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Bank Risk Taking and Competition Revisited

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Abstract

This study reinvestigates the theoretical relationship between competition in banking and banks' exposure to risk of failure. There is a large existing literature that concludes that when banks are confronted with increased competition, they rationally choose more risky portfolios. We briefly review this literature and argue that it has had a significant influence on regulators and central bankers, causing them to take a less favorable view of competition and encouraging anti-competitive consolidation as a response to banking instability. We then show that existing theoretical analyses of this topic are fragile, since they do not detect two fundamental risk-incentive mechanisms that operate in exactly the opposite direction, causing banks to aquire more risk per portfolios as their markets become more concentrated. We argue that these mechanisms should be essential ingredients of models of bank competition.

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I. Introduction

It is a hoary notion in banking that "excessive competition" can lead to socially undesirable outcomes in the form of bank failures, runs, and panics.[2] The basic idea is that when banks can earn monopoly rents, they become relatively conservative. Their banking charter is valuable and thus they shun the risk of bankruptcy, because bankruptcy would cause them to lose it. At least one widely cited empirical study provides support for this view,[3] as do a host of theoretical analyses to be reviewed momentarily.

This paper shows that there exist two fundamental risk-incentive mechanisms that operate in exactly the opposite direction, causing banks to become on more risky as their markets become more concentrated. The first mechanism exists on the asset side of banks balance sheets and has been undetected in widely cited studies that concentrate on deposit market competition. Ceteris paribus, as competition declines banks, earn more rents in their loan markets by charging higher loan rates. In themselves, higher loan rates would imply higher bankruptcy risk for bank borrowers. This effect is further reinforced by moral hazard on the part of borrowers who, when confronted with higher interest costs, optimally increase their own risk of failure. The second mechanism is equally striking in its implications for competition risk in banking noxus. It allows for a fixed, out-of-pocket cost that is relized by banks if they go bankrupt. As will be shown, under reasonable assumptions, when the number of banks in a market increases, deposits, assets, and profits per bank decline. Thus the (constant) cost of bankruptcy increases relative to everything else. This acts as a disincentive to risk taking that is ever increasing as the number of competitors increases.

We return to these issues momentarily, after a brief review of the literature.

A. Literature Review

Modern models of bank risk taking feature the role of deposit insurance and other government interventions that result in moral hazard, which distorts banks' risk incentives. Broadly speaking, this literature concludes that deposit insurance results in an incentive to intentionally take on risk of failure, possibly without limit. The incentive is due to a payoff structure in which large gains go to bank shareholders and large losses to the government.

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[2]As recently noted by a prominent central banker, "The legislative reforms adopted in most countries as a response to the banking and financial crises of the 1930's shared one basic idea which was that, in order to preserve the stability of the banking and financial industry, competition had to be restrained. This fundamental proposition was at the root of the reforms introduced at that time in the United States, Italy, and most other countries." Tomaso Padoa-Schioppa (2001, p. 14).

[3]An early and important empirical paper by Keeley (1990) suggested that when their shareholders had large stakes, banks held systematically less risky portfolios than when their shareholders did not.

Conceptually, the way to solve this problem is to provide bank shareholders with a stake in the firm that is sufficiently high to ensure that their incentives are aligned with those of the deposit insurer.[4]

There are two related but different ways to implement such a policy: the policymaker can either force bank shareholders to hold a large stake against their will; or it can give them a large stake that they will hold voluntarily.[5] The forcing policy refers to mandatory capital requirements in which the regulator imposes constraints on the use financial leverage.[6] However, there is a continuing debate over whether such policies are efficient, or even effective. A recent study by Hellman, Murdoch, and Stiglitz (2000), shows that capital requirements may be totally ineffective if it is necessary to set them beyond some threshold, at which the charter value of the bank (or the present discounted value of its equity claim) is driven below the option value of playing a high risk strategy against the deposit insurer. In essence, capital requirements may fail because, if they are set high enough to protect the deposit insurer, banks will discount the future and adopt go-for-broke strategies.[7]

As noted, there is a second regulatory approach and that is to give bank equity holders a sufficiently large stake in their bank. This is accomplished by a policy of intentionally allowing banks to earn monopoly rents so that the franchise becomes valuable and going broke costly. Such policies have been recently analyzed in Allen and Gale (2000), Hellman, Murdoch and Stiglitz (2000), and Repullo (2002). In each of these studies, as banks earn more rents in deposit markets, their equilibrium risk of failure declines. Allen and Gale (2000) study an environment in which banks choose a parameter that determines the default risk of their assets, and are Cournot-Nash competitors in deposit markets. They show that as the number of deposit market competitors increases, the optimal risk of failure unambiguously increases. Hellman, Murdoch, and Stiglitz (2000) study a policy of deposit

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[4]Another approach is to "correctly" price deposit insurance so that increasing risk of failure results in increasing insurance costs [Merton (1977)]. However, this is hard to implement in practice given the opaqueness of banks, and is unlikely to be optimal policy anyway, if the general equilibrium effects of regulatory policy are taken into account [Boyd, Chung and Smith (2002)].

[5]Theoretically, for such policies to work, either the insured bank's ability to increase risk of failure must be bounded, or higher risk of failure must be "costly" in the sense that it results in decreasing expected asset returns. [See Kareken and Wallace (1978) for a case in which such policies will not work].

[6]Such policies are the essence of the BIS capital standards and are almost universally employed by bank regulators.

[7]Another interesting paper by Marshall and Prescott (2000) finds that capital requirements, even if they can effectively contain moral hazard, are unlikely to be optimal unless accompanied by other policy interventions.

interest rate ceilings and find that such regulation decreases risk of failure. In their model, this policy is more effective than capital regulation and can, under certain conditions, be an optimal policy. A recent, dynamic extension along similar lines is provided by Repullo (2002).

These studies, and others, share two important assumptions. The first assumption is that banks' optimal asset allocations are determined by solving a *portfolio problem* that takes asset prices and return distributions as given. Although many other banking studies make similar assumptions, there is a large and growing literature that does not. A common alternative assumption is that banks solve an *optimal contracting problem* in which the actions of borrowers are unobservable, or observable at cost.[8] We will show that in the latter kind of moral hazard model of a bank, competition plays a new and different role; further, we present a simple moral hazard model in which, as bank markets become more competitive, risk of failure unambiguously declines.

What explains this radical reversal of the predictions of theory? Intuitively, in the portfolio model, as deposit markets become more concentrated banks use their market power to become more profitable. Resultantly, they become less eager to seek low probability, high return outcomes. Any direct effect of loan market competition is ignored. In the contracting model, on the other hand, banks compete in both deposit and loan markets. Less competition means more rents earned in deposit markets (as before), but also means more rents earned in loan markets. Obviously, higher loan rates are charged to bank customers as concentration increases. In themselves, higher loan rates imply higher bankruptcy rates for borrowers, but the loan market risk channel is further enhanced by moral hazard on the part of borrowers. When confronted with higher loan rates charged by banks, they optimally adjust their investment policies in favor of more risk.

Notice that it is exactly the same kind of mechanism that is influencing both banks and their loan customers—but having opposite effects. Less competition in banking results in higher deposit rates, bank profits go up, and banks intentionally seek less risk. At the same time, less competition in banking means higher loan rates, borrower profits go down, and they intentionally seek more risk. In the simple moral hazard model to be presented, the loan market effect dominates and increasing competition unambiguously results in lower bank risk. However, we are not claiming much generality for this result. What we are claiming is that the loan market channel exists and a priori is just as important as the deposit market channel.

A second common feature of the literature just reviewed is that it ignores bankruptcy costs. Yet, in many modern models of the banking firm, such costs are included and play an

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[8]So many papers fit this description it is impossible to cite them here. See Gorton and Winton (2002) for an excellent review of this literature.

important role.[9] In particular, allowing for ex-post bankruptcy costs in "costly state verification" environments produces the much-desired result that debt claims are the bank's optimal contract.[10] For present purposes, bankruptcy costs are important for a different reason. They represent a cost that grows relatively larger as the number of banks in a market increases and the equilibrium size of each bank declines.

In a moment, we turn to our analysis. Before doing that, we briefly argue that the recent theoretical literature has had some significant effect on policymakers. Or put another way, we argue that this topic is of more than theoretical interest.[11]

B. Policy Ramifications

We believe that the body of research just reviewed has had a material impact on bank regulators and central bankers. Specifically, we believe that there is a widely-held view among policymakers that reduced competition in banking is not necessarily bad because—other effects not withstanding—reduced competition results in a more stable banking industry. Obviously, policymakers are aware of other social costs that may be associated with bank rent-earning. That is not the point. In the environment of the last several decades, with banking crises occurring around the globe, policymakers might be expected to pursue risk-abatement strategies even if there were some "attendant costs."[12] That is our main point, and to argue otherwise is to argue that policymakers ignore the economics literature.

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[9]See Gorton and Winton (2002).

[10]Most but not all of this literature has assumed fixed bankruptcy costs as we do here. For an exception see Chang (1999). Empirical studies suggest that actual bankruptcy costs of U.S. corporations are quite large relative to total assets and have both a fixed and a variable component (White,1983).

[11]Three recent papers are tangentially related to this study: Covitz and Heitfield (1999), Buraschi and Hao (2001) and Caminal and Matutes (2002), in an important sense. In each case, their results are at odds with a simple direct relationship between bank concentration and risk. Yet, none of these papers, (as well as the several papers that analyze features of bank loan competition in special versions of industrial organization models, reviewed by Gorton and Winton (2002, III.D)), model bank choices as contracting problems in two markets simultaneously. As argued in our conclusions, such a modeling strategy is necessary to incorporate the two fundamental forces we identify.

[12]Carletti and Hartmann (2002), argue this same point. "Finally, it may be that the very influential 'charter value hypothesis' (see e.g. the discussion of Keeley [1990] and others below), saying roughly that a too competitive banking sector will be prone to instability, has convinced some countries to counterbalance the competition-oriented antitrust review with a stability-oriented supervisory review of bank mergers."

Precisely documenting that such a view is widely held, however, is difficult. For obvious reasons, policy spokespersons are loath to publicly state that they encourage monopoly rent-earning by banks so as to stabilize that sector. However, there is an historical track record of events that is suggestive. In the United States, the Federal Reserve System has been consistently permissive of bank mergers even when they involved the very largest banks, despite the existence of a large literature suggesting that such mergers produce little or nothing in the way of scale or scope economies. (e.g., Group of Ten (2001), De Nicoló (2000) and the literature cited therein).[13]

There is also much suggestive evidence based on the treatment of banks in the many banking crises around the world. Local and international agencies have pursued aggressive merger policies in almost all crisis situations, even in bank markets that were already highly concentrated by any standard.[14] But, combining two or more large, bankrupt banks does not increase the equity capital or reduce the loan losses of the survivor in any immediate way. What it does do is to reduce competition in bank markets and possibly allow the survivor banks to earn greater profits in the future.

II. A Model of Bank Competition

We begin with a model presented by Allen and Gale (chapter 8, 2000), which is used for our "base case." Then, we will modify the model to allow for the existence of a loan market.

A. Basic Setup

The economy lasts two dates: 0 and 1. There are two classes of agents, banks and depositors, and all agents are risk-neutral.

Banks

There are N banks which have no initial resources but have access to a set of constant return-to-scale risky technologies indexed by S. Given an input level y, the risky technology yields Sy with probability $p(S)$ and 0 otherwise.

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[13]There is also a smaller but growing literature suggesting that a primary motivation for the combination of large banking firms in the U.S. is simply to become so large that the survivor bank is "too big to fail," or too large and complicated to effectively regulate (e.g., Kane (2000)).

[14]In evaluating banking crises around the world in the last twenty years, Caprio and Klingebiel (2000) conclude that "achieving better banking will require the use of both *carrot—in the form of profitable opportunities for banking (our italics)*—and stick—such as prompt replacement of bad managers, substantial losses for (and replacement of) owners and more mobile deposits. Such mechanisms will ensure that bankers take risks, but only risks that are prudent" (p. 296).

Assumption 1. *p(S) satisfies:* $p(0)=1, p(\bar{S})=0, p'<0$ *and* $p''\leq 0$ for all $S\in[0,\bar{S}]$.

Thus, *p(S)S* is a strictly concave function of *S* and reaches a maximum *S** when,

$$p'(S^*)S^*+p(S^*)=0.$$

Given an input level *y*, increasing *S* from the left of *S** entails increases in both the probability of failure and expected output. To the right of *S**, the higher *S*, the higher is the probability of failure and the lower is expected output. The bank's (date 0) choice of *S* is unobservable to outsiders. The date 1 outcome is not verifiable and outsiders can only observe and verify at no cost whether the outcome has been successful (positive output) or unsuccessful (zero output). Of necessity, therefore, contracts are simple debt contracts.

Depositors

The total supply of deposits is represented by an upward sloping inverse supply curve, denoted by $r_D(\cdot)$, with,

Assumption 2. $r_D(\cdot)$ *satisfies:* $r_D(0)\geq 0, r_D'>0, r_D''\geq 0$.

Total deposits of bank *i* are denoted by D_i, and total deposits of all banks by $\sum_i D_i$.

Deposits are insured, so that the relevant supply does not depend on risk, and for this insurance banks pay a flat rate deposit insurance premium, denoted by $\alpha>0$.

Banks compete for deposits in a Nash fashion. If we assume that the market is replicated, an increase in competition is represented by increasing the number of banks and depositors at the same rate[15]. As in Allen and Gale, we assume that the rate of interest on deposits is a function of deposits per bank, i.e.

$$r_D=r_D\left(\sum_{i=1}^{N}D_i/N\right).$$

[15]This is a so-called replica economy in which the number of banks and depositors are assumed to increase or decrease at the same rate. We can just as well study a fixed-size economy in which the number of depositors is fixed and the deposit rate depends on total deposits. For present purposes it makes no difference at all in terms of risk incentives (see footnote 15). However, in Section III. where we introduce bankruptcy costs, it does make an important difference. There, it is more reasonable to assume a fixed-size economy.

In a Nash equilibrium, each bank i chooses $(S_i, D_i) \in \left[0, \bar{S}\right] x R_+$ that is the best response to the strategies of other banks. The pair (S_i, D_i) is chosen to maximize

$$p(S_i)\left(S_i D_i - r_D\left(\sum_{i=1}^{N} D_i / N\right) D_i - \alpha D_i\right).$$

Necessary conditions for an interior equilibrium ($D_i > 0$ and $S \in (0, \bar{S})$) are,

$$p'(S_i)\left(S_i D_i - r_D\left(\sum_{i=1}^{N} D_i / N\right) D_i - \alpha D_i\right) + p(S_i) D_i = 0, \qquad (1)$$

$$p(S_i)\left(S_i - r_D\left(\sum_{i=1}^{N} D_i / N\right) - r_D'\left(\sum_{i=1}^{N} D_i / N\right) D_i / N - \alpha\right) = 0. \quad (2)$$

In a symmetric interior equilibrium $(S_i, D_i) = (S, D)$ for all i and $p(S) > 0$. Hence, the above conditions reduce to:

$$p'(S)(S - r_D(D) - \alpha) + p(S) = 0, \qquad (3)$$

$$-\frac{p(S)}{p'(S)} = r_D'(D) D / N. \qquad (4)$$

Allen and Gale prove that the above system has a unique solution. It can be also verified that the risk shifting parameter S increases with N, and deposits per bank D increase with N. If we consider a fixed market size economy (number of depositors is unchanged), all the above results hold except that deposits per bank decrease as N increases[16].

[16]The following parametric example of a replica economy and a fixed size economy can clarify these statements. Let $p(S) = 1 - AS$, and $r_D(X) = B_0 + B_1 X$, with both coefficients strictly positive, and assume $1/A > B_0 + \alpha$. Then, solving conditions (3) and (4) gives, $S = \frac{1}{A} - \frac{1/A - B_0 - \alpha}{N+2}$, and $D = \frac{1/A - B_0 - \alpha}{B_1} \frac{N}{N+2}$. Clearly, the risk of failure and equilibrium

To summarize results:

Proposition 1 (Allen and Gale (2000)) In a symmetric interior equilibrium, the equilibrium level of risk shifting S is strictly increasing in N. As $N \to \infty$, $S \to \bar{S}$.

We should note that the simple monotonic relationship between the number of banks in the market and equilibrium risk-seeking in this model breaks down if deposit insurance is fairly priced and the deposit insurer always breaks even. In the Appendix, we show that in this case there may be one equilibrium, several or no equilibria, depending on the number of banks.

B. The Model with a Loan Market

In the above setup, banks allocate their assets by solving a portfolio problem which trades off risk of failure and expected returns. For many purposes, this stylization is perfectly acceptable. But it ignores the existence of a loan market. For present purposes it means that changes in bank market structure (N) can only affect asset allocations <u>indirectly</u>; e.g., through their effect on deposit costs. This is unrealistic and important for, in effect, it amounts to permitting the number of competitors in the deposit market to change, while holding the number of competitors in the loan market fixed.[17] As we show next, it is relatively easy to allow for the same N banks competing for both deposits and loans so that, as N changes, both markets are symmetrically affected.

Entrepreneurs

Consider many entrepreneurs, who have access to projects of fixed size, normalized to 1, with the two-point random return structure previously described. They borrow from banks, who cannot observe their risk shifting choice S, but take into account the best response of entrepreneurs to their choice of the loan rate. Given a loan rate r_L, entrepreneurs choose $S \in \left[0, \bar{S}\right]$ to maximize:

$$p(S)(S - r_L).$$

By the strict concavity of the objective function, an interior solution to the above problem is characterized by

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deposit levels are both increasing functions of the number of banks. For the fixed size economy, $S = \frac{1}{A} - \frac{1/A - B_0 - \alpha}{N+2}$, and $D = \frac{1/A - B_0 - \alpha}{B_1} \frac{1}{N+2}$. The equilibrium risk shifting parameter S in the fixed-size economy is identical to that of the replication economy. However, in the fixed size economy D is decreasing in N, and goes to 0 as N goes to infinity.

[17]The Hellmann et. al. study has the same structure and is susceptible to the same criticism.

$$S+\frac{p(S)}{p'(S)}=r_L. \tag{5}$$

Let L denote the total amount of loans. The inverse demand for loans satisfies:

Assumption 3. $r_L(0)>0, r_L'<0, r_L''\le 0$ and $r_L(0)>r_D(0)$,

with the last condition ensuring the existence of equilibrium. Consistent with our treatment of deposit market competition, we assume that the rate of interest on loans is a function of loans per bank: $r_L=r_L(L/N)$.

Banks have no equity in this model, so that the balance sheet identity requires that $L=\sum_{i=1}^{N}D_i$. In a Nash equilibrium, each bank chooses deposits to maximize profits, given similar choices of the other banks, and taking into account the entrepreneurs' choice of S. Thus, bank i chooses D_i to maximize:

$$p(S)\left(r_L\left(\sum_{i=1}^{N}D_i/N\right)D_i-r_D\left(\sum_{i=1}^{N}D_i/N\right)D_i-\alpha D_i\right),$$

subject to

$$S+\frac{p(S)}{p'(S)}=r_L\left(\sum_{i=1}^{N}D_i/N\right), \tag{A}$$

where (A) reflects the equality of total loans with total deposits, and the fact that borrowers will choose an optimal (for them) value of S. Let $S\left(\sum_{i=1}^{N}D_i/N\right)$ denote the function implicitly defined by (A).

Bank i chooses D_i to maximize:

$$\Pi(D_i,D_{-i})\equiv p\left(S\left(\sum_{i=1}^{N}D_i/N\right)\right)\left(r_L\left(\sum_{i=1}^{N}D_i/N\right)D_i-r_D\left(\sum_{i=1}^{N}D_i/N\right)D_i-\alpha D_i\right)$$

subject to

$$0\le S\left(\sum_{i=1}^{N}D_i/N\right)\le\overline{S}.$$

Given N, the necessary conditions for an interior equilibrium are:

$$\Pi_1(D_i,D_{-i})=0,$$

$$\Pi_{11}(D_i,D_{-i})\le 0.$$

The first-order and second-order necessary condition for a symmetric interior equilibrium are:

$$\left(r_L(D)-r_D(D)-\alpha\right)-F(D,N)=0. \tag{6}$$

$$\left(r_L'(D)-r_D'(D)\right)\frac{1}{N}-F_1(D,N)\leq 0 \tag{7}$$

where

$$F(D,N)\equiv D\frac{r_D'(D)-r_L'(D)}{N+\dfrac{p'(S(D))S(D)D}{p(S(D))}}.$$

The term $F(D,N)$ in (6) incorporates "monopoly rents," adjusted for the effect on the probability the bank is repaid due to a choice a *D*, represented by the term in the denominator.

Assume that equation (7) holds with strict inequality for all $N\geq 1$. Then, $r_L'(D)-r_D'(D)-F_1(D,N)<0$. Moreover, note that $F_2(D,N)<0$. Totally differentiating equation (6), we get

$$\left(r_L'(D)-r_D'(D)-F_1(D,N)\right)dD-F_2(D,N)dN=0.$$

Thus, for any finite *N*:

$$\frac{dD}{dN}=\frac{F_2(D,N)}{r_L'(D)-r_D'(D)-F_1(D,N)}>0$$

and, using the total differential of equation (A),

$$\frac{dS}{dN}=S'(D)\frac{dD}{dN}<0$$

Moreover, $F(D,N)\to 0$ as $N\to\infty$.

The foregoing statements are summarized in the following:

Proposition 2 In a symmetric interior equilibrium, the equilibrium level of risk shifting *S* is strictly decreasing in *N*. As $N\to\infty$, the Nash equilibrium converges to the competitive outcome, $r_L(L) - r_D(D) - \alpha = 0$.

Summary. The intuition behind Proposition 2 is straightforward. As banks obtain increased market power in the loan market, they use it to raise loan rates *ceteris paribus.* Entrepreneurs optimally respond (for reasons that are well-known), by increasing the risk of their investment projects. The banks are aware that this response will occur, and take it into account in their choice of a loan rate. Exactly this kind of interaction has been featured in most modern models of bank lending that feature moral hazard on the part of entrepreneurs. However, this important interaction is absent in all models that treat bank lending as a portfolio problem so that changes in N do not directly affect asset allocations.

III. Introducing Bankruptcy Costs

We next modify the basic model of Section II by introducing a fixed bankruptcy cost. As mentioned in the introduction, allowing for a bankruptcy cost is "realistic" and will introduce a new risk effect.

Given an input level y, the risky technology yields Sy with probability $p(S)$ and 0 otherwise. However, in the state in which the return to investment is zero, we assume banks incur a fixed bankruptcy cost $c>0$.[18] While other specifications are possible, the results presented below only depend on the presence of a fixed cost in the bankruptcy state.

We assume that deposit insurance is charged at a flat rate and, without loss of generality, set the insurance rate per unit of deposit equal to zero. Banks have no equity.

Banks compete for deposits in a Nash fashion in a market of fixed size, where the numbers of depositors is unchanged. Differing from the previous section, an increase in competition is represented by increasing the number of banks only. Thus, we assume that the rate of interest on deposits is a function of total deposits:[19] $r_D = r_D(\sum_i D_i)$.

In a Nash equilibrium, each bank i chooses $(S_i, D_i) \in \left[0, \bar{S}\right] x R_+$ that is the best response to the strategies of other banks. The pair (S_i, D_i) is chosen to maximize

$$p(S_i)\left(S_i D_i - r_D\left(\sum_{i=1}^{N} D_i\right) D_i\right) - c(1 - p(S_i)).$$

Necessary conditions for an interior equilibrium ($D_i > 0$ and $S \in (0, \bar{S})$) are,

[18]Our results would not be materially affected if we assumed, perhaps more realistically, that bankruptcy costs have both a fixed and a proportional to size component.

[19]In this version of the model, the fixed economy (market) size assumption is admittedly important. However, we believe it is quite reasonable to assume that, as the number of banks in a given market increases (decreases), the average size of each bank decreases (increases). That is all that is really necessary for our results.

$$p'(S_i)\left(S_i(D_i - r_D\left(\sum_{i=1}^{N} D_i\right))D_i + c\right) + p(S_i)D_i = 0, \qquad (8)$$

$$p(S_i)\left(S_i - r_D\left(\sum_{i=1}^{N} D_i\right) - r_D'\left(\sum_{i=1}^{N} D_i\right)D_i\right) = 0. \quad (9)$$

In a symmetric interior equilibrium $(S_i, D_i) = (S, D)$ for all i and $p(S) > 0$. Hence, the above conditions reduce to:

$$p'(S)(S - r_D(ND)) + \frac{c}{D} + p(S) = 0, \qquad (9)$$

$$S - r_D(ND) - r_D'(ND)D = 0. \qquad (10)$$

As can be seen from a comparison between (9) and (3), the key difference between the set-up of the previous section and the current one is that here marginal costs and benefits of risk shifting depend on bank's size, whereas in the Section II they did not. This is due to the fact that, with a fixed bankruptcy cost, as a bank becomes smaller (a lower D), bankruptcy costs per unit invested increase.

More (Nash) competition in a market of fixed size implies that banks face higher deposit costs and at the same time become smaller and smaller relative to the market. On the one hand, higher deposit costs prompt banks to take on more risk owing to the standard risk-shifting argument. On the other hand, per unit invested bankruptcy costs become higher and higher as deposits per bank shrink, prompting banks to take on less risk. It is apparent that the this effect may dominate the standard risk shifting effect as competition increases, since banks become smaller and bankruptcy costs per unit invested become larger.

Consider an economy with a linear deposit demand schedule, $r_D(X) = B_0 + B_1 X$, and a probability of success linear in the risk shifting variable, $p(S) = 1 - AS$. After substituting (10) in (9) and rearranging, equations (9) and (10) become:

$$-AB_1(N+2)D^2 + (1 - AB_0)D - cA = 0, \qquad (11)$$

$$S - B_0 - B_1(N+1)D = 0. \qquad (12)$$

Table 1 denotes the unique (symmetric) equilibrium value of risk shifting S as a function of the number of banks N for a given set of parameters[20]. The maximum number of banks

[20] The smaller root of equation (11) does not yield an equilibrium, since expected profits are negative for all N.

consistent with non negative expected profits is 59. Clearly, S first increases from N=1 to N= 15, and then decreases afterwards. The simple monotonic relationship between risk and competition no longer holds. Notice that in this example (and all the others we have constructed), the probability of success in an equilibrium with the maximum number of banks achieving non negative profits is always greater than that with one monopolist bank.

Table 1. Numerical Example with Bankruptcy Costs
($B_0 = 0$, $B_1 = 0.1$, $A = 2$, and $c = 0.01$)

N	S	D	$p(S)$	Expected Profit
1	0.32928	1.64642	0.34143	0.08597
5	0.41622	0.69369	0.16757	0.03199
10	0.43516	0.39560	0.12968	0.01159
15	0.43605	0.27253	0.12789	0.00553
20	0.43073	0.20511	0.13853	0.00304
30	0.41137	0.13270	0.17726	0.00114
40	0.38382	0.09361	0.23237	4.69084e-04
59	0.28400	0.04733	0.43201	3.04662e-05

Summarizing:

Proposition 3. In the presence of fixed bankruptcy costs, there exists economies in which the equilibrium level of risk shifting S increases for all $N \leq N'$, and decreases for all $N > N'$.

To sum up, the key reason behind the reversal of the risk-shifting effect is the dependence of the risk-shifting choices on the size of a bank relative to the market. Such dependence arises from fixed bankruptcy costs. As competition increases, banks' bankruptcy costs are increasing at the margin, inducing banks to take on less risk, *ceteris paribus.* The benefits of risk shifting may be offset by bankruptcy costs as competition increases. Of course, these interactions are undetected in any model where bank risk choices are independent of size and there are no bankruptcy costs.

An obvious question at this point is "What happens if bankruptcy costs are introduced into the Section II. model with entrepreneurs and a loan market?" The answer is that the model, and its implications, unavoidably becomes much more complicated. That's because bankruptcy costs need to be introduced for both banks and entrepreneurs, and the effects of the two are quite different. As discussed in the next section, this is on our agenda for future research. The goal here has been merely to challenge the conventional wisdom with the simplest and most defensible assumptions possible.

IV. Summary and Conclusions

The existing theoretical literature concludes that when banks are confronted with increasing competition, moral hazard is exacerbated and they intentionally take on more risk. We have reviewed this literature and shown that a positive relationship between the number of bank competitors and risk-taking is fragile. **First**, it makes an enormous difference when one allows for the existence of loan markets and requires that there be the same number of banks competing for both deposits and for loans. In this version of the model, we assumed that borrowers determine project risk, conditional on the loan rate set by banks. In effect, we took the bank portfolio problem and transformed it into a contracting problem with moral hazard. With that modeling structure, banks use increasing market power, ceteris paribus, to raise loan rates and, when confronted with increased funding costs, borrowers optimally choose higher-risk projects. **Second**, when one allows for bankruptcy costs of banks, a new disincentive to risk taking is introduced. Importantly, this disincentive grows in relative importance as bank markets become more competitive and in equilibrium the representative bank becomes smaller.

In our models, banks strategic interaction has been modeled à la Cournot for the sake of transparency and simplicity. Other forms of bank strategic interaction, such as price competition in the context of locational models, have been used in the banking literature. It might be useful to see how our results are affected by other forms of market interaction.

It seems clear that a continuous asset return distribution is more general than the degenerate asset return distribution employed here. Moreover, it makes a difference when the researcher allows for bankruptcy costs in some bad states of the world. Thus, this is an obvious extension of our work. In addition, future modeling efforts should include elements of both what we have called a "portfolio model" and a "contracting model." In reality, banks hold large portfolios of debt and equity securities traded in markets in which they are price takers. At the same time, banks hold many different kinds of loans (with different potential for moral hazard problems). Both kinds of activities need to be included in the same model, and this is something we have not done.[21] In addition, it would be a good idea to allow for the issuance of bank equity claims. We have not considered this modeling extension here, but it is potentially important for two reasons. First, equity claims are not insured and thus (unlike insured deposits) their expected returns depend on default probabilities. Second, equity claims are traded in "the equity market" and to a first approximation the number of competitors in this market is independent of the number of banks.

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[21]The model could also include a more complicated contracting environment between banks and borrowers (or between banks and the FDIC); for example, by including technologies for costly monitoring. (See, for example, Covitz and Heitfield, 1999). It seems to us that these kinds of complications are likely to be of second-order importance in the context of optimal contracting, for they will not change the nature of risk-seeking incentives, either for banks or for bank borrowers.

Our research plans include studying these extensions in a general equilibrium environment. Until that work is done (by us or others), there we are unawere any compelling theoretical arguments that banking stability decreases (or increases) with the degree of competition in bank markets.

The Section II Model with Fairly Priced Deposit Insurance

We examine the case in which the deposit insurance premium α is variable and is set in an actuarially fair manner such that the deposit insurer just breaks even. This is achieved by requiring that the liability of a deposit insurance agency, given by:

$$L(N) \equiv ND\big((1-p(S))r_D(D)-p(S)\alpha\big).$$

holds in equilibrium with $L(N)=0$.

Necessary conditions for a strictly positive symmetric equilibrium are:

$$S-r_D(D)-\alpha=-\frac{p(S)}{p'(S)}, \tag{A.1}$$

$$-\frac{p(S)}{p'(S)}=r_D'(D)D/N, \tag{A.2}$$

$$\alpha=\frac{1-p(S)}{p(S)}r_D(D). \tag{A.3}$$

Substituting (A.3) in (A.1), these conditions can be written as:

$$p(S)S+\frac{p(S)^2}{p'(S)}=r_D(D), \tag{A.4}$$

$$-\frac{p(S)}{p'(S)}N=r_D'(D)D. \tag{A.5}$$

Denote the inverse of r_D by f, and the inverse of $r_D'(D)D$ by F.

Let $h(S)=p(S)S+\frac{p(S)^2}{p'(S)}$ and $g(S)=-\frac{p(S)}{p'(S)}$. The above system can be written as:

$$D=f(h(S)), \tag{A.6}$$

$$D=F(g(S)N). \tag{A.7}$$

Let

$$G(S,N)\equiv f(h(S))-F(g(S)N).$$

Clearly, an interior symmetric solution to the system (10)-(11) is given by a value of $S\in(0,\overline{S})$ that satisfies $G(S,N)=0$.

Observe:

- $G(S,N)$ is strictly decreasing in N;

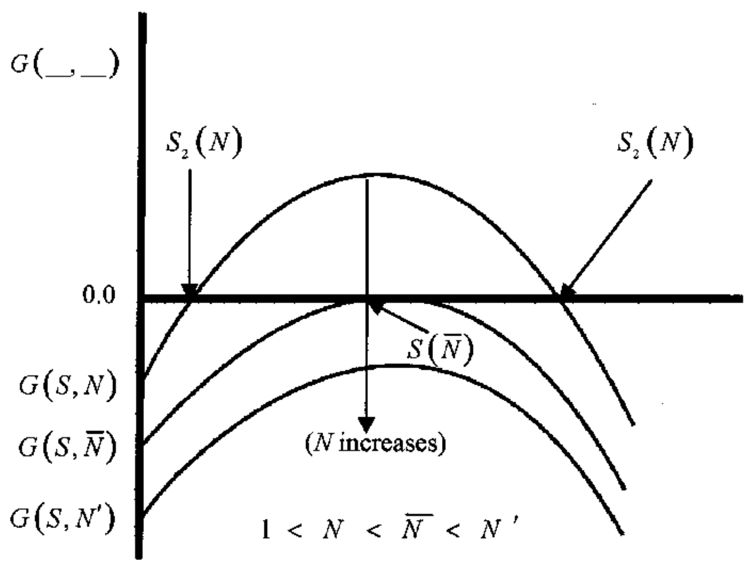
- $G(0,N) = f(h(0)) - F(g(0)N) = f(1/p'(0)) - F(-N/p'(0)) < 0$ for any N;
- $G(\bar{S},N) = f(h(\bar{S})) - F(g(\bar{S})N) = f(0) - F(0) \leq 0$ for any N;

and, in particular, $G(\bar{S},N) < 0$ if $r_D(0) > 0$.

If $r_D(0) > 0$, an equilibrium exists for a given N if there is some $S' \in (0,\bar{S})$ such that $G(S',N) = 0$. For N arbitrarily large, $G(S,N) < 0$ for any S, so for large N no equilibrium exists.

It is clear that if $r_D(0) > 0$ and for a given N the function G is positive for some S (and this is not easy to verify, see below), then it intersects the horizontal axis in at least two points, since it is negative at the boundaries *0* and $\bar{S}$. The larger is N, the lower is G for any S. Thus, as N increases, the zeroes of G move in opposite directions, the smaller increasing and the larger decreasing. Since G becomes negative for large N, there exists an $\bar{N}$ such that there is only one S such that $G(S,\bar{N}) = 0$. For $N > \bar{N}$ there is no equilibrium (Figure 1 shows these relationships.).

Figure 1. Equilibria with Fairly Priced Deposit Insurance[22]



[22]This graph shows the main properties of Proposition 1. In particular, $1 < N < \bar{N} < N'$. Thus, as $N > 1$ increases in the figure, the number of equilibria declines from two (or more) to one (at $\bar{N}$) and then to none (when $N > N'_{\square}$).

To summarize:

Proposition A1. Assume $r_D(0) > 0$. If there exists an $S \in [0, \overline{S}]$ such that $G(S,1) \geq 0$, then:

a) There exists an $\overline{N}$ such that $G(S^*, \overline{N}) = 0$, a unique equilibrium,
b) There exist at least two equilibria S_1 and S_2, with $S_1 < S_2$ for any N that satisfies $1 \leq N < \overline{N}$,
c) As $N \uparrow \overline{N}$, $S_1 \uparrow S^*$ and $S_2 \downarrow S^*$.

We should note Proposition A1 is only interesting when its initial "if" statement is satisfied—that is, when there exists at least one symmetric interior equilibrium. We have not been able to prove that this "if" statement can ever (never) be satisfied, or found a numerical example with $S^* < \overline{S}$. But that is not the point. Under the assumption $r_D(0) > 0$, if there do exist equilibria their existence will depend on N in a rather complicated way. As N increases, first, there will be multiple equilibria, then a unique one, and then (for sufficiently large N) no equilibria at all.

Alternatively, if $r_D(0) = 0$, then there exist economies in which a symmetric interior equilibrium does not exist for any finite N. To show this, let $p(S) = 1 - AS$, where $A > 0$ (thus, $\overline{S} = 1/A$), and $r_D(X) = B_0 + B_1 X$, with both coefficients strictly positive. Equations (A.4) and (A.5) become,

$$-2AS^2 + 3S - \frac{1}{A} = B_1 D$$

$$\frac{1}{A} - S = B_1 D/N$$

Combining equations by eliminating D, produces the following quadratic equation in S.

$$2AS^2 - (3+N)S + \frac{N+1}{A} = 0$$

and the solutions S_1 and S_2 are given by the quadratic formula:

$$S_1 = \frac{3+N}{4A} - \frac{\sqrt{(3+N)^2 - 8(1+N)}}{4A}$$

$$S_2 = \frac{3+N}{4A} + \frac{\sqrt{(3+N)^2 - 8(1+N)}}{4A}$$

Since a real solution for S_2 is always greater than $\overline{S} = 1/A$, it is of no interest. It can be easily verified that $S_1 = 1/A$ for any N.

To summarize:

Proposition A2. Assume $r_D(0) = 0$. There exist economies in which no symmetric interior Nash equilibrium exists.

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