau) \\ -(1+2\delta\gamma(1-\pi)\tau) & 2(1+\delta\gamma(1-\pi)\tau) \end{pmatrix}^{-1} \begin{pmatrix} \dfrac{\tau}{\pi} + \dfrac{R_0}{\mu\pi} - \delta(1-\pi)(v - \dfrac{R_0}{\pi}) \\ \dfrac{\tau}{\pi} + \dfrac{R_0}{\mu\pi} - \delta(1-\pi)(v - \dfrac{R_0}{\pi}) \end{pmatrix}$$

where $\gamma = \dfrac{\pi}{2\tau(1-\delta\pi(1-\pi))}$. Straightforward calculations yields Result 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:

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