

Do Public Banks have a Competitive Advantage?

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Abstract

Public banks are often blamed to possess an unfair competitive advantage in the form of lower funding costs due to a state guarantee on their deposits. However, public and private banks tend to differ not only in their funding costs, but also in the way they deal with borrowers in financial distress. The model presented in this paper shows that if banks differ in these two characteristics, a separation of borrowers may result, with public banks lending to risky firms and private banks lending to safe firms. This separation can explain differences in the lending behavior and performance of public and private banks as observed in the market. Interestingly, the separation may persist even when funding costs are equal, implying that an abolition of state guarantees will not necessarily lead to identical performance of the two types of banks.

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1 Introduction

Public banks that hold state guarantees on their deposits often enjoy lower funding costs than private banks in the same market. This difference, which the Banking Federation of the European Union estimated to amount to up to 20 basis points (Gloyens, 2002), tends to be blamed to distort competition in favor of public banks. The argument was prominent enough for the European Commission to initiate legal action against German regional and municipal banks in 2001, which led to the abolition of the state guarantees in Germany in July 2005.

Another characteristic in which public and private banks tend to differ, but which is omitted in many discussions of the issue (see, e.g., Chakravarty and Williams, 2006), is their different knowledge of the local market, and their willingness to support local (small) firms. Indeed, local public banks do not only tend to have more knowledge and experience regarding the local market due to an extensive branch network, they also have the *mandate* to support the local economy (see their statutes, e.g., in Germany and Switzerland). For example, in Germany local public banks (*Sparkassen*) are obliged to “ensure an appropriate and sufficient provision of money and loans to all parts of the population and especially to small and medium-sized enterprises”¹. This is reflected in the banks’ policy statements, where they claim to “support the firm even through critical times as long as it is economically [...] justifiable” (Sparkassenfinanzgruppe, 2007). Overall, this strategy seems to be reflected in the public’s perception of public vs. private banks. For example, for all years between 2001 and 2007, the local public banks were the banks that Germans trusted most. A similar picture arises in several other European countries where strong non-private banks exist, for example in Austria, France, Netherlands, Switzerland and Russia, where public and cooperative banks head the list (Reader’s Digest, 2007).

The model presented in this paper analyzes the market structure that results if public and private banks differ in both their funding costs and the way they deal with borrowers in financial distress. It is based on a simple self-selection mechanism as introduced by Rothschild and Stiglitz (1976), and shows that a separated market can emerge in which private banks lend only to safe firms, while public banks lend only to risky firms. Since these types of firms may differ in more than the risk they present (e.g., in their size, field of activity, global integration etc.), this market separation offers one explanation why private and public banks differ in their performance under different market conditions.

The predictions of the model are supported by data on the German loan market for small and medium-sized firms. It shows that a relatively higher share of firms with a low (self-reported) degree of creditworthiness, i.e., risky firms, borrow from public banks (73%) than from private banks (19%). For firms with a high degree of creditworthiness, i.e., safe firms, the difference is less pronounced (51% vs.

¹§4, no. 1, Niedersächsisches Sparkassengesetz 16.12.2004 / 15.11.2005

30%) (Paul et al, 2003). This tendency is consistent with data which shows that especially very small firms (up to 10 employees), which are usually seen as being very risky, tend to borrow from public banks (BDS/DGV, 2007).

The model supplements the extensive literature that exists on financial market competition. However, the setup differs noticeably from some of the related research. First, by focusing on the competition between the two types of banks, I do not consider alternative sources of external funds like stocks or bonds. Although this seems a realistic assumption in particular for small and medium-sized firms, it means that I do not account for implications that the competition between banks and financial markets may have on the behavior of banks.² For example, in the model of Chemmanur and Fulghieri (1994) banks compete with financial markets. There, establishing a reputation for auditing firms in distress creates a competitive advantage for the bank over bond holders. This argument is different from mine, and which strategy a bank chooses may ultimately depend on its competitors and the relative importance of the different groups of customers.

Second, apart from the public bank's willingness and ability to "support firms as long as it is economically justifiable", I do not assume that public banks differ in their policies from private banks. Rather, I analyze their behavior as profit maximizers. Hence, in contrast to the literature on soft budget constraints (see, e.g., Dewatripont and Maskin, 1995; Maskin, 1996) I do not assume that the state encourages the public bank to make unprofitable loans, but to assess the viability of all firms in distress. Projects that are not viable are liquidated.

In sections 2 and 3 I develop the model and describe the situation in a pooled market. Market separation is analyzed in section 4, and extended in section 5. Section 6 concludes. Proofs are in the appendix.

2 Model

There are two types of firms, safe and risky, indexed s and r , respectively. Firm types are private information, i.e., only the firm itself knows its type. Each firm has a single investment project that requires external finance in $t = 0$ and produces output x_j in $t = 1$, $j \in \{s, r\}$ (see fig. 1 for the sequence of events). Since it does not affect the argument, I set the discount factor between $t = 0$ and $t = 1$ to 1. The amount of external finance is also normalized to 1. All projects have non-negative net present value (NPV). This may be the result of, e.g., a pre-contract audit, which is able to distinguish negative NPV projects from positive NPV projects, but not different types of profitable projects. For example, the audit can assess the hard facts of a project like its technological quality, but not the soft facts like the risk attitude of the management, its skill, etc.

²For literature on how different firms choose between bank finance and, e.g., bonds, see Diamond (1991), Houston and James (1996), Johnson (1997), and Bolton and Freixas (2000).

is extended. Their value in $t = 1$ is zero. Hence, in $t = \frac{1}{2}$ it is efficient for a bank to extend the loan in the first case but liquidate the firm in the second.

To distinguish the two cases, banks can audit firms. The audit reveals unprofitable firms with certainty and viable firms with an error margin. q_i denotes the quality of the audit, i.e., the conditional probability that an economically viable firm in financial distress is identified as such.³ If the firm is identified as viable, the bank extends its loan but renegotiates the loan contract to obtain a share k_j of the output. The firm's output x_j is known in $t = \frac{1}{2}$, i.e., the firm type is revealed through the audit. For the renegotiation, I assume a form of Nash bargaining where both players receive equal shares of the surplus over the original repayment, $\frac{x_j - R_i}{2}$, and the bank additionally receives its repayment R_i . Hence, the bank receives a share $k_j = \frac{x_j + R_i}{2x_j}$ of x_j , while the firm receives $1 - k_j = \frac{x_j - R_i}{2x_j}$ of x_j . The audit quality of both banks is assumed to be high enough such that the audit has a positive expected value, i.e., it is ex-ante efficient for both types of banks to audit all firms in distress.

The quality of the audit, q_i , is the only characteristic in addition to funding costs in which the two types of banks are allowed to differ. It captures several aspects of the way a bank deals with borrowers in financial distress, e.g., the likelihood of the bank auditing at all, the probability of recognizing a viable firm, the costs of the audit etc.

3 Lending in the Pooled Market

Consider first the case of a pooled loan market. Both types of banks enter the market simultaneously, and compete for borrowers. Firms obtain expected profits under pooling of

$$P_j^{pool} = (x_j - R_i^{pool})(1 - p_j + \frac{1}{2}p_j p_v q_i)$$

where R_i^{pool} denotes the repayment that bank i charges a pooled firm population. Given the firms' participation constraints, $P_j^{pool} \geq 0$ (no losses in expectation), banks can charge maximum repayments of $R_r^{max} = x_r$ for risky firms and $R_s^{max} = x_s$ for safe firms. Since $x_s < x_r$ by assumption, x_s is binding for the repayment if a bank wants to lend to all firms.

However, depending on the parameters, it may be more profitable for a bank to set $R_i^{pool} = x_r$ and lend to risky firms only, instead of serving the whole market at a repayment of x_s . Since credit rationing is not the focus of this paper, I make the following assumption:

³This means that I assume the audit to produce Type II error of $1 - q$ but no Type I error (see Chemmanur and Fulghieri, 1994, for a similar renegotiation outcome). A possible explanation for this assumption is that banks only renegotiate a loan if they are certain that the expected output will be produced. If there are doubts, they prefer to liquidate. I do not explicitly include costs of the audit. However, they would strengthen rather than weaken the argument.

A1: The share ϕ of safe firms in the population is large enough such that credit rationing is not profitable for the banks:

$$\frac{\phi}{1-\phi} > \frac{(x_r - x_s)(1 - p_r + \frac{1}{2}p_r p_v q_i)}{(1 - p_s)x_s + p_s(y + p_v q_i(x_s - y))} \quad \forall i \quad .$$

Banks then obtain expected profits

$$\begin{aligned} \Pi_i^{pool} &= \overbrace{\phi[(1 - p_s)R_i^{pool} + p_s(y + p_v q_i(\frac{1}{2}(x_s + R_i^{pool}) - y))]}^{\text{exp. profit from lending to safe firms}} \\ &+ \underbrace{(1 - \phi)[(1 - p_r)R_i^{pool} + p_r(y + p_v q_i(\frac{1}{2}(x_r + R_i^{pool}) - y))]}_{\text{exp. profit from lending to risky firms}} - r_i. \end{aligned}$$

Neither type of bank is allowed to incur losses in expectation, i.e., banks' participation constraints are given by $\Pi_i^{pool} \geq 0$. Banks therefore have to charge minimum repayments of

$$R_i^{pool, min} = \frac{2(r_i - \bar{p}y) + p_v q_i(2\bar{p}y - \bar{p}x)}{2(1 - \bar{p}) + p_v q_i \bar{p}} \quad (1)$$

where $\bar{p} = \phi p_s + (1 - \phi)p_r$ is the average probability of distress, and $\bar{p}x = \phi p_s x_s + (1 - \phi)p_r x_r$ is the average probability of distress weighted with the respective outputs.

$R_i^{pool, min}$ is increasing in funding costs r_i and decreasing in audit quality q_i . Hence, which bank is successful in a pooled market depends on these two parameters. In particular, if the public bank's funding costs are lower, and its audit quality is not worse than that of the private banks it lends to all firms in the market. Even if there is no difference in funding costs, as long as the public bank is perceived as offering a higher audit quality, the private banks cannot compete in the market.

To reflect the empirical evidence as discussed in the introduction (see, e.g., Gloyens, 2002; Chakravarty and Williams, 2006), for the remaining analysis I make the following assumptions:

A2: The public bank has lower funding costs than the private banks:

$$r_{pu} < r_{pr} \quad .$$

A3: The probability that a firm in distress is identified as viable is at least as high for the public bank as it is for the private banks:

$$q_{pu} \geq q_{pr} \quad .$$

To simplify notation, I assume that if firms are indifferent between the two types of banks, they borrow from the public bank. In the pooled market, this means that the public bank can offer a repayment equivalent to the lowest profitable repayment of the private banks, and lend to all firms. This result is summarized in

Proposition 1 :

If assumptions A1-A3 are satisfied, in a pooled market the public bank sets a repayment of $R_{pu}^{pool*} = \min\{x_s, R_{pr}^{pool, \min}\}$ and lends to all firms.

4 Lending in the Separated Market

In the pooled market, the private banks are not able to compete with the public bank. However, under certain circumstances, they are able to separate the market and lend to safe firms only. The conditions under which separation can be achieved are derived in this section.

In a separated market firms obtain expected profits of

$$P_j^{sep, i} = (x_j - R_i^{sep})(1 - p_j + \frac{1}{2}p_j p_v q_i)$$

with R_i^{sep} denoting the repayment of bank i under separation. As before, maximum repayments as derived from firms' participation constraints are $R_r^{max} = x_r$ and $R_s^{max} = x_s$. Separation is obtained if firms self-select, i.e., if risky firms prefer the loan of the public bank, while safe firms prefer the loan of the private banks. This yields the incentive constraints

$$\begin{aligned} P_r^{sep, pu} &> P_r^{sep, pr} && \text{for risky firms and} \\ P_s^{sep, pu} &< P_s^{sep, pr} && \text{for safe firms.} \end{aligned}$$

From these constraints it follows that given the public bank's repayment R_{pu} , private banks have to charge a minimum repayment to deter risky firms from choosing its loan of

$$R_{pr}^{min} = \frac{R_{pu}(1 - p_r + \frac{1}{2}p_r p_v q_{pu}) - \frac{1}{2}p_r p_v x_r (q_{pu} - q_{pr})}{1 - p_r + \frac{1}{2}p_r p_v q_{pr}} . \quad (2)$$

To attract safe firms they can charge a maximum repayment just below

$$R_{pr}^{max} = \frac{R_{pu}(1 - p_s + \frac{1}{2}p_s p_v q_{pu}) - \frac{1}{2}p_s p_v x_s (q_{pu} - q_{pr})}{1 - p_s + \frac{1}{2}p_s p_v q_{pr}} . \quad (3)$$

If separation is achieved, i.e., the public bank lends to risky firms and the private banks lend to safe firms, banks obtain profits per contract of

$$\begin{aligned} \Pi_{pu}^{sep} &= (1 - p_r)R_{pu}^{sep} + p_r(y + p_v q_{pu}(\frac{1}{2}(x_r + R_{pu}^{sep}) - y)) - r_{pu} \\ \Pi_{pr}^{sep} &= (1 - p_s)R_{pr}^{sep} + p_s(y + p_v q_{pr}(\frac{1}{2}(x_s + R_{pr}^{sep}) - y)) - r_{pr} . \end{aligned}$$

From the banks' participation constraints (non-negative expected profits) result the minimum feasible repayments they can charge under separation as

$$\begin{aligned} R_{pu}^{sep, min} &= \frac{r_{pu} - p_r y - p_r p_v q_{pu}(\frac{1}{2}x_r - y)}{1 - p_r + \frac{1}{2}p_r p_v q_{pu}} \\ R_{pr}^{sep, min} &= \frac{r_{pr} - p_s y - p_s p_v q_{pr}(\frac{1}{2}x_s - y)}{1 - p_s + \frac{1}{2}p_s p_v q_{pr}} . \end{aligned} \quad (4)$$

Separation is feasible if the minimum repayment from (4) that private banks have to set under separation in order not to make losses in expectation is lower than the maximum repayment from (3) they can set in order to attract safe firms. The lowest repayment the public bank can set when serving a non-separated market is $R_{pu}^{pool,min}$ from (1), which depends on r_{pu} . This defines the critical disadvantage in funding costs r_{pr}^* , such that private banks with funding costs below r_{pr}^* are able to offer separating loan contracts to safe firms without making losses in expectation:

$$r_{pr}^* = (1 - p_s)R_{pu}^{pool,min} + \frac{1}{2}p_s p_v \left(R_{pu}^{pool,min} q_{pu} - (q_{pu} - q_{pr})x_s \right) + p_s y + p_s p_v q_{pr} \left(\frac{1}{2}x_s - y \right).$$

The details are in the appendix.

Proposition 2 :

If A1-A3 are satisfied and $r_{pr} < r_{pr}^$, there exists a unique separating equilibrium such that the private banks lend to safe firms, the public bank lends to risky firms, and banks set repayments*

$$R_{pr}^* = \frac{r_{pr} - p_s y - p_s p_v q_{pr} \left(\frac{1}{2}x_s - y \right)}{1 - p_s + \frac{1}{2}p_s p_v q_{pr}}$$

$$R_{pu}^* = \frac{R_{pr}^* + \frac{p_s}{2(1-p_s)} p_v q_{pu} x_s}{1 + \frac{p_s}{2(1-p_s)} p_v q_{pu}}.$$

In words, the private banks set the minimum repayment that separates firms and allows them to make non-negative profits, while the public bank sets the maximum repayment that ensures separation given the private banks' repayment.

Proposition 2 holds also for the marginal case of Assumption 2, $r_{pr} = r_{pu}$. This shows that the separation of the market does not depend on the public bank's advantage in funding costs. Even if the funding costs are equal for both banks, as long as the (perceived) audit quality of the private banks is lower than that of the public bank, they have an incentive to separate the market.

5 Committing not to audit

Even if the private banks are able to offer an audit quality as high as that of the public bank, they may choose not to do so. Rather, they may commit to a lower audit quality than they are technically able to offer, and build a reputation for easily foreclosing on borrowers. This can have two reasons. First, if the difference in audit quality between the public and private banks becomes negligible, separation is no longer possible since R_{pr}^{min} in (2) and R_{pr}^{max} in (3) converge. This means that if the private banks continue to face higher funding costs they can neither separate the market nor compete in a pooled market. The only feasible strategy may then be to offer an artificially low audit quality as a self-selection tool for the

firms.

Second, as will be shown below, commitment to a low audit quality may allow banks to obtain positive profits in equilibrium. These are sustainable since with zero profits the threat to offer a low audit quality is not credible and would lead to a breakdown of separation.

Consider a game in which the lending process between $t = 0$ and $t = 1$ (the stage game of the previous sections) is repeated an infinite number of times. The private banks' discount factor, reflecting their time preference and continuation probability (or time horizon), is δ . Firms live only for one period, but information regarding the banks' behavior is transmitted from one generation of firms to the next; it is common knowledge.

The assumption of firms living only for one period is a simplification that can be interpreted as follows. Each period, some firms newly enter the market and some drop out. For those firms that stay, the management may change or they may invest in new projects. This means that a firm that was of safe type in period t (and could be identified as such since it took a loan from a private bank) is not necessarily of safe type in period $t + 1$. Accordingly, the public bank cannot give firms contract offers according to their type. The information asymmetry persists and hence the chance for the private banks to separate firms.

For simplicity, consider the case where the private banks commit to not auditing at all, i.e., $q_{pr} = 0$. This means they liquidate all firms in financial distress. The maximum repayment that private banks can then set in order to attract safe firms is given by substituting $q_{pr} = 0$ in (3):

$$R_{pr}^{max} = R_{pu} - \frac{p_s}{2(1-p_s)} p_v q_{pu} (x_s - R_{pu}) \quad . \quad (5)$$

Since the audit is assumed to have a higher expected return than liquidation, the policy to audit distressed firms is self-enforcing. In contrast, a credible threat not to audit although an audit technique exists has to be achieved through reputation building: Liquidating distressed firms without an audit leaves both players, bank and viable firm, worse off in the short run. Although the bank can execute the liquidation threat because distress gives it power over the firm, short-term rational behavior would induce it to audit all firms. Given rational expectations, risky firms would anticipate the bank's deviation from its liquidation policy and free-ride on the cheaper loan.

In order to make foregoing short-term profits from the audit profitable, and thus the liquidation threat credible and self-enforcing, the discounted profits from lending to safe firms in the future have to exceed the expected profits from extending the loan of distressed but economically viable firms today. Given the private banks' repayment under separation, R_{pr}^{sep} , credibility requires that

$$\frac{\Pi(R_{pr}^{sep})}{1-\delta} \geq p_s p_v q_{pr} \left(\frac{1}{2} (x_s + R_{pr}^{sep}) - y \right) \quad (6)$$

where $\Pi(R_{pr}^{sep})$ is the banks' profit per contract if charging repayment R_{pr}^{sep} . The details are in the appendix. If a private bank deviates from its strategy not to audit, the credibility of the liquidation threat is lost. Risky firms are then attracted by the lower repayment, separation fails and the bank obtains negative expected profits.

In the separating equilibrium of section 4, the profits of the private banks are zero, such that (6) would fail. In order for credibility to be achieved, the profit of the private banks must be positive. This means that for a separating equilibrium with a credible liquidation threat to exist, the following condition must be satisfied: The minimum repayment implicitly defined in (6) that private banks set in order to credibly commit to liquidation and separate borrowers is lower than the maximum repayment from (5) they can set in order to attract safe firms, given that the public bank sets its lowest feasible pooling rate from (1). This yields the critical rate r_{pr}^{**} for the private banks' funding costs as

$$r_{pr}^{**} = (1 - p_s)R_{pr} + p_s y - (1 - \delta)p_s p_v q_{pr} \left(\frac{x_s + R_{pr}}{2} - y \right)$$

where $R_{pr} = \frac{2(r_{pu} - \bar{p}y) + p_v q_{pu}(2\bar{p}y - \bar{p}x)}{2(1 - \bar{p}) + p_v q_{pu} \bar{p}} - \frac{p_s}{2(1 - p_s)} p_v q_{pu} \left(x_s - \frac{2(r_{pu} - \bar{p}y) + p_v q_{pu}(2\bar{p}y - \bar{p}x)}{2(1 - \bar{p}) + p_v q_{pu} \bar{p}} \right)$,

and \bar{p} and $\bar{p}x$ are defined as in (1). The private banks then set repayments such that (6) is satisfied with equality, while the public bank sets the maximum separating repayment, given the repayment of the private banks:

Proposition 3 :

*If A1 and A2 are satisfied and $r_{pr} < r_{pr}^{**}$, in the infinitely repeated game there exists a separating equilibrium where private banks liquidate all firms in distress, lend only to safe firms and set*

$$R_{pr}^{**} = \frac{(1 - \delta)p_s p_v q_{pr} \left(\frac{1}{2}x_s - y \right) - p_s y + r_{pr}}{1 - p_s - \frac{1 - \delta}{2} p_s p_v q_{pr}} .$$

The public bank lends only to risky firms and sets

$$R_{pu}^{**} = \frac{R_{pr}^{**} + \frac{p_s}{2(1 - p_s)} p_v q_{pu} x_s}{1 + \frac{p_s}{2(1 - p_s)} p_v q_{pu}} .$$

Setting R_{pr}^{**} , all private banks make positive profits in equilibrium. Even perfect competition between private banks does not drive profits to zero, because this would render the liquidation threat non-credible by violating condition (6), and separation would fail.

Note that in the above equilibrium, no private bank has an incentive to unilaterally offer an audit quality $q_{pr} > 0$, since this would attract all borrowers and the bank would make losses in expectation. However, other separating equilibria of

the repeated game exist, where all private banks commit to q_{pr} such that $q_{pu} < q_{pr} < 0$. Which audit quality maximizes the private banks' profits depends on the parameters of the market.

6 Conclusion

In this paper I propose a model of bank competition where public and private banks differ not only in funding costs but also in the quality with which they audit borrowers in financial distress. It shows that if private banks are less able to detect viable firms and are therefore unable to compete in a pooled market, they may choose to separate the market and lend only to safe firms. Separation may arise independently of the public bank enjoying lower funding costs, as long as the audit quality of the private banks is not superior. This means that even if the state guarantees for public banks are abandoned as, e.g., in Germany in 2005, the separation of the market may persist.

The difference in audit quality is the crucial assumption that the model is based on. However, as section 5 shows, this difference may arise not only from the private banks' lower ability to identify viable firms, but also from a commitment not to do so. This suggests that private banks may have an incentive *not* to invest in auditing resources, e.g., by keeping the number of branches and the effort they invest per contract (the number of employees) limited.

The separation of the market in safe and risky borrowers may explain the different performance of public and private banks under different market conditions. Events that are relatively more favorable to risky firms, e.g., to small and owner-managed firms, can be expected to increase the performance of public relative to private banks. For example, economic and financial crises outside the local market tend to affect larger firms that are more integrated in the international markets stronger than small firms. Accordingly, such crises may affect private banks more than public banks. In contrast, events that favor firms which are active in several markets, like recessions in the local market, can be expected to improve the relative performance of private banks.

To verify the predictions of the model, detailed empirical studies are necessary. For example, the abolition of the state guarantees for public banks in Germany in 2005 could serve as a natural experiment to study the effect of an equalization of funding costs on the structure of the loan market, and the performance of public vs. private banks.

Appendix

Proof of Proposition 1

$x_s < R_{pu}^{pool,min}$:

- i) For $R_{pu}^{pool} < x_s$, the public bank lends to all firms, but obtains lower profits than with $R_{pu}^{pool} = x_s$.
- ii) For $x_s < R_{pu}^{pool} \leq x_r$, the public bank lends only to risky firms. Per assumption A1, this is less profitable than lending to the whole population at x_s .

$x_s \geq R_{pu}^{pool,min}$:

- i) For $R_{pu}^{pool} < R_{pu}^{pool,min}$, the public bank lends to all firms, but obtains lower profits than with $R_{pu}^{pool} = R_{pu}^{pool,min}$.
- ii) For $R_{pu}^{pool} > R_{pu}^{pool,min}$ the private banks are able to offer a feasible pooling repayment and attract all firms. □

Proof of Proposition 2

R_{pr}^* :

- i) For any $R_{pr} > R_{pr}^*$, competing private banks can set R'_{pr} with $R_{pr} > R'_{pr} \geq R_{pr}^*$ and lend to all safe firms at non-negative profits.
- ii) For $R_{pr} < R_{pr}^*$, the private bank makes losses in expectation, which violates its participation constraint.

R_{pu}^* :

- i) For $R_{pu} > R_{pu}^*$, risky firms borrow from private banks and the public bank makes zero profits.
- ii) For $\frac{R_{pr}^*(1-p_s + \frac{1}{2}p_s p_v q_{pr}) - \frac{1}{2}p_s p_v x_s (q_{pr} - q_{pu})}{1-p_s + \frac{1}{2}p_s p_v q_{pu}} < R_{pu} < R_{pu}^*$, separation persists but the public bank makes lower profits.
- ii) For $R_{pu} < \frac{R_{pr}^*(1-p_s + \frac{1}{2}p_s p_v q_{pr}) - \frac{1}{2}p_s p_v x_s (q_{pr} - q_{pu})}{1-p_s + \frac{1}{2}p_s p_v q_{pu}}$ the public bank lends to the whole market but makes losses in expectation. This violates its incentive constraint.

Derivation of r_{pr}^*

The maximum repayment the private banks can set in order to attract safe firms, dependent on the public bank's repayment, is given by safe firms' incentive constraint from equation (3) as

$$R_{pr}^{max} = \frac{R_{pu}(1 - p_s + \frac{1}{2}p_s p_v q_{pu}) - \frac{1}{2}p_s p_v x_s (q_{pu} - q_{pr})}{1 - p_s + \frac{1}{2}p_s p_v q_{pr}} .$$

The lowest feasible repayment the public bank can set under separation is $R_{pu}^{sep,min}$ as determined by its participation constraint from equation (4). Hence, one obtains

$$R_{pr}^{max} = \frac{R_{pu}^{sep,min}(1 - p_s + \frac{1}{2}p_s p_v q_{pu}) - \frac{1}{2}p_s p_v x_s (q_{pu} - q_{pr})}{1 - p_s + \frac{1}{2}p_s p_v q_{pr}}$$

as the highest incentive compatible repayment the private banks can charge if the public bank competes with its lowest feasible separation repayment. In order for the private banks' participation constraint to be met, R_{pr}^{max} has to exceed their minimum repayment under separation, $R_{pr}^{sep,min}$ in (4). This gives the condition

$$\frac{R_{pu}^{sep,min}(1 - p_s + \frac{1}{2}p_s p_v q_{pu}) - \frac{1}{2}p_s p_v x_s (q_{pu} - q_{pr})}{1 - p_s + \frac{1}{2}p_s p_v q_{pr}} \geq \frac{r_{pr} - p_s y - p_s p_v q_{pr}(\frac{1}{2}x_s - y)}{1 - p_s + \frac{1}{2}p_s p_v q_{pr}} .$$

Solving for r_{pr} yields

$$r_{pr}^* = (1 - p_s)R_{pu}^{pool,min} + \frac{1}{2}p_s p_v \left(R_{pu}^{pool,min} q_{pu} - (q_{pu} - q_{pr})x_s \right) + p_s y + p_s p_v q_{pr} \left(\frac{1}{2}x_s - y \right) .$$

Derivation of the credibility condition (6)

The profit that is lost per contract per period if distressed but viable firms are liquidated is $p_s p_v q_{pr}(\frac{1}{2}(x_s + R_{pr}^{sep}) - y)$. The private banks lend to safe firms, of which p_s enter into distress. A share p_v of these is viable, but only q_{pr} of them would be identified as viable in an audit. Compared to liquidating them, the private bank would obtain a profit of $\frac{1}{2}(x_s + R_{pr}^{sep}) - y$ by extending their loans.

The profit the private banks forgo if they lose the credibility of their liquidation threat and separation fails in all future periods is determined as the present value of obtaining the profit $\Pi(R_{pr}^{sep})$ from cooperation in infinitely many periods, given their discount factor δ .

Note that since the number of firms private banks lend to is the same over time as long as the market does not change, if the credibility condition holds for one contract, it holds for an arbitrary number of contracts the banks sell each period.

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