Market power and banking failures

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Abstract

We investigate whether more competition in the banking industry necessarily results in a higher probability of banking failures, as it is often suggested. In our model borrowers face a moral hazard problem, which induces banks to choose between costly monitoring and credit rationing. We show that investment decreases with the lending rate and increases with monitoring effort. Since incentives to monitor are enhanced by market power, the relationship between market structure and investment is ambiguous. In the presence of non-diversifiable risk and decreasing returns to scale, more investment implies higher failure rates. As a result, the relationship between market power and banking failures is ambiguous. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction

Can excessive competition jeopardize the solvency of the banking system? Does prudential regulation become more necessary after restrictions on deposit interest rates, branching, and other anti-competitive measures are lifted? Such questions
are at the heart of the policy debate over banking deregulation. Our aim is to provide some new insights into these issues, in particular regarding the exposure of banks to aggregate risk under alternative market structures.

Market power is often associated with a lower probability of a banking failure. Such a negative relationship is usually attributed to various reasons. Firstly, higher lending rates result in lower investment levels and thus a higher expected return of the marginal project, which implies a lower probability of bankruptcy. Secondly, the higher are the future expected profits of a bank, the larger is the opportunity cost of going bankrupt, which reduces the incentive to over invest in risky assets. Finally, on the deposit side, competition will tend to increase deposit rates pushing the margin further down and failure probabilities up. Some of the existing theoretical models confirm these intuitions.\(^1\)

However, this literature disregards the fact that a major characteristic of banks is their ability to reduce the scope of moral hazard and adverse selection problems, exploiting their comparative advantage in the provision of monitoring services. In this paper we argue that market power may affect bank solvency not only through the traditional channels, but also by altering banks’ incentives to invest in reducing information asymmetries about project selection. We show that if such an effect is strong enough tighter competition in the loan market may actually be associated with higher bank solvency.

The main ingredients of the model are the following. Firstly, because of limited liability and non-verifiable actions, contracts cannot be complete and entrepreneurs’ incentives to allocate funds to alternative projects are distorted. Similarly as in our companion paper (Caminal and Matutes, 1997), banks have two ways to induce appropriate project choices. On the one hand, by rationing credit, the bank increases the marginal return of the capital invested and thus makes it less attractive for entrepreneurs to deviate and undertake excessively risky projects. On the other hand, the bank can deal with the agency problem by monitoring borrowers in the interim of the relationship. Thus, credit rationing and monitoring are imperfect substitutes: by spending resources the bank can lend more capital since the firm’s incentive problem vanishes when the firm’s activities are monitored by the bank.\(^2\)

Secondly, we assume that all projects are ex-ante identical and are subject to a multiplicative aggregate shock. In this case, the riskiness of a loan increases with its size. The reason is that, under decreasing returns to scale and multiplicative uncertainty, the distribution of the rate of return of a project shifts to the left when the level of investment increases. In the real world, firms face both idiosyncratic

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\(^1\)See, for instance, Chan et al. (1992), and Matutes and Vives (1996, 2000).

\(^2\)Our approach to monitoring is analogous to that in Besanko and Kanatas (1993), in the sense that in both cases bank monitoring implies that borrowers take more efficient decisions.
and aggregate risk. However, as long as banks hold a well diversified loan portfolio, bank solvency is only affected by aggregate risk. Thus, for simplicity, we abstract from idiosyncratic risk and focus exclusively on aggregate uncertainty.

We explore the trade-off between rationing and monitoring for two extreme market structures, monopoly and Bertrand competition, so as to investigate the implications of banks’ choices on the likelihood of bankruptcy. Our main conclusion is that the relationship between market structure and banking failure is ambiguous. The argument goes as follows.

The relationship between market power and loan sizes is ambiguous since it depends on the net effect of two countervailing forces. On the one hand, a monopoly bank by setting a higher interest rate worsens the unmonitored firm’s incentive problem, which in turn tightens the credit constraint. On the other hand, a monopoly bank has a bigger incentive to exert monitoring effort and thus decreases the likelihood of credit rationing. Since larger loans are more exposed to multiplicative uncertainty, it follows that lack of market power and solvency risk do not always move together. Specifically, when monitoring costs are so high that banks do not monitor regardless of market structure, competitive banks are more likely to fail. Indeed, they set lower lending rates implying that firms’ incentive constraint is not so tight and thus they can extend credit further than a monopoly bank. For intermediate monitoring costs, only a monopoly bank will exert monitoring effort and hence faces no need to credit-ration loan applicants. In such circumstances, the monopoly bank is more exposed to aggregate risk than competitive banks and it is thus more likely to fail. For very low monitoring costs every bank will monitor and lend the efficient capital amount. In this latter case the banking failure probability is independent of market structure.

Our paper is consistent with the empirical evidence in Petersen and Rajan (1995), which uncovers a positive correlation between market concentration and investment in customer relationships, which in turn increases the likelihood of financing credit-constrained firms. Indeed, this paper provides further support for the idea that market power provides positive incentives to reduce agency problems through monitoring, which results in firms enjoying easier access to external financing. Our main contribution here is to show that as a consequence of this there may be higher failure rates as banking becomes more concentrated.

Undoubtedly, it may still be the case that in the real world the traditional channels dominate and tighter competition reduces the solvency of the banking

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3In Caminal and Matutes (1997) we characterize the optimal banking market structure without aggregate shocks and when monitoring effort is not contractible, and show that in general some market power improves welfare because incentives to exert monitoring effort increase with market power. In the present paper, we allow banks to commit to monitoring (i.e. monitoring is contractible) and do not carry out a welfare analysis of market structure. In an adverse selection framework, Villas-Boas and Schmidt-Mohr (1999) also show that less competition in banking may actually increase welfare.
The contribution of this paper is precisely to demonstrate that the relationship between market power and bank solvency is complex, and it is not sufficient to focus on how liberalization affects the charter value of banks and the associated incentives to risk taking.

In Section 2 we present the model. Section 3 characterizes the features of optimal debt contracts with and without monitoring. Sections 4 and 5 investigate the incentives to monitor, and the equilibrium lending levels of a competitive and a monopoly bank, respectively. Section 6 derives the implications of our model on failure probabilities and welfare. Concluding remarks close the paper.

2. The model

In this section we present a static model of a credit market subject to aggregate uncertainty and where lending is restricted by a moral hazard problem. There are three types of agents: depositors, banks and entrepreneurs. Banks intermediate between depositors and borrowers. They are risk neutral and have limited liability. Depositors supply their funds inelastically at the gross interest rate $I$. Moreover, deposits are fully insured and hence the face value of deposit contracts is also $I$. For simplicity, we assume that insurance premia are flat.

2.1. Investment technology

Entrepreneurs are risk neutral, endowed with zero wealth and have access to investment opportunities whose return is determined by the combination of three elements: (i) decreasing returns to scale in investment, (ii) a multiplicative aggregate shock, and (iii) the project choice.

More specifically, entrepreneurs (we will use the term ‘entrepreneur’ and ‘firm’ interchangeably) have access to a continuum of investment projects, indexed by $\alpha$, and are subject to limited liability. Given $\alpha$ in the interval $[\alpha, 1]$ and the investment level $k$, entrepreneur $i$ obtains a stochastic return given by:

$$F(k, \alpha) = \begin{cases} \mu \varphi(\alpha) f(k) & \text{with density } \alpha_i h(\mu) \\ 0 & \text{with probability } (1 - \alpha_i) \end{cases}$$

where $\mu$ is a macroeconomic shock with a density function $h(\mu)$, which takes

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4Keeley (1990) provides some evidence for the US economy that bank default risk increases with the liberalization of the financial system. Demirgüç-Kunt and Detragiache (1998), looking at cross-country evidence, conclude that when the institutional environment is strong the relationship between liberalization and financial fragility is weak.
strictly positive values, and is continuous and twice differentiable in the interval \([\mu, \bar{x}]\). The realization of \(\mu\) is the same for all projects and entrepreneurs.\(^5\)

For simplicity, we solve the model for specific functional forms that, as we will see below, allow simple parametrizations. Specifically,

\[
f(k) = k^\lambda \quad 0 < \lambda < 1
\]

and

\[
\varphi(\alpha) = \frac{1 + (1 - z) \ln \alpha}{\alpha} \quad 0 < z < 1.
\]

Thus, an increase in 1\% in investment increases expected return by \(\lambda\)%\(^6\). Also, notice that \(\alpha \varphi(\alpha)\) is an increasing function of \(\alpha\). Thus, the expected return of the project increases with \(\alpha\). Since the probability of failure is \(1 - \alpha\), clearly the efficient project is characterized by \(\alpha = 1\). Also, \(\varphi(\alpha)\) monotonically increases if \(\alpha < \exp \{-z/(1 - z)\}\), and decreases otherwise. Thus, by assuming that \(\alpha = \exp \{-z/(1 - z)\}\), since no entrepreneur will ever choose a project in the increasing section of \(\varphi(\alpha)\), we do not need to worry about the possibility of having corner solutions at \(\alpha\).

The parameter \(z\) measures the intensity of the moral hazard problem. For a given value of \(\alpha\) and conditional on the project success (which ex-ante occurs with probability \(\alpha\)), the higher the value of \(z\), the higher the return. Given that under limited liability entrepreneurs only care about the non-negative interval of the return distribution, the parameter \(z\) provides an indication of the incentives to choose inefficient projects.

The variable \(\alpha\) can literally be interpreted as a technology choice, but also more generally as reflecting any decision taken by the entrepreneur that is costly to verify and that influences the distribution of returns (R&D policy, quality of supplies, and so on). A similar framework was presented in Bacchetta and Caminal (2000).

2.2. Information structure

A crucial feature of the model is that the project type \(\alpha\) is the entrepreneur’s private information. However, the bank, by incurring a cost \(c\), can observe and also collect hard evidence on \(\alpha\). Thus, by monitoring the bank makes \(\alpha\)

\(^5\)In fact, all we need is that banks cannot perfectly diversify their portfolio of loans. This occurs, for instance, when banks are specialized in a particular type of borrower with correlated risks. Clearly, this is also the case with aggregate shocks. For simplicity we make the latter assumption.

\(^6\)Constant elasticity of the production function facilitates the presentation but it is not essential. However, if we allow the elasticity to increase with the investment level, then the first order condition of some of the optimization problems we analyze may have multiple solutions.
contractible. The idea is that the bank can get somewhat involved in the decision making of the firm. For instance, a bank representative may sit in the firm’s board of directors, or a bank agent may meet regularly with the borrower to check that the funds are appropriately used. On the other hand, we assume that the realization of the macroeconomic shock is publicly observable but not verifiable, and hence payments cannot be conditional on $\mu$.

Furthermore, once the return of the project, $F$, is realized, a signal $s$ is observed by everyone. The entrepreneur can choose between two actions: (i) to be honest, in which case $s = F$ (output is publicly observable), and (ii) to hide the project’s return, in which case $s = 0$. In either case, the bank can verify ex-post the return of the firm by paying a cost $d$, which is assumed to be sufficiently large.\(^7\)

For simplicity, we assume that the costs involved in the monitoring activity at the interim stage, $c$, as well as in the ex-post verification of returns, $d$, are non-pecuniary, so that they do not affect the bank’s failure probability. Thus, we are describing a situation in which there is no conflict of interest between the owners and the managers of the bank, and the latter must exert effort to monitor firms at the interim stage and to verify returns ex-post. Therefore, the organization as a whole maximizes the difference between pecuniary profits and the costs of effort. Such an assumption is clearly extreme but allows us to concentrate on loan sizes as the only determinant of the probability of failure, which makes the analysis much more transparent.\(^8\)

2.3. Contracts

Given that it is costly to verify output ex-post, debt contracts (fixed repayment $r$ per unit borrowed) are optimal. However, if the bank monitors the firm then the contract can specify $\alpha$. Debt contracts require the bank’s commitment to verify output ex-post when the borrower does not meet her payment obligations. Such a commitment is intended to avoid strategic default. In our case, the firm may be unable to repay the loan due to a low realization of the macroeconomic shock, which is public information. Thus, in order to minimize verification costs the bank can commit to verify and seize all output ex-post if one of the two things happens: either $s = 0$, or the firm does not pay $\min \{rk, s\}$. Such a commitment discourages strategic default, and it implies that expected verification costs are $(1 - \alpha)d$.

2.4. Timing

The timing of the game is the following.

Stage 1: competition in contracts.

\(^7\)See footnote 10.

\(^8\)In the last section we discuss the implications of relaxing such an assumption.
Banks simultaneously offer contracts \((r, k)\), and may also commit to monitor the firm at stage 2 in which case the contract includes a project choice, \(\alpha\). After observing all the contracts offered by the banks, each entrepreneur chooses one of them.

Stage 2: investment and interim monitoring.
Capital is assigned to firms and banks fulfil the monitoring commitment.
Stage 3: project selection.
Firms choose project \(\alpha\), possibly restricted by the contract they signed.
Stage 4: outcomes.
Project returns, \(F\), are realized, the signals \(s\) are observed and payments are made. Verification costs are incurred if required.

We discuss in Section 6 the extent to which relaxing the banks’ ability to commit to monitoring would affect our conclusions.

2.5. Further assumptions

In order to avoid trivial outcomes, we require that if the firm is offered the optimal level of capital and a loan rate \(r\), \(r > l\), then it has incentives to choose an inefficient project. Given our parametrization this is equivalent to the following assumption:

**Assumption 1.**

\[\lambda > 1 - z.\]

We also assume that:

**Assumption 2.**

\[\mu < E(\mu)(1 - z).\]

As we will see this assumption implies that, in the absence of bank monitoring, there is sufficient variability of the macroeconomic shock that the firm fails with positive probability.

Finally, for technical reasons\(^9\) we require that \(h(\mu)\) be such that

**Assumption 3.**

\[-h'(\mu) < \frac{h(\mu)}{\mu}.\]

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\(^9\)Assumption 3 rules out the existence of multiple equilibria of the continuation game for a given contract.
3. Preliminaries

3.1. Optimal contracts under bank monitoring

Given that the bank has committed to monitoring the firm, the contract consists of a triple \((r, k, \alpha)\). The payoff of the firm can be written as follows:

\[
\pi = \alpha \int_{\mu_v} \left[ \mu \varphi(\alpha)f(k) - r \right] dH(\mu)
\]

where

\[
\mu_v = \max \left\{ \frac{r}{\varphi(\alpha)f(k)} \right\},
\]

is the threshold level of \(\mu\) such that the entrepreneur cannot meet her payment obligations.

For \((\alpha, r, k)\) such that \(\alpha r > I\), then even when all the firms go bankrupt the bank need not, and the payoff to the bank is:

\[
B = \int_{\mu_v} \left[ (\alpha r - I)k \right] dH(\mu) + \int_{\mu_u} \left[ \alpha \varphi(\alpha)f(k) \mu - I k \right] dH(\mu) - c -(1 - \alpha)d
\]

where \(\mu_u\) is the threshold level of \(\mu\) below which the bank goes bankrupt, i.e.

\[
\mu_u = \max \left\{ \frac{I k}{\alpha \varphi(\alpha)f(k)} \right\} \leq \mu_v.
\]

Notice that the probability that the bank goes bankrupt increases with \(k\) and decreases with \(\alpha\).

With ex-ante monitoring, the optimal contract \((r, k, \alpha)\) is the solution to

Maximize \(\pi\)

subject to \(B \geq B\)

Unsurprisingly, in the optimal contract parties are willing to commit to the efficient project choice \((\alpha = 1)\). The reason is that \(\alpha = 1\) maximizes the joint payoffs, for any value of investment. The next step is to characterize the efficient investment level. Let us denote by \(S(k)\) the aggregate surplus obtained by the bank and the firm for a given level of investment when \(\alpha = 1\), i.e.

\[
S(k) = \int_{\mu_u} \left[ \mu f(k) - I k \right] dH(\mu).
\]

Let \(k^* = \text{argmax } S(k)\). In Appendix A it is shown that \(k^*\) is the unique solution to:
Lemma 1. The optimal contract under bank monitoring specifies \( \alpha = 1 \) and a level of capital \( k = k^* \). The interest rate increases with \( B \).

The formal proof can be found in Appendix A. The main idea is that bank monitoring eliminates asymmetric information and, as a result, there exists an investment level, \( k = k^* \), and a project choice, \( \alpha = 1 \), such that joint payoffs are maximized independently of how they are distributed. The distribution of surplus can be done through the interest rate. That is, \( r \) and hence the share of the surplus of the bank, depends on \( B \) (market structure) but it does not interfere with the maximization of the total surplus. Therefore, in equilibrium total surplus, gross of monitoring costs, is \( S^* = S(k^*) \).

3.2. Optimal contracting in the absence of bank monitoring

In the absence of ex-ante monitoring \( \alpha \) cannot be contracted upon. At the contract design stage parties anticipate that given \((r, k)\) the firm will select \( \alpha \) in order to maximize expected profits:

\[
\text{Maximize } \alpha \int_{\mu^\alpha} [\mu \varphi(\alpha) f(k) - rk] dH(\mu)
\]

subject to \( \alpha \in [\alpha, 1] \).

The first order condition for an interior solution implies that:

\[
\alpha^*(r, k) = \frac{(1 - z)E[\mu | \mu \geq \mu_\alpha] f(k)}{rk}.
\]

In Appendix A we show that the first order condition uniquely characterizes the solution. Notice that the direct effect of \( k \) and \( r \) on \( \alpha \) is negative. However, \( r \) and \( k \) also influence \( \alpha \) through \( \mu_\alpha \), and this indirect effect is positive. In any case, we show that the direct effect always dominates and thus incentives improve by reducing \( k \) or by reducing \( r \). That is, due to limited liability the larger the required payment \( rk \) the bigger the incentives of the firm to deviate and choose increasingly inefficient projects. Conversely, restricting \( k \) results in a higher average return of the safe and efficient project and thus it reduces the incentives to deviate. The question remains as to how the optimal contract (in the absence of monitoring) trades-off inefficient projects and inefficient investment levels. To address this issue we must investigate the pairs \((r, k)\) that:
Maximize $\pi$
subject to $B > \bar{B}$, and
$\alpha = \min (\alpha^*, 1)$

The next lemma characterizes these contracts.

**Lemma 2 (credit rationing).** In the absence of ex-ante monitoring, the optimal contract includes a level of capital, $k$, $k' < k^*$, which is the unique solution to:

$$(1 - \varepsilon)\mathbb{E}[\mu | \mu > \mu_v] f(k') = rk^c$$

and induces the firm to choose $\alpha = 1$. The level of investment, $k'$, and the interest rate, $r$, decreases and increases with $B$, respectively.

Thus, in the absence of monitoring it is efficient to restrict lending in order to induce the entrepreneur to choose the efficient project. Since the interest rate increases with the bank’s monopoly power ($B$), the level of investment must be reduced to maintain the project choice unchanged. Hence agency costs translate exclusively into inefficiently low levels of investment, but not into project choices which are dominated in terms of risk and return. This will be true in general if ex-post verification costs are sufficiently high. Otherwise, the equilibrium outcome of a wider class of moral hazard problems could involve a combination of both inefficient investment levels and excessively risky project choices. This second element would unnecessarily complicate the analysis and make less transparent the analysis of how alternative market structures deal with non-diversifiable risk.

Since $k'$ decreases with $r$, then we can write aggregate surplus as a decreasing function of $r$. More specifically,

$$S'(r) = S(k'(r)).$$

Also since $k'(r) < k^*$, $S'(r) < S(k^*)$ for all $r \geq I$. In words, under credit rationing, total surplus (gross of monitoring costs) is lower than under the efficient

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Footnote 10: If the probability that the entrepreneur cannot meet her payment obligations, $H(\mu_v)$, were exogenous, then the optimal contract would induce $\alpha = 1$ even in the extreme case of zero verification costs. The reason is that any arbitrary contract $(k, r)$ that induces $\alpha < 1$ is dominated by a contract with the same level of investment and a lower interest rate. A reduction of 1% in the interest rate improves the firm’s incentives, and causes exactly a 1% increase in the probability of success. As a result, the bank’s payoff are unchanged but the firm’s payoff strictly increases. However, in general, a lower interest rate implies a lower probability of default (a lower $\mu_v$) and as a result a decrease in $r$ also improves the firm’s incentives, but the induced increase in $\alpha$ is smaller (see expression (A.1) in Appendix A). Therefore, in general we need strictly positive verification costs to make sure that the optimal contract always induces the efficient project choice. See Eq. (A.4) in Appendix A for an indication of the minimum size required.
investment level. Moreover, total surplus decreases with the bank’s monopoly power (with the interest rate).

4. Bertrand competition

Until now we have not specified the number of banks, \( n \). Given the structure of the game, it only makes a difference whether \( n \) is greater than or equal to one. In the first case, we have Bertrand competition and in the second we have a monopoly.

With Bertrand competition \( (n > 1) \), the first step is to specialize the discussion of the previous section to the case \( B = 0 \). Following Lemma 1, if the bank monitors the firm then the contract includes \( \alpha = 1, k = k^* \), and \( r \) such that \( B = 0 \). Indeed, notice that the firm’s and the bank’s profits decrease and increase with \( r \), respectively; hence the constraint \( B \geq 0 \) is binding. As a result, \( r > I \) in order to cover monitoring costs.

Following Lemma 2, if the bank does not monitor the firm then the contract specifies \( k = k'(r) \) (which induces \( \alpha = 1 \)). Since in this case the bank must not recover any monitoring cost, then \( r = I \).

The next step is to characterize the conditions under which Bertrand competitors offer credit with and without monitoring. Let \( \pi^* \) and \( \pi' \) be the firm’s payoff with and without ex-ante monitoring. Under Bertrand competition, monitoring will take place if and only if:

\[ \pi^* \geq \pi'. \]

Given that in both cases the bank’s expected payoff is zero, this is equivalent to:

\[ c \leq S^* - S'(I). \]

Hence, we have the following result:

**Proposition 1.** There exists a threshold level of monitoring cost below which Bertrand competitors monitor the firms. More specifically, let \( c = S^* - S'(I) \). Then under Bertrand competition, equilibrium can be characterized as follows:

1. (1.1) if \( c \leq c \), banks commit to monitor and sign contracts with \( \alpha = 1, k = k^* \), and an interest rate that allows them to break even;
2. (1.2) if \( c > c \), banks offer contracts with \( k = k'(I), r = I \) and do not monitor firms. Nevertheless, firms find it optimal to choose the efficient project.

5. Monopoly

In the case of a single bank, the equilibrium contract is better understood as the solution which maximizes \( B \) subject to \( \pi \geq 0 \). If there is ex-ante monitoring then,
following Lemma 1, the contract includes $k = k^*$, $\alpha = 1$, and $r$ arbitrarily large. In this case the bank can appropriate all the surplus (gross of monitoring costs), $S^*$.

When the bank does not monitor the firm, following Lemma 2, the bank offers $k'(r)$, which induces the firm to select the efficient project choice ($\alpha = 1$). In this case, the monopolist faces a downward sloping credit schedule, which is determined by the firm’s incentive constraint, and as a result the bank cannot appropriate all the surplus. In other words, firms are able to capture some informational rents. More formally, the problem of the monopolist consists of choosing $r$ in order to maximize:

$$B(r) = [1 - H(\mu_p)](r - I) k'(r) + \int_{\mu_u}^{\mu_p} [\mu p k'(r) - Hk'(r)] dH(\mu).$$

It is sufficient to notice that the monopoly interest rate, $r_m$, is above $I$ (positive margin). It follows that $k'(r^m) < k'(i)$. Indeed, with $r = I$, $\mu_p = \mu_u$ and profits equal zero, while higher lending rates yield positive profit.

Let $B^*$ and $B^c$ denote the payoff (gross of monitoring costs) earned by a monopoly bank with and without monitoring, respectively. The monopolist monitors the firm if and only if:

$$c \leq B^* - B^c.$$

Notice that:

$$B^* - B^c > S^* - S'(r^m) > S^* - S'(I).$$

The first inequality comes from the fact that in the absence of bank monitoring firms earn positive profits (informational rents), and thus $S'(r^m) > B^c$. The second inequality is due to the fact that $S'(r)$ is a strictly decreasing function. Therefore, Proposition 2 follows:

**Proposition 2.** The threshold level of monitoring cost below which a monopoly bank monitors firms is higher than the threshold level for competitive banks. More specifically, under monopoly, there exists a $\tilde{c} > c$, such that the following hold:

1. (1.1) if $c \leq \tilde{c}$, the bank commits to monitoring, imposes $\alpha = 1$ and lends $k = k^*$, at an arbitrarily large interest rate;
2. (1.2) if $c > \tilde{c}$, the bank offers contracts with $k = k^c(r^m)$, $r^m > I$, and does not monitor firms. Nevertheless, firms choose the efficient project.

6. Banking failures and market structure

In our model banks fail only if the realization of the macroeconomic shock is very low, i.e. if and only if:
\[\mu < \mu_n = \frac{I_k}{f(k)}.\]

Therefore, the probability that a bank fails depends exclusively on its exposure to aggregate risk, which in turn depends on the average loan size. Specifically, a higher level of investment implies a higher probability of failure. In this section we examine the relationship between market structure, the loan size and the probability of banking failures.

The analysis in the previous sections shows that whenever banks monitor entrepreneurs, under both market structures, the level of capital is \(k^*\) and hence the probability of banking failure is \(H_1 > 0\), where

\[H_1 = H\left(\frac{I_k}{f(k^*)}\right).\]

If banks do not monitor firms then the level of capital does depend on banks’ market power. In the case of Bertrand competition, \(r = I\) and \(k = k'(I) < k^*\) and the probability of banking failure is \(H_2\), where

\[H_2 = H\left(\frac{I_k'(I)}{f(k'(I))}\right).\]

In the case of a monopoly bank, \(r = r^M > I\) and \(k = k'(r^M) < k'(I)\), and the probability of banking failure is \(H_3\), where

\[H_3 = H\left(\frac{I_k'(r^M)}{f(k'(r^M))}\right).\]

Hence, \(0 = H_1 < H_2 < H_3\).

Also, Propositions 1 and 2 indicate that a monopoly bank has larger incentives to monitor.

As a result, the relationship between monopoly power and loan sizes (and hence probability of banking failure) is in general ambiguous, since it will be the net effect of two countervailing forces. On the one hand, more monopoly power implies higher incentives to monitor and larger investment levels. On the other hand, for a given monitoring effort, more monopoly power implies larger interest rates and lower investment levels.

In our model the sign of the net effect of these two forces depends on the size of monitoring costs. Let us consider three regions.

(i) If \(c < c_1\), then under both market structures banks have incentive to monitor and hence the probability of banking failure is \(H_1\), independent of the degree of market power.

(ii) If \(c \in [c_1, c]\), Bertrand competitors do not monitor firms but a monopoly bank
does. As a result, the probability of banking failure under monopoly is higher than under competition: \( H_1 > H_2 \).

(iii) If \( c > \bar{c} \), banks do not monitor independently of the degree of market power. As a result, a monopoly bank sets a higher interest rate, grants lower levels of investment and hence fails with lower probability: \( H_3 < H_1 \).

The following proposition summarizes our findings:

**Proposition 3.** The relationship between market structure and the probability of banking failure is ambiguous. With multiplicative shocks the probability of banking failure increases with the average loan size. However, a monopoly bank may lend more or less than competitive banks, depending on the relative costs of monitoring and credit rationing. More specifically, there exist threshold values \( (\bar{c}, \bar{c}) \), \( 0 < \bar{c} < \bar{c} \), such that:

(i) if \( c < \bar{c} \), the probability of failure is independent of the market structure;
(ii) if \( c \in [\bar{c}, \bar{c}] \), a monopoly bank fails with higher probability than competitive banks;
(iii) if \( c > \bar{c} \), a monopoly bank fails with a lower probability than competitive banks.

As far as welfare is concerned, the implications of the model should be taken with care since we are not modelling banks’ private and social bankruptcy costs, and our analysis is very partial in this sense. Bearing this limitation in mind, however, the model has clear cut implications that are worth exploring. To do so, it is convenient to distinguish two stages; firstly, the welfare implications conditional on the information structure, and, secondly, the welfare implications regarding information acquisition. Given the information structure, it is clear that competitive banks lend the efficient levels of capital and hence their exposure to the aggregate shock is efficient given the information they have. A monopoly, on the other hand, restricts credit beyond the efficient level in the presence of a moral hazard problem and hence it is underexposed to aggregate shocks relative to the second best.

The next question is whether banks take the efficient decision regarding the acquisition of information. In our model, competitive banks monitor if and only if it is efficient while a monopoly bank has excessive monitoring incentives since \( r^M > I \) and thus \( S'(r^M) < S'(I) \). As a result, while a competitive bank is always efficiently exposed, a monopoly’s exposure to aggregate shocks can be excessive or insufficient from a welfare point of view.

The welfare implications conditional on the information structure depend only on two crucial features: (i) in the absence of monitoring, banks choose to ration credit (rationing and monitoring are substitutes), (ii) the firm’s incentives worsen
with the interest rate. These two features are likely to appear in a wider class of models. However, it is worth discussing the extent to which the incentives to acquire information are model-dependent. In particular, if monitoring effort were non-contractible then we would be facing a double moral hazard problem and hence the contract must provide incentives to the bank as well. As a result the incentives to acquire information would be reduced. In a related paper (see Caminal and Matutes, 1997) we show that, in a similar framework but without aggregate shocks, when monitoring effort is not contractible then the competitive bank under supplies monitoring effort relative to the first best, while a monopoly monitors if and only if total welfare increases. Therefore, we cannot claim that the welfare implications drawn above are robust.

7. Concluding remarks

Our main conclusion is that there is no clear-cut relationship between market structure in banking and exposure to non-diversifiable risk. How relevant is aggregate portfolio risk? To the extent that banks are restricted to specific regions which are specialized in a small set of industries, it is obviously very important. Even when the regulatory environment allows banks to diversify across regions, macroeconomic shocks are still relevant for any geographic area. Furthermore, banks may choose not to diversify their loan investments to reduce total monitoring cost by specializing in certain types of firms facing correlated risks.

It is commonly believed that deregulation in the banking industry, by increasing the degree of competition, may increase the likelihood of banking crises. Our analysis shows that this is not necessarily the case. The reason why a monopolist might go bankrupt more often than a competitive bank is that bigger incentives to solve agency problems translate into more incentives to take aggregate risk. Our result has been derived within the setting of a specific moral hazard problem with the feature that in equilibrium firms and banks only fail due to macroeconomic shocks. Clearly, in the real world both firms and even banks may fail because of project choices. Also project choices themselves may depend on the market structure. Thus, the actual relationship between market power and financial fragility is clearly very complex. Yet the question is whether the driving forces behind our results are likely to be present or are artefacts of the model.

Thus, the issue arises as to what are the essential assumptions leading to the ambiguity result. An essential ingredient is that risk exposure increases with the level of investment. If aggregate shocks are multiplicative then it simply requires decreasing returns to scale to investment. The other two key ingredients are that monitoring and credit rationing are substitutes to alleviate a moral hazard problem, and that a monopoly is more likely to monitor firms than competitive banks. Regarding the former, there is some empirical support for the idea that close ties
with banks alleviate credit constraints,\textsuperscript{11} which indicates that the trade-off between monitoring and credit rationing is rather plausible. Regarding the latter, a monopoly bank is more likely to monitor than competitive banks because market power allows the bank to appropriate a higher proportion of the rents created by monitoring. It holds in the present framework where monitoring is contractible, but it also holds in frameworks where it is not contractible (see Caminal and Matutes, 1997).

Our model has also abstracted from pecuniary costs of monitoring and verification, as well as from adverse selection problems. If monitoring costs were pecuniary then, ceteris paribus: (i) a bank with a higher exposure to aggregate risk would have more incentives to monitor (since the costs of monitoring would be paid only in case of non-failure) and (ii) by monitoring a bank would bear a higher risk of failure (because of higher costs). These two new channels would complicate the analysis without bringing substantial additional insights.\textsuperscript{12}

In an adverse selection framework, with ex-ante screening instead of interim monitoring, new effects are possible. Nevertheless, the type of effects analyzed in this paper are likely to be present, provided individual investment exhibits decreasing returns to scale and there exist aggregate portfolio shocks. For instance, more screening (induced by higher monopoly power) is likely to be associated with lower individual risk, and as a result the bank would be willing to accept larger exposure to aggregate shocks. If borrowers are small with respect to the bank’s portfolio, then the relationship between bank solvency and market power would be analogous to our model. However, if the size of individual loans is significant with respect to the bank’s portfolio, then the probability of banking failure would depend on the interplay between individual and aggregate risk, and either could dominate.

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\textsuperscript{11}See for instance Petersen and Rajan (1994), Hoshi et al. (1990a,b), Lummer and McConnell (1989) and Berger and Udell (1995).

\textsuperscript{12}For values of $\alpha$ strictly less than one, the probability of banking failure is also higher if verification costs are pecuniary. This fact combined with banks’ limited liability imply that the incentives to take excessive risk (to offer contracts that induce values of $\alpha$ below one) are higher than in the case of non-pecuniary verification costs. However, provided that $d$ is higher than a certain threshold, the optimal contract would still induce $\alpha$ equal to one, although the level of the threshold is likely to be higher than in the case of non-pecuniary costs. In expression (A.4) in Appendix A, pecuniary verification costs translate into a higher value of $\mu_0$. Clearly, such a derivative would still be negative if $d$ is sufficiently high.
Appendix A

**Proof of Lemma 1.** The payoffs of the entrepreneur and the bank can be written as follows:

\[
\pi = \alpha \varphi(a) f(k) \int_{\mu} \mu \, dH(\mu) - \alpha r [1 - H(\mu_0)]
\]

\[
B = (1 - z) f(k) \int_{\mu} \mu \, dH(\mu) + \alpha \varphi(a) f(k) \int_{\mu_0} \mu \, dH(\mu)
- [1 - H(\mu_0)] [Ik + d(1 - \alpha)].
\]

Notice that once again \(\pi\) and \(B\) increase and decrease, respectively, with \(r\). Therefore, the constraint \(B = 0\) is always binding. Thus, the optimization problem to characterize the optimal contract can be written as follows: choose \((k, a)\) in order to maximize

\[
\pi = \alpha \varphi(a) f(k) \int_{\mu} \mu \, dH(\mu) - [1 - H(\mu_0)] [Ik + d(1 - \alpha)] - B.
\]

Notice that \(\pi\) strictly increases with \(a\), and hence the optimal value of \(a\) is equal to 1. Hence, the problem is now to maximize \(S(k) - B\). Given that, the optimal value of \(k\) is, by definition, \(k = k^*\).

Finally, we show that \(k^*\) is the unique solution of the first order conditions to the problem of maximizing \(S(k) - B\). Given that, the optimal value of \(k\) is, by definition, \(k = k^*\).

The first order condition is given by:

\[
f'(k) \int_{\mu} \mu \, dH(\mu) - f[1 - H(\mu_0)] = 0.
\]

Given the definition of \(\mu_n\) and the functional form of \(f(k)\), we can rewrite the above expression and have:

\[
\lambda \int_{\mu_n} \mu \, dH(\mu) - \mu_n [1 - H(\mu_n)] = 0.
\]

Since there is a one to one relationship between \(k\) and \(\mu_n\), if we show that there...
exists a unique $\mu_k$ that solves the above expression, then there exists a unique $k$ that solves the original first order condition.

Let us define

$$\Phi(\mu_0) = \lambda \int_{\mu_0} \mu \, dH(\mu) - \mu_0[1 - H(\mu_0)].$$

Notice that,

$$\Phi(\mu) = \lambda E(\mu) - \mu > 0,$$

by Assumption 2. Also,

$$\Phi'(\mu_0) = -[1 - H(\mu_0)] + (1 - \lambda)\mu_0h(\mu_0)$$

$$\Phi''(\mu_0) = (2 - \lambda)h(\mu_0) + (1 - \lambda)\mu_0h'(\mu_0) > 0,$$

by Assumption 3. Finally,

$$\Phi(\mu) = 0$$

$$\Phi'(\mu) > 0.$$

As a result, there exists a unique $\mu_k$ that solves $\Phi(\mu_k) = 0$ with $\Phi'(\mu_k) < 0$ (and thus the second order condition holds).

**Proof of Lemma 2.** We search for contracts on the efficient frontier, given the entrepreneur’s moral hazard problem. Thus, we need to find the pair $(r, k)$ that solves the following optimization problem:

Maximize $\pi$

subject to $B \geq B$

and $\alpha = \min (\alpha^*, 1)$

where

$$\alpha^*(r, k) = \frac{(1 - z)E[\mu | \mu > \mu_e]f(k)}{rk}.$$  \hspace{1cm} (A.1)

Notice that, because of Assumption 1, it is impossible to have $\alpha = 1$, if $k = k^*$, and $r = I$. In fact, if $k = k^*$, and $r = I$, then $\mu_e = \mu_{\alpha^*}$, and thus:

$$\alpha^* < \frac{\lambda f(k^*)}{rk^*[1 - H(\mu_{\alpha^*})]} = 1.$$

Suppose that in the optimal contract $(r, k)$ are such that $\alpha^* = 1$ and $\mu_e \geq \mu$. In this case
\[ \mu_v = \frac{rk}{\varphi(\alpha)f(k)}. \]  
(A.2)

Solving (A.2) for \( r \) and plugging it into (A.1) and rearranging:

\[ \alpha \varphi(\alpha) = \frac{(1 - z)E(\mu | \mu > \mu_v)}{\mu_v}. \]  
(A.3)

First of all, we show that if \( \alpha = 1 \), then the probability of default is indeed positive as assumed, i.e. \( H(\mu_v) > 0 \). Define

\[ \Psi(\mu_v) = (1 - z) \mu dH(\mu) - \mu [1 - H(\mu_v)]. \]

Notice that when \( \Psi = 0 \), (A.3) is satisfied at \( \alpha = 1 \), we search for a number \( \mu_v \), \( \mu_v \in (\mu, \mu) \) such that \( \Psi(\mu_v) = 0 \).

Notice that

\[ \Psi(\mu) = (1 - z)E(\mu) - \mu > 0 \]

\[ \Psi(\mu) = 0 \]

and

\[ \Psi'(\mu) = -[1 - H(\mu_v)] + zm_vh(\mu_v). \]

Hence,

\[ \Psi'(\mu) = z\mu h(\mu) > 0. \]

Also, notice that \( \Psi(\mu) \) is convex. Its second derivative can be written as:

\[ \Psi''(\mu_v) = (1 + z)h(\mu_v) + zm_vh'(\mu_v) \]

and from (A.3) it is positive. Therefore, there exists a unique value of \( \mu_v \in (\mu, \mu) \) such that \( \Psi(\mu_v) = 0 \) and \( \Psi'(\mu_v) < 0 \).

Secondly, we show that we cannot have \( \alpha = 1 \) and zero failure probability. Suppose we do, i.e. \( k_v \) satisfies:

\[ (1 - z)E(\mu)f(k) = rk. \]

Also, it must be the case that:

\[ \mu_v \leq \frac{rk}{f(k)}. \]

Combining these two equations:

\[ (1 - z)E(\mu) \leq \mu_v. \]
By Assumption 2 we reach a contradiction.

Thirdly, from Eq. (A.3) if $\alpha < 1$, then the probability of default is always positive. To see this, we use the implicit function theorem to obtain:

$$
\frac{d\mu_{\nu}}{d\alpha} = -\frac{1 - H(\mu_{\nu}) - z\mu_{\nu} h(\mu_{\nu})}{\mu_{\nu}[1 - H(\mu_{\nu})]^{1 - z} \alpha}.
$$

Since $\Psi'(\mu_{\nu}) < 0$, the numerator is positive and thus $\mu_{\nu}$ increases if $\alpha$ falls.

It follows, then, that for any $\alpha^* < 1$ the failure probability is positive as assumed. In such a case, the bank’s payoff can be written as a function of $k$ and $\mu_{\nu}$ (for a given $k$, a higher value of $r$ implies a higher value of $\mu_{\nu}$):

$$
B = (1 - z) f(k) \int_{\mu_{\nu}}^{\mu_{\nu}} \mu \ dH(\mu) + \alpha \varphi(\alpha) f(k) \int_{\mu_{\nu}}^{\mu_{\nu}} \mu \ dH(\mu) \\
- [1 - H(\mu_{\nu})][Ik + d(1 - \alpha)]
$$

where $\alpha$ is a decreasing function of $\mu_{\nu}$, and $\mu_{\nu}$ is a function of both $k$ and $\mu_{\nu}$.

Computing the partial derivative:

$$
\frac{dB}{d\mu_{\nu}} = [\alpha \varphi(\alpha) - (1 - z)] f(k) \mu_{\nu} h(\mu_{\nu}) \\
+ \left\{ \frac{1 - z}{\alpha} f(k) \int_{\mu_{\nu}}^{\mu_{\nu}} \mu \ dH(\mu) + [1 - H(\mu_{\nu})]d \right\} \frac{d\alpha}{d\mu_{\nu}}
$$

(A.4)

The first term is positive and the second is negative. However, since we have assumed that the verification costs ($d$) are sufficiently large, then the bank’s payoff decreases with $\mu_{\nu}$. In other words, it is never optimal to set an interest rate so high so as to induce the firm to choose $\alpha < 1$.

Finally, since at the optimal contract $\alpha = 1$, from Eq. (A.3) we have that $\mu_{\nu}$ is determined independently of $r$ and $k$. Indeed, from (A.3) $\mu_{\nu} = \mu^c$ where $\mu^c$ is the unique solution to:

$$
(1 - z) E(\mu | \mu > \mu^c) = \mu^c.
$$

(A.5)

Therefore, the optimal contract consists of a pair ($k$, $r$) such that:

(i) $(1 - z) E(\mu | \mu > \mu^c) f(k^c) = r \mu^c$

(A.6)

(ii) $B(r, k^c) = B$.

Hence, from (A.6) it is immediate that $k^c$ decreases with $r$. Also, we can write the bank’s payoff for $\alpha = 1$ as:
It is immediate to show that, starting at \( k' (I) \), \( B \) increases as \( k' \) decreases until we reach the maximum level of \( B \) (at the monopoly interest rate). Hence, in the relevant region, a higher value of \( B \) can only be reached through a higher interest rate and lower investment.

References


