Bank Competition and Credit Standards

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This article offers an explanation for the substantial variation of credit standards and price competition among banks over the business cycle. As the economic outlook improves, the average default probabilities of borrowers decline. This affects the profitability of screening and causes bank screening intensity to display an inverse U-shape as a function of economic prospects. Low screening activity in expansions creates intense price competition among lenders and loans are extended to lower-quality borrowers. As the economic outlook worsens, price competition diminishes, and credit standards tighten significantly. Deposit insurance may contribute to the countercyclical variation of credit standards.

Banks are often criticized for drastic variations in lending policies. During economic downturns, banks appear to be very restrictive in granting loans to businesses. When economic prospects are good, credit quality standards seem to soften substantially. Policymakers and regulators have tried to encourage bankers to maintain relatively constant standards over the business cycle. For example:

> Fed Chairman Alan Greenspan in recent years has publicly urged banks not to get lax in their lending standards. But more recently, the Fed has had the opposite concern. Minutes of the Dec. 19 meeting of the Fed's policy making body cited "stricter credit terms for many business borrowers" as a factor dragging down business spending (Banks Put Tighter Controls on Loans, *Wall Street Journal*, February 6, 2001).

As the economy picked up in 1994, regulators advised banks to tighten their lending practices:

> The trend, a reversal of tight lending policies that drew flak from regulators in recent years, has the same folks fretting again, for the opposite reason. Concerned about a repeat of the loan debacles of the 1980s, Federal Reserve Board chairman Alan Greenspan and Comptroller of the Currency Eugene Ludwig have chastised banks for

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a perceived weakening in credit standards and urged them to avoid drifting into loose lending policies [Perlmuth (1994)].

Why do bank credit policies fluctuate over the business cycle? This article provides a theoretical framework consistent with the informal observations as to lending practice changes. It attributes changes in bank lending standards to changes on the lenders' demand side. The main argument is that different phases of the business cycle are associated with different information collection and processing activities of banks and different degrees of credit market competition, which prompt higher credit standards during recessions and looser ones in boom times.[1]

In the normal course of business, banks compete on price for extending loans to borrowers whose qualities are unknown ex ante. They screen applicants in order to reduce uncertainty. Screening is costly. The costs include loan officers' time in contacting credit agencies, previous creditors, suppliers, and customers, as well as conducting a financial analysis of the borrower's servicing ability. Corporate loans are frequently reviewed also by external specialists. Lending behavior depends crucially on a bank's information production activities. The amount of effort a bank devotes to the evaluation of an applicant depends on the payoffs of the evaluation process. These payoffs depend in turn on the situation of the economy as well as the applicant's industry. Over the business cycle, the average quality of borrowers varies considerably. Average quality is low when economic prospects are gloomy, but high when they are bright.

Consider a severe recession. Then, the proportion of creditworthy firms is small. Under these circumstances, the most important function of bank screening is to select creditworthy applicants from a pool of below-average quality to whom credit offers can be made. To find it profitable to grant credit to an applicant in such an adverse situation, a bank needs not only a positive impression of the applicant, but its information must also be relatively precise. Because intensive screening yields a negative assessment with high probability, the marginal benefit from testing is low. Therefore banks' optimal intensity of screening is low as well, and banks on average have relatively imprecise information about each applicant. This implies that in severe recessions, banks base their decisions mostly on the general economic conditions rather than on individual borrower assessments and rarely make credit offers. As the economic outlook improves and the share of high-quality borrowers increases, the incentive to screen is augmented as well, because its marginal benefit is higher. This holds only as long as the share of good borrowers is below a certain level. As the borrower pool improves beyond this level, the main function of

[1] The connection of countercyclical variations in credit standards with changes in the intensity of credit market competition and banks' screening activities is an issue frequently discussed in professional banking journals and the business press [see, e.g., Gamble (1994) and Perlmuth (1994)].

screening is to weed out low-quality borrowers. A reduction in the fraction of bad risks causes the marginal benefit of screening to decrease, which leads to a lowering of screening activity.[2]

When banks face competition for extending loans, it is rational that a bank will not rely solely on its own assessment. A bank will also take the quality of competing banks' information into account. If a competitor's assessment is negative, the competitor drops out of the competition for granting the loan, which improves the chance that one of the remaining banks wins the contest. Winning the competition thus implies relatively unfavorable evaluations by the winner's competitors. Since these evaluations include valuable information about the quality of the borrower, the winning bank should revise its assessment downward. This "winner's curse" effect induces banks to behave more conservatively. The implication is that it is sometimes optimal for a bank to refrain from offering credit even when its own assessment indicates a creditworthy applicant. The extent of the winner's curse effect depends not only on the information quality of the bank and the information quality of the bank's competitors, but also on the average quality of borrowers. Thus its effect on information collection, lending, and pricing depends on the prospects of the economy and the applicant's industry.

Taking the effects of competition into consideration, the basic intuition about information production activities and lending policies of banks remains valid. When economic prospects are either very good or very bad, banks do not evaluate applicants thoroughly. They spend more resources on screening when the economic outlook is neither bright nor extremely gloomy. The percentage of good applicants who are denied credit decreases as economic prospects improve and the percentage of bad applicants granted credit increases. This finding holds both for an individual bank and in the aggregate. Compromising credit standards in good times means that the average default risk is highest for loans originated in times of relatively good economic prospects.

Even with a constant number of lending institutions, bank competition varies significantly over the business cycle. Very restrictive lending policies in recessions imply that only few banks are willing to lend to an applicant. This means that pricing competition among lenders is not very intense, which is reflected in relatively high markups. In very favorable economic environments, more banks offer credit to a borrower. Lenient lending policies imply a higher degree of competition between lenders, and interest rate margins are low. At the same time loans are

[2] Indeed, regulators associate times of lenient lending policies with low screening and monitoring activities of banks. In a survey uncovering low credit standards, the Federal Reserve documents that in only 20% to 30% of cases were banks producing formal projections of a borrower's future performance (Supervisory Letter of the Board of Governors of the Federal Reserve System SR 98-18 (SUP), June 23, 1998).

associated with high default risks. This lends some support to the notion that problems of bank insolvency may originate in boom times.[3]

Credit standards increase with a ceteris paribus increase of the lenders' cost per loan extended, since a smaller potential profit decreases the inclination to lend. Thus an increase in deposit rates due to aggressive lending can provide a partial balance to relaxing credit standards too far in expansion periods. The insurance of deposits eliminates a reaction of deposit rates to changes in lending behavior and thus fosters risk taking in boom periods even in the absence of moral hazard.

This article is related to several strands of literature. It enriches the literature on discriminatory common value auctions with endogenous information acquisition [see Lee (1984), Matthews (1984), and Hausch and Li (1993)] and on banking competition as a special form of such an auction [see Broecker (1990), Riordan (1993), Thakor (1996), Kanniainen and Stenbacka (1998), and Cao and Shi (2001)]. The first group of articles does not consider the specific characteristic of credit markets that even the highest bid may entail negative profits. Hence entry decisions play an important role in credit markets even when direct entry costs are negligible. In the first three of the second group of articles, this is taken into account, but signals are unrealistically assumed to be of an exogenous quality and costless.

Only Thakor (1996), Kanniainen and Stenbacka (1998), and Cao and Shi (2001) consider costly screening. In Thakor (1996) and Kanniainen and Stenbacka (1998), decisions of banks to offer credit are made public before the interest rates are fixed. This leads to competition à la Bertrand if more than one lender is willing to lend. This assumption is unrealistic, since banks have incentives to keep their decision secret. In this article, entry decisions are private information until credit conditions are specified. Cao and Shi (2001) independently develop a model in which banks can choose whether or not to screen an applicant. Once a bank opts to screen a borrower, however, the level of screening is exogenous. Unlike Cao and Shi (2001), this article allows banks a continuous choice of the level of information acquisition.

This article is also related to models on the variation of lending policies over time. Like this article, Bernanke and Gertler (1989, 1990) offer an explanation for cycles in lending standards, independent of any restrictions on lenders' supply side.[4] Bernanke and Gertler argue that worsening business conditions reduce firms' net worth, increasing agency costs that

[3] Federal Reserve Chairman Alan Greenspan remarked: "There is doubtless an unfortunate tendency among some, I hesitate to say most, bankers to lend aggressively at the peak of a cycle and that is when the vast majority of bad loans are made" (speech before the Independent Community Bankers of America, March 7, 2001).

[4] For models in which lenders' supply plays a role, see Bernanke and Blinder (1988), and in an internal capital market context, Bolton and Dewatripont (1995).

lenders face. Since loans are less attractive, fewer loans are made, and markups on any credit that is extended is higher to compensate for higher costs of distress. In contrast to Bernanke and Gertler, this article's arguments are based on imperfect screening of potential borrowers rather than on monitoring necessities of loans by banks. Also, Bernanke and Gertler do not consider changes in bank competition.

Rajan (1994) attributes the easing of credit to short-term interests of banks driven by relative performance evaluation by the stock market. Bank reputation could suffer if a bank fails to expand credit volume while others are doing so. This may lead to the financing of projects with negative net present values (NPVs) for banks. In the model presented here, banks maximize profits and never finance negative expected NPV projects. Banks' credit-granting policies depend on their information collecting activities and on the extent of the winner's curse effect. The winner's curse effect may cause banks to refrain from making a credit offer even when their own evaluation indicates a positive expected profit.

Berger and Udell (2003) propose that countercyclical credit standards may result from the gradual deterioration of the banks' ability to identify potential borrower problems. For example, as time passes after the last significant experience with loan problems, more and more experienced loan officers are replaced by inexperienced ones. This may lead to a relaxation of credit standards as loan officers become less able to discriminate between borrowers of low and high quality.

Acharya and Yorulmazer (2002) provide an alternative explanation why loans originated at the peak of the business cycle may cause a banking sector to experience problems. The authors argue that banks have an incentive to invest in positively correlated risks, since depositors honor doing so with lower deposit rates. This is the case because banks' investment in correlated risks makes depositors' learning about the quality of bank loan portfolios relatively efficient; each loan default allows depositors to draw conclusions about all banks' loan portfolios. Acharya and Yorulmazer show that banks' incentive to invest in correlated risk is strong toward the end of a boom when future expected bank profits are low.

The remainder of the article is organized as follows: In Section 1, the optimal decisions by banks with respect to screening intensity and loan specifications are derived. Section 2 provides a more detailed analysis of the lending policies of banks in different stages of the business cycle. Section 3 analyzes how the default risk of loans varies with economic prospects. The effects of changing economic conditions on bank profits are discussed in Section 4. Section 5 comments on the impact of deposit insurance on bank behavior. Section 6 discusses empirical implications of the model and existing evidence. Section 7 concludes.

1. A Simple Model of Lending

A simple static model attempts to map the screening and lending decisions of banks.

1.1 Setup

Consider two profit-maximizing lenders, $i = 1, 2$, and one borrower. The borrower belongs to one of two types. The types are labeled good, G, and bad, B. To a good borrower, an investment project is available that yields a monetary, publicly verifiable return of $X > 1$, and one unit of money is necessary for investing in the project. To a bad borrower, the only investment project available yields a monetary, publicly verifiable return of zero for an outlay of one unit of money. The prior probability of the borrower being a good type is $\lambda \in (0, 1)$. A borrower does not know its own type.[5]

Borrowers do not have cash on their own and have to borrow money to invest. In the loan contract, the borrower and one of the lenders agree to a sum to be paid by the borrower after the project is completed.

Ex ante, lenders are uncertain about the borrower's type as well. To identify the borrower's type, lenders can perform an imperfect test. With probability q_i, the test allows lender i to privately observe a signal, $s_i = B, G$, which perfectly reveals the true type of the borrower. With probability $1 - q_i$, the test yields an uninformative signal, $s_i = 0$. An uninformative signal does not reveal anything about the borrower's ability to repay the loan; that is, the initial belief of the lender remains unchanged. Conditional on the true type of the borrower, signals between lenders are independent. A cost $C(q_i)$ is associated with the test. The cost function is increasing, $C'(q_i) \geq 0$, and strictly convex, $C''(q_i) > 0$. It is assumed that the shape of the cost function leads to an interior solution.[6]

After each lender observes its signal, it decides whether to offer credit and, if so, which credit rate to demand not knowing the signal or the decision of the competing lender. Formally the strategy of lender i can be described as $(q_i, o_i^B, o_i^0, o_i^G)$, where $q_i \in [0, 1]$ represents the screening intensity and each $o_i^{s_i} \in \{na \cup \mathbb{R}_+\}$ the credit-offering decision based on signal $s_i \in \{B, 0, G\}$. Any credit-offering decision, $o_i^{s_i}$, is either a rejection of the applicant, represented by na, or an offer of one unit of credit with a specified nonnegative repayment. Denote the repayment amount of lender i by b_i.

The borrower minimizes its cost of funds. If only one lender offers credit, the borrower accepts this offer. In case of two credit offers, the

[5] This is not a critical assumption. One could assume that the borrower knows its type as long as good borrowers cannot signal their type and both borrower types apply for a loan. The latter could, for example, be ensured by assuming that even a low-quality borrower has a positive probability of succeeding or that a borrower obtains a nonverifiable control rent when investing irrespective of its type.

[6] One example is $C(q_i) = \xi q_i^2$ with a sufficiently large ξ.

borrower selects the one requiring the lower repayment. If both lenders are identical, the firm accepts each with probability 0.5. If credit is granted, the investment project is carried out and, after it is completed, the verifiable cash flows are used to repay the loan.

Lenders are assumed to be able to raise one unit of deposits for one period at a nonnegative interest rate. The required repayment for these deposits is denoted by $\delta \in [1, X)$.[7] The assumption of a constant deposit rate is relaxed in Section 5. Deposits have to be raised only if a credit is granted. If a lender's offer is accepted, its profit depends on the type of the borrower. If the borrower is of type B, the lender's profit is $-\delta - C(q_i)$, and if it is of type G, the profit is $\min\{b_i, X\} - \delta - C(q_i)$.[8] If a lender does not offer credit or its offer is declined, its profit is $-C(q_i)$.

In an equilibrium, both lenders maximize their expected profits given the correctly anticipated strategy of their competitor. The analysis focuses on symmetric equilibria. Please note that lender i's set of credit offer choices, $o_i^{s_i}$, can be determined independently of q_i for $q_i \in (0, 1)$. This is the case because the level of q_i does not affect the posterior belief for each signal, but only the probability that a specific posterior occurs. Thus, for a given signal, the marginal effect of a certain loan-offering decision on expected profits is not influenced by the choice of q_i. To keep the analysis tractable it is also assumed that o_i^B, o_i^0, and o_i^G are chosen independently of each other.

1.2 Analysis

1.2.1 Credit offers and loan pricing. Consider first lender i's decision problem after a signal is obtained. When it decides on its credit offer and the repayment objective, its testing cost is sunk and thus does not affect the decision. A lender's expected profit excluding the cost for borrower evaluation is termed expected net revenue. Since it observes neither any action nor the signal of its competitor, the lender has to consider all possible strategies of its rival.

Note that all loan contracts that specify a repayment objective larger than or equal to X are equivalent, since the borrower will repay at most an amount of X. Thus we can, without loss of generality, focus on contractually specified repayments, b_i, $i = 1, 2$, for which $b_i \leq X$. Given that a lender incurs a loss when lending to a low-quality borrower irrespective of the interest rate specified, an important part of a lender's strategy is its decision when to reject an application and when to offer credit. In the

[7] For example, if depositors expect their deposits to be safe and there is competition among depositors, $\delta = 1$ is a reasonable value.

[8] By choosing this setup, the analysis abstracts from any risk-shifting incentive on the part of a lender caused by debt financing. The model's results do not rely on this assumption. As long as a bank incurs a fixed cost per defaulted loan, and therefore has a lower ex ante risk of lending as λ increases, the findings do not change materially.

following, the probability that bank i makes a credit offer when signal s_i is obtained is denoted by $\mu_i^{s_i}$. Lemma 1 is a first statement on lenders' decisions when to offer credit for any anticipated testing intensity of the rival.

Lemma 1.

(*a*) *For bank i, $i=1, 2$, a strategy that does not include $\mu_i^B=0$ and $\mu_i^G=1$ is weakly dominated.*
(*b*) *Given $0<q_i<1$, $i=1, 2$, $\mu_i^B=0$ and $\mu_i^G=1$ in equilibrium.*

Proof. See Appendix A.

If a lender gets to know that the applicant is of type B, it does not offer credit since it knows that the loan will not be repaid. This leads to negative net revenues for the lender, no matter which repayment it demands. If the evaluation reveals that the borrower is of type G, it receives a credit offer. When the lender offers credit and specifies a repayment of $b_i \geq \delta$, its expected net revenues will never be negative. Doing so is at least as profitable as not offering credit. Henceforth we restrict the analysis to situations in which $\mu_i^B=0$ and $\mu_i^G=1$.

It turns out that it is necessary to allow for mixed strategies in loan pricing:

Lemma 2. *For $0<q_i<1$, $i=1, 2$, an equilibrium will not be one in pure strategies with respect to loan pricing.*

Proof. The argument is similar to Broecker (1990, Proposition 2.1). Suppose both lenders choose pure strategies. Note first that when a lender offers credit and a repayment of $b_i=\delta$ on $s_i=0$, this yields a negative expected net revenue (since credit is offered on $s=G$ and denied on $s=B$), which will not occur in equilibrium. Hence it is excluded in the further analysis of this proof.

Suppose lender j follows a pure strategy in loan pricing. Without loss of generality this proof assumes $b_i^G \leq \max\{b_j^G, b_j^0\}$. In addition, suppose first that $\mu_j^0 \in (0,1]$ and $X \geq b_j^G > b_j^0 > \delta$. Then the expected net revenue of lender i who has obtained $s_i=G$, p_i^G is given by

$$p_i^G = \begin{cases} (b_i-\delta)[\frac{1}{2}q_j+(1-q_j)(1-\mu_j^0)] & b_j^0 < b_j^G = b_i^G \\ (b_i-\delta)[q_j+(1-q_j)(1-\mu_j^0)] & b_j^0 < b_i^G < b_j^G \\ (b_i-\delta)[q_j+(1-q_j)((1-\mu_j^0)+\frac{1}{2}\mu_j^0)] & b_j^0 = b_i^G < b_j^G \\ (b_i-\delta) & b_i^G < b_j^0 < b_j^G. \end{cases}$$

Within each region an increase in b_i increases net revenues. Once the next region is reached, there is a discrete reduction in net revenues. Thus there is no b_i that cannot be improved upon.

The same argument holds for the other possible pure strategies of lender j, $b_j^G \leq b_j^0$, and for $\mu_j^0 = 0$. Thus there cannot be an equilibrium in pure strategies with respect to loan pricing. ■

Let $F_i : b_i \mapsto [0, 1]$, $i = 1, 2$, denote lender i's cumulative distribution function of the repayments in case of a good signal ($s_i = G$) and $H_i : b_i \mapsto [0, 1]$, $i = 1, 2$ denote the cumulative distribution function on an inconclusive test result ($s_i = 0$). The supports of these functions are characterized by $[\underline{b}_i^F, \bar{b}_i^F]$ and $[\underline{b}_i^H, \bar{b}_i^H]$, respectively. Let $p_i^{s_i}$ denote the expected net revenues of lender i after having obtained signal s_i. p_i^G is given by

$$p_i^G = \int_{\underline{b}_i^F}^{\bar{b}_i^F} \left\{ (b_i - \delta) \left[q_j [1 - F_j(b_i)] + (1 - q_j) \left((1 - \mu_j^0) + \mu_j^0 [1 - H_j(b_i)] \right) \right] \right\} dF_i(b_i). \tag{1}$$

If $s_i = G$, lender i knows that the loan will be repaid. If its loan contract offer is accepted, the net revenue is $(b_i - \delta)$. The expression in the large square brackets characterizes the probability that the offer is accepted. This probability is determined by the competitor's evaluation intensity, q_j, its credit offer probability if an uninformative signal is obtained, μ_j^0, and the repayment distribution in the case of a good signal and of an uninformative one, F_j and H_j, respectively.

If lender i obtains an inconclusive test result, its expected net revenue is

$$\begin{aligned} p_i^0 = \mu_i^0 \int_{\underline{b}_i^H}^{\bar{b}_i^H} & \Big\{ -(1 - \lambda) q_j \delta + (b_i - \delta) \lambda q_j [1 - F_j(b_i)] \\ & + (\lambda b_i - \delta)(1 - q_j) \Big((1 - \mu_j^0) + \mu_j^0 [1 - H_j(b_i)] \Big) \Big\} dH_i(b_i). \end{aligned} \tag{2}$$

While in the case of a positive signal, credit is offered with certainty, this need not be the optimal action when $s_i = 0$. Thus μ_i^0 explicitly enters the expression. As before, the integral consists of the probability that the competitor obtains a certain signal multiplied by the expected net revenue in each case.

The first term in the integral of Equation (2), $-(1 - \lambda) q_j \delta$, represents the familiar winner's curse effect in common value auctions. A lender offering credit on an inconclusive test result faces the risk that its competitor knows that the applicant is not creditworthy. In this case it will always win the auction. The extent of the effect depends on the screening activity of the competitor, the prior belief λ, and the cost of deposits, δ. The higher q_j, the greater the probability that the rival has superior information, and the lower λ, the greater the probability that this information is negative and thus leads to a winner's curse. δ represents the loss incurred by the lender if a loan is extended to a low-quality borrower.

The net revenue to lender i when a negative signal is obtained is obviously $p_i^B = 0$, since it does not approve credit.

Now one can derive the equilibrium allocation for a given screening intensity. Let C^0 denote the space of continuous functions.

Proposition 1. *For a given $q_1 = q_2 = q \in (0, 1)$ and both $F(b)$ and $H(b) \in C^0([\delta, X])$ there exists a unique symmetric equilibrium with respect to loan pricing and when to make a loan offer. For*

$$\lambda \leq \frac{\delta}{q\delta + X(1-q)}, \tag{3}$$

credit is offered only on a positive signal (i.e., $\mu^0 = 0$). The repayment in case of $s = G$ is determined according to the cumulative distribution function

$$F^{\mu^0=0}(b) = \begin{cases} 0 & b < X - q(X-\delta) \\ \frac{1}{q}\left(1-(1-q)(X-\delta)\frac{1}{b-\delta}\right) & b \in [X - q(X-\delta), X] \\ 1 & b > X. \end{cases} \tag{4}$$

For

$$\lambda > \frac{\delta}{q\delta + X(1-q)},$$

credit is offered on an uninformative signal with probability

$$\mu^0 = 1 - \frac{(1-\lambda)\delta}{\lambda X - \delta}\frac{q}{1-q} > 0. \tag{5}$$

The repayments in case of a positive and an uninformative signal are determined according to the cumulative distribution functions

$$F^{\mu^0>0}(b) = \begin{cases} 0 & b < \frac{\delta}{\lambda} \\ \frac{1}{q}\left(1 - \frac{1-\lambda}{\lambda}\frac{\delta}{b-\delta}\right) & b \in \left[\frac{\delta}{\lambda}, \left(1 + \frac{1-\lambda}{\lambda}\frac{1}{1-q}\right)\delta\right] \\ 1 & b > \left(1 + \frac{1-\lambda}{\lambda}\frac{1}{1-q}\right)\delta \end{cases} \tag{6}$$

$$H^{\mu^0>0}(b) = \begin{cases} 0 & b < \left(1 + \frac{1-\lambda}{\lambda}\frac{1}{1-q}\right)\delta \\ \frac{1}{\mu^0}\left(1 - \frac{(1-\lambda)\delta}{\lambda b - \delta}\frac{q}{1-q}\right) & b \in \left[\left(1 + \frac{1-\lambda}{\lambda}\frac{1}{1-q}\right)\delta, X\right] \\ 1 & b > X. \end{cases} \tag{7}$$

Proof. See Appendix B.

If λ is relatively low, lenders do not offer credit on $s = 0$. Then price competition for the loan occurs only if both lenders obtain positive evaluation results. A lender who obtains a positive signal does not know whether its rival's result is positive or inconclusive. The positive probability that the competitor offers credit as well makes it suboptimal to demand the monopoly repayment of X. Yet because of the positive probability that the competitor does not offer credit, a lender has some market power. Thus it demands a repayment that is considerably higher than the repayment objective that would result from competition à la Bertrand, $b = \delta$.

Figures 1 and 2 illustrate a lender's bidding decision for a given screening intensity, q. Figure 1 depicts the density of repayments demanded when a positive signal is obtained, $f(b)$, in an example representing the $\mu^0 = 0$ regime. As long as $f(b)$ is positive, it is a decreasing and convex function in b. The support of the random variable specifying the repayment objective has the maximum repayment, X, as its upper bound. Its lower bound is $X - q(X - \delta)$, which is strictly larger than δ. Given a positive evaluation result, the expected net revenue for a lender when a credit offer is made is $(1 - q)(X - \delta) > 0$.

If λ is relatively high, μ^0 is positive. Then, with the same number of banks, the competition for extending the loan is more intense since each lender's competitor also offers credit on less accurate information. A lender that has obtained a good signal knows about the applicant's ability to repay the loan. Thus it is eager to win the contest, which makes it optimal to bid relatively aggressively. If a lender's evaluation yields an inconclusive result, it bids more conservatively since it still faces default

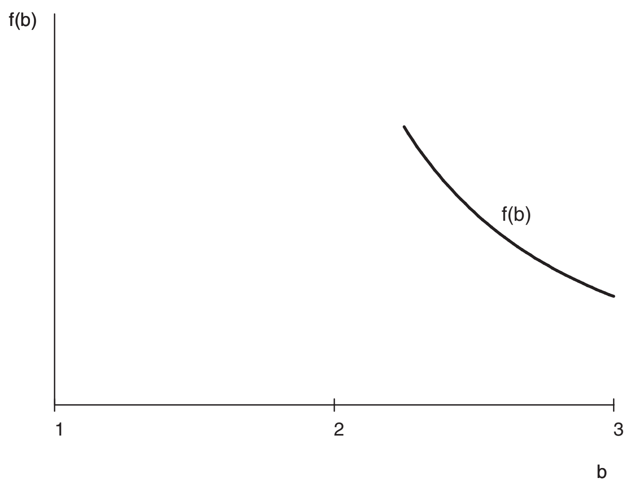

Figure 1
Density of repayments for a positive signal, $f(b)$, in case of $\lambda \leq \lambda^*$. $X = 3$, $\delta = 1$, $\lambda = 0.3$, and $q = 0.375$.

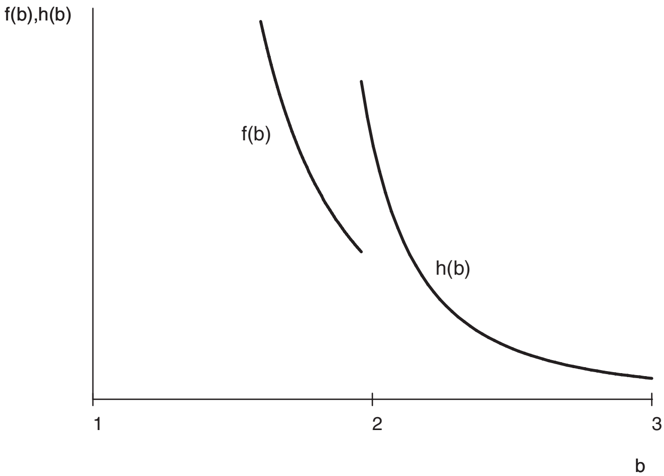

Figure 2
Densities of repayments for a positive signal, $f(b)$, and an inconclusive signal, $h(b)$, in case of $\lambda > \lambda^*$. $X = 3$, $\delta = 1$, $\lambda = 0.625$, and $q = 0.375$.

risk. Conservatism increases as the lender takes the potential superiority of the opponent's information into account. If the rival's signal is negative, the lender is the only one offering credit, which results in a loss. These negative payoffs have to be compensated by gains when the lender wins the contest for a creditworthy applicant.

As Figure 2 shows, the difference in bidding aggressiveness takes a special form. The repayment demanded on a positive signal (characterized by the density $f(b)$) is never greater than the one demanded on an inconclusive signal (characterized by the density $h(b)$). The supports of the density functions of the random variables do not overlap except at one point, $b = (1 + \frac{1-\lambda}{\lambda}\frac{1}{1-q})\delta$. Over the range of the support, both density functions are decreasing and convex. If a lender obtains a positive signal, it does not find it attractive to increase the repayment objective beyond $(1 + \frac{1-\lambda}{\lambda}\frac{1}{1-q})\delta$, because the reduced probability of winning the contest outweighs the increased profits in case of winning the contest. Given a positive evaluation result, the expected net revenue for a lender when a credit offer is made is $\frac{1-\lambda}{\lambda}\delta > 0$. When a lender offers credit on an inconclusive result, its expected net revenue is zero, since it does not have an information advantage over its competitor.

The decision whether to offer credit on an inconclusive signal depends crucially on the winner's curse effect. If there was no competitor, a lender could realize nonnegative expected profits by making a credit offer when $\lambda \geq \frac{\delta}{X}$. When a competitor is present, the breakeven point is strictly higher, $\lambda \geq \frac{\delta}{q\delta + (1-q)X}$. This means that under some circumstances the winner's curse effect makes banks refrain from offering credit even if their own credit evaluations indicate a positive expected profit from doing so. Even if lenders are willing to offer credit on inconclusive test results, they never do so with probability one.

1.2.2 Screening. Each lender chooses a screening level in order to maximize expected profits. Given λ, lender i's probabilities of obtaining a positive and an inconclusive signal are λq_i and $1-q_i$, respectively. Making use of Lemma 1, the expected profit of lender i, P_i, can be written as

$$P_i = \lambda q_i p_i^G + (1-q_i)p_i^0 - C(q_i) \tag{8}$$

As a result, one obtains

Proposition 2. *The game has a unique symmetric equilibrium that satisfies* $F(b)$ *and* $H(b) \in C^0([\delta, X])$.

If $\lambda \leq \lambda^*$, *the test intensity,* $q^{\mu^0}=0$, *of each lender in the symmetric equilibrium is uniquely defined by*

$$\lambda(1-q^{\mu^0=0})(X-\delta) = C'(q^{\mu^0=0}). \tag{9}$$

If $\lambda > \lambda^*$, *the test intensity,* $q^{\mu^0} > 0$, *of each lender in the symmetric equilibrium is uniquely defined by*

$$(1-\lambda)\delta = C'(q^{\mu^{0>0}}). \tag{10}$$

$\lambda^* \in (0,\ 1)$ *is uniquely defined by the equation* $\lambda(q(\lambda)\delta + X(1-q(\lambda))) - \delta = 0$, *where* $q(\lambda)$ *is uniquely defined by* $(1-\lambda)\delta - C'(q) = 0$.

Proof. See Appendix C.

Remark. *Screening intensities are strategic substitutes if* $\lambda \leq \lambda^*$ *and strategically neutral otherwise.*

A corollary can be obtained by partial differentiation:

Corollary 1. *If* $\lambda < \lambda^*$, *the equilibrium screening intensity strictly increases with* λ. *If* $\lambda > \lambda^*$, *the equilibrium screening intensity strictly decreases with* λ.

Figure 3 depicts the equilibrium screening intensities, q, for varying prior beliefs, λ. For a small ex ante probability of facing a creditworthy borrower (small λ), the screening activity is determined by the increasing function of Equation (9). If loans are granted on good signals, the sole purpose of screening is to detect creditworthy borrowers. When the probability of facing a good borrower is low, the probability of a successful test — which corresponds to the marginal revenue of screening — is low as

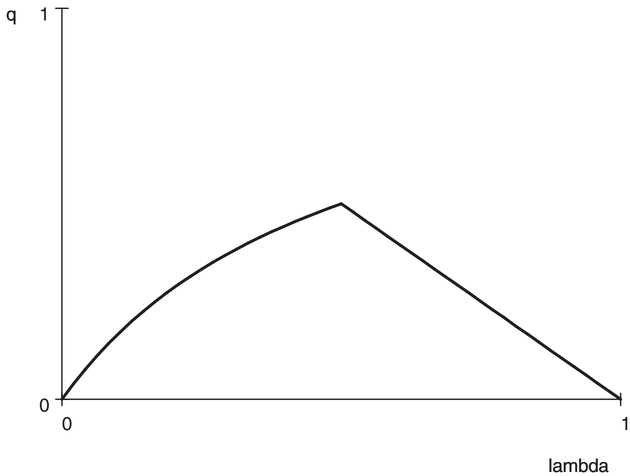

Figure 3
Bank screening intensities, q, for varying λ. $X=3$, $C(q)=\frac{1}{2}q^2$, and $\delta=1$.

well. Hence lenders are willing to commit only limited resources for testing creditworthiness. As λ increases, marginal revenue of screening, and thus screening intensity, increase as well. This occurs only up to a certain level of λ, λ^*. For $\lambda > \lambda^*$, screening activity is determined by the decreasing function of Equation (10). In this regime, credit is offered also on an inconclusive test result. Then, although a lender still attempts to detect good borrowers, the purpose of screening is also to sort out bad applicants. As λ increases, the marginal revenue of screening activity drops, which in turn diminishes screening intensity.

2. Credit Standards

Credit standards of banks vary as λ varies. In the following, differences in λ are interpreted as differences in economic prospects. This captures the notion that in expansion periods, existing projects become more profitable and new investment opportunities open up. Thus overall future firm profits increase as economic prospects improve. These developments in expansions allow some companies that had not been creditworthy before to become creditworthy.[9]

To analyze bank lending conduct, it is necessary to characterize lending restrictiveness independently of the composition of the borrower pool. We

[9] Formally, an increase in λ implies that the distribution of firms improves in the sense of first-order stochastic dominance. An alternative way to model this type of improvement of the distribution is to assume an increase in the level of profits, X, in expansions. This does not qualitatively change the results derived in this section.

describe credit standards in terms of the probabilities of errors banks make when they face a given type of applicant. A high probability that a good applicant is not offered credit indicates that a lending policy is restrictive. A high probability that a bad applicant is offered credit suggests that a lending policy is lenient.

The probabilities that a good applicant is not offered credit and that a bad one is offered credit are denoted by GN and BY, respectively. They are given by

$$GN = (1-q)^2(1-\mu^0)^2 \tag{11}$$

$$BY = 2(1-q)\mu^0 - (1-q)^2(\mu^0)^2. \tag{12}$$

Banks' lending policies depend on the economic outlook in a systematic way.

Proposition 3. *GN is strictly decreasing with λ. BY is nondecreasing with λ. More specifically, BY equals zero when $\mu^0 = 0$ and strictly increases with λ when $\mu^0 > 0$.*

Proof. Taking the partial derivatives of GN and BY with respect to λ within the particular regime yields the result. ■

This result implies that lending policies are unambiguously more restrictive in economic downturns than in upturns. To characterize the degree of leniency of bank lending policies, consider any differentiable function $L(GN, BY)$ that satisfies $\frac{\partial L}{\partial GN} < 0$ and $\frac{\partial L}{\partial BY} > 0$. Proposition 3 ensures that $L(GN, BY)$ strictly increases in λ. Thus the model offers an explanation of the observed countercyclical variations in lending standards by banks.

Figure 4 illustrates the result. The thick line shows an example for $L(GN, BY)$, $L(GN, BY) = BY - GN$, as a function of the prior belief, λ. It is a strictly upward-sloping function.

The restrictiveness of lending policies depends crucially on the incentives for evaluating applicants' creditworthiness. Proposition 4 identifies the specific role that screening intensities play for credit standards. Therein GN_q and BY_q denote the size of type I and type II errors for a given value of q, respectively. As in Section 1, the equilibrium value of q in the different regimes is denoted by $q^{\mu^0=0}$ and $q^{\mu^0>0}$.

Proposition 4. *Assume a parameter constellation such that $\mu^0 = 0$. Then for all $q > q^{\mu^0=0}$, $GN_q < GN_{q^{\mu^0=0}}$, and $BY_q = BY_{q^{\mu^0=0}}$.*

Assume a parameter constellation such that $\mu^0 > 0$. Then for all $q > q^{\mu^0>0}$ that lead to $\mu^0 > 0$, $GN_q > GN_{q^{\mu^0>0}}$ and $BY_q < BY_{q^{\mu^0>0}}$.

Proof. Taking the partial derivatives of GN and BY with respect to q within the particular regime yields the result.

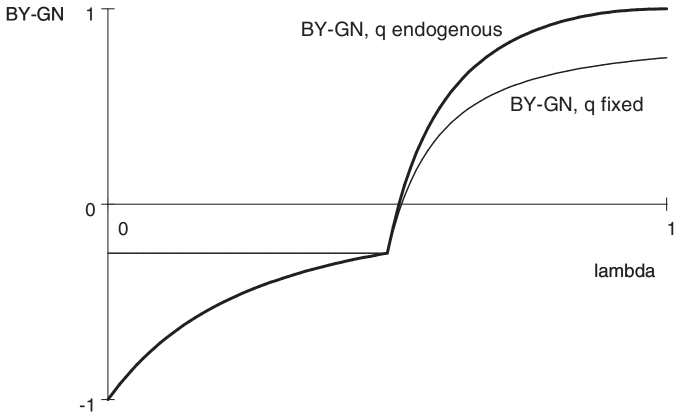

Figure 4
Bank error probabilities for varying λ. $L(GN,\ BY) = BY - GN$. The thick line shows $L(GN,\ BY) = BY - GN$ for endogenously determined screening intensity. The thin line displays $L(GN,\ BY)$ when the screening intensity is fixed at the level that prevails at λ^*. $X = 3$, $C(q) = \frac{1}{2}q^2$, and $\delta = 1$.

The result demonstrates that the effect an increase in q has on credit standards depends on economic conditions. Bank lending policy is less restrictive, the more resources are devoted to screening as long as $\lambda < \lambda^*$. When $\lambda > \lambda^*$, however, lending policy is more restrictive the higher the screening activity. This result in conjunction with Proposition 2 ($q^{\mu^0=0}$ increasing in λ and $q^{\mu^0>0}$ decreasing in λ) implies that the modification in lenders' screening decisions with a change in the economic outlook amplifies the reactions of their lending policies. Since lenders' decisions on how thoroughly to evaluate loan applicants depend on borrowers' ex ante perceived default risk, lenders display more extreme changes in lending standards as a borrower's default risk changes.

The thin line in Figure 4 depicts the function if the screening activity is fixed at the level that is chosen at λ^*. Lending policy becomes less restrictive as λ increases since the winner's curse effect is less severe if λ is high. When the screening decision is endogenous, the variation of credit standards is more extreme. Credit standards are very high in times of grim prospects for the economy or for the applicant's industry (high GN and low BY) and are relaxed as λ increases (low GN and high BY).

The low levels of q when λ is high or low produce opposite lending policies. A low q leads to soft credit standards when λ is high, because the winner's curse effect is weakened substantially (the impact of a change in q on the winner's curse effect is proportional to the size of λ). This leads to a high μ^0, which implies that a large proportion of bad applicants obtain credit. When λ is low, credit is offered only in response to a positive test result. In this case a low q means that a substantial fraction of good borrowers are denied credit.

In general, the prior belief depends not only on changes in the stage of the business cycle. It is also related to general industry characteristics (such as the degree of competition) as well as on idiosyncratic factors. That is, lender behavior can vary for companies operating in different industries or even in the same output market if there are differences in individual credit ratings. Thus the analysis needs not only be interpreted in a time-series dimension, all the results derived can also be interpreted cross-sectionally. Interpreted in a cross-sectional way, the model claims that, all things being equal, lending standards differ for firms of different ex ante qualities in a systematic way. Firms ex ante viewed as high quality face a lower standard than firms that are not. The variation in credit standards is amplified by the endogenous borrower evaluation decisions banks make.

3. Default Risk of Loans

Lending standards have a significant impact on the expected default risk of loans. Weakening credit standards as economic prospects improve point toward an increased default risk when economic prospects are good. On the other hand, the average quality of applicants improves as well, which indicates a reduced default risk.

Proposition 5. *If $\lambda \leq \lambda^*$, the probability of a credit default is zero.*

If $\lambda > \lambda^*$, the probability of a credit default is strictly positive and given by $(1-\lambda)[(1-q)\mu^0 - \frac{1}{2}(1-q)^2(\mu^0)^2]$ per application and $\frac{(1-\lambda)[2(1-q)\mu^0-(1-q)^2(\mu^0)^2]}{\lambda[1-(1-q)^2(1-\mu^0)^2]+(1-\lambda)[2(1-q)\mu^0-(1-q)^2(\mu^0)^2]}$ per credit granted.

This result implies that the default risk of each loan is highest when $\lambda > \lambda^*$. When λ is lower, banks are conservative and lend only to high-quality applicants. Since banks' lending standards relax as economic prospects improve, the quality of loan portfolios deteriorates over a certain range. Only when the pool of applicants reaches a sufficiently high quality does default risk decline. Figure 5 depicts both the default probability per applicant and per credit granted. Up to $\lambda = \lambda^*$, both default probabilities are identical and equal to zero. For values of λ above λ^*, the default probabilities are positive and, naturally, the default probability per credit granted is larger than the one per applicant.

Thus the analysis lends some support to the notion that problems of bank insolvency may frequently originate in times of good economic situations. Of course, when loan defaults are not perfectly correlated, a portfolio of loans reduces the probability of a low cash flow through diversification. If there is a positive correlation of loan defaults, however,

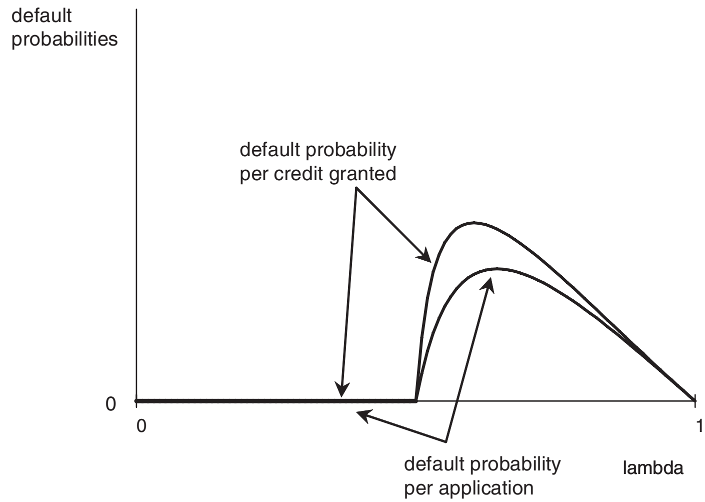

Figure 5
Probabilities of default per application and per credit granted for varying λ. The probabilities of default per application and per credit granted are identically zero for $\lambda \leq \lambda^*$. For $\lambda > \lambda^*$, the upper line depicts the default probability per credit granted and the lower line the default probability per application. $X = 3$, $C(q) = \frac{1}{2}q^2$, and $\delta = 1$.

the highest probability for a negative overall cash flow is strictly above the cutoff level λ^*.

4. Bank Profits

What do lending policies imply for bank profits originating at different points in the business cycle? When economic prospects improve, the proportion of creditworthy applicants increases, suggesting potentially higher profits originating in times of a good economic outlook. Since lenders' inclination to offer credit increases with λ, however, price competition between banks is intensified as λ goes up.

Using the equilibrium decisions of banks, the expected bank profits generated can be determined.

Proposition 6. *The expected profit of each bank in the two regimes is given by*

$$P(\lambda, X, C(q)) = \begin{cases} \lambda q^{\mu^0=0}(1 - q^{\mu^0=0})(X - \delta) - C(q^{\mu^0=0}) & \lambda \leq \lambda^* \\ (1 - \lambda) q^{\mu^0>0}\delta - C(q^{\mu^0>0}) & \lambda > \lambda^*. \end{cases} \tag{13}$$

For $\lambda < \lambda^*$, the expected profit strictly increases with λ. For $\lambda > \lambda^*$, the expected profit strictly declines with λ.

The expected net revenue per loan granted decreases strictly with λ.

Proof. See Appendix D.

Although a higher λ means a higher probability that the applicant is creditworthy, expected profits decrease with λ when $\mu^0 > 0$. The greater price competition among lenders reduces interest rate margins sufficiently to more than compensate for reduced ex ante default risk. The opposite is the case for λ below λ^*. Consequently, the expected profit increases with λ.

If credit is offered with a positive probability on an inconclusive signal, a bank's profit does not depend on a firm's profitability, X. Even in an imperfectly competitive lending market, any additional surplus created by a more profitable project is entirely competed away in a sufficiently positive environment ($\lambda > \lambda^*$).

5. Risky Deposits and the Effects of Deposit Insurance

So far, the deposit rate, δ, has been assumed a constant. This is a sensible assumption, if the deposit rate is unaffected by the volume and the riskiness of bank lending. This is, for example, the case when deposits are insured. In the following, a scenario is studied in which deposits are potentially risky. Then, credit standards affect the deposit rates banks face. In turn, the deposit rate feeds back to credit standards by influencing potential profits and thus competition. Comparing a situation with risky and safe deposits allows us to determine the effects of deposit insurance on the lending decisions of banks and the quality of loan portfolios.[10]

Assume now that risk-neutral depositors still obtain the promised amount of δ for one unit of deposits if the borrower repays its loan. In this case the lender can use the repayment to make all promised payments to its depositors. If the borrower defaults, however, the depositors expect a payment of $\theta \in [0, \delta]$ by the lender for one unit of deposits. If $\theta < \delta$, the depositors anticipate a positive probability for financial distress of the bank. In this case depositors may receive a lower amount than promised or incur a cost in order to obtain the full payment. The latter may consist, for example, of lawyer fees or of time spent in negotiations with management and other creditors. No deposits are raised if a lender does not grant credit to an applicant. In addition, a lender that needs a unit of deposits offers a repayment amount δ that renders depositors indifferent between depositing money and not doing so. If the risk-free rate is zero and when the default probability per credit granted is denoted by Δ, this implies $(1-\Delta)\delta + \Delta\theta = 1$ or $\delta = \frac{1-\Delta\theta}{1-\Delta}$. The loss of a lender in case of a credit default is assumed to be the same as in the basic model, δ.[11]

[10] I am grateful to an anonymous referee for pointing out this application of the model.

[11] Despite the fact that depositors bear some risk, the model continues to exclude any risk-shifting incentive induced by moral hazard (see footnote 8). Again, this assumption does not affect the results qualitatively.

The case when the deposits are fully insured corresponds to $\theta = 1$. Since there is no risk of losing money for depositors, the required interest rate on deposits is zero and $\delta = 1$ over the entire range of λ, irrespective of the loan default probability. Assume for now that the price of deposit insurance is zero. Then, lenders don't face an additional charge above the deposit rate of zero. If θ is smaller than one, δ is determined by the default probability per credit granted, Δ, as given in Proposition 5.

The following result compares a lending environment with risky deposits, $\theta \in [0, 1)$, to one with deposit insurance (or safe deposits), $\theta = 1$:

***Proposition* 7.** *Suppose the price of deposit insurance is zero and define* $\lambda^*(\delta = 1)$ *as the level of* λ^* *for* $\delta = 1$.

In equilibria with $\lambda \leq \lambda^*(\delta = 1)$, *screening and lending behavior is independent of whether there is deposit insurance or not.*

In equilibria with $\lambda > \lambda^*(\delta = 1)$, *screening intensities and credit standards are higher, loan default rates are lower, and expected profits of lenders are higher in the absence of deposit insurance than if deposits are insured.*

Proof. Note that lender behavior does not directly respond to a change in θ, but only indirectly via a corresponding change in the deposit rate.

λ^* increases in δ; $\frac{\partial \lambda^*}{\partial \delta} = \frac{(1 - \lambda q + \lambda (X - \delta)\frac{1-\lambda}{C''(q)})}{q\delta + X(1-q) + \lambda(X - \delta)\frac{\delta}{C''(q)}} > 0$. Thus there cannot be equilibria with positive default risk for $\lambda \leq \lambda^*(\delta = 1)$. This implies that, irrespective of θ, $\delta = 1$ as in the case of deposit insurance.

For $\lambda > \lambda^*(\delta = 1)$ there cannot be equilibria leading to zero probability of credit default, which implies $\delta > 1$. In this regime, the partial derivatives of q, GN, and of the expected profits with respect to δ are positive, and those of BY and Δ are negative. This proves the second part of the claim. ■

Deposit insurance has no effect on lending decisions as long as these are very conservative. Depositors are not concerned about losing their deposits even without deposit insurance and do not require a markup when deposit insurance is not present. Thus bank behavior is unaffected by the existence of deposit insurance.

When lenders are less conservative due to a good economic outlook, deposit insurance reduces deposit rates. In this economic environment, the consequences of a decreasing deposit rate are twofold: it increases potential profits ($X - \delta$ increases) and it intensifies competition among lenders. For a lender who receives positive information about an applicant, a reduced deposit rate increases competition in two ways. On the one hand, a competing informed lender will bid more aggressively due to its lower cost. On the other hand, an uninformed competitor is more inclined to lend because its potential profits increase and its loss in case of a default is reduced, which also mitigates the winner's curse effect. The analysis documents that a ceteris paribus reduction in the deposit rate reduces the profitability of informed lending. As a consequence, screening activity is reduced and profits decrease. The cheaper deposits and the competitor's lower screening activity increase the probability that an uninformed lender offers credit. This implies relaxed credit standards and an increase in the default probability of a loan.

Figure 6 illustrates the consequences of insured deposits on loan default. For values of λ below $\lambda^*(\delta = 1)$, the default risk is zero. In this case it is inconsequential whether deposits are potentially risky. Lending behavior in this situation ensures the repayment of any deposits. For λ above $\lambda^*(\delta = 1)$, the default probability with risky deposits is represented by the lower curve and the one with safe deposits by the upper curve. In this regime a deposit recovery rate smaller than one leads to a positive interest rate on deposits, since default probability is positive. A larger deposit rate reduces default rates. Allowing for endogenously determined deposit rates, however, does not alter the result that the maximum of average loan risk is for λ larger than $\lambda^*(\delta = 1)$.

The analysis above abstracts from an explicit charge for deposit insurance per unit of deposits. A charge for deposit insurance per unit of deposits actually affects the results, since it influences the costs of lending for banks. The general result is that lending standards increase as ceteris paribus the costs of granting a loan increase. Thus, as long as deposit insurance leads to reduced costs of granting a loan, it relaxes credit standards. This argument also implies that in the context of this model,

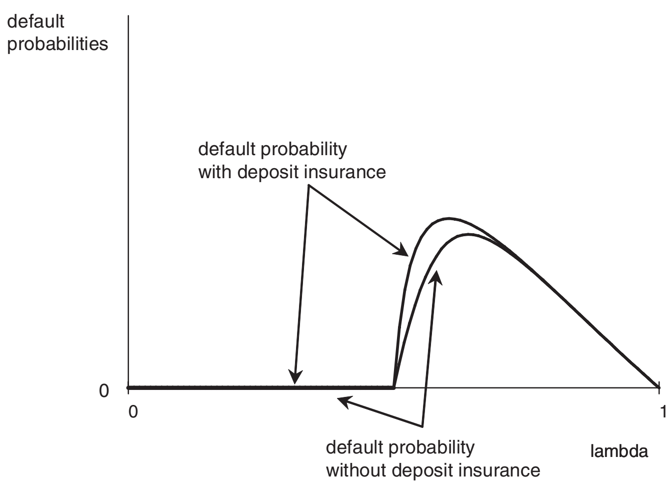

Figure 6
Probabilities of default per credit granted with and without deposit insurance for varying λ. The probabilities of default per credit granted with and without deposit insurance are identically zero for $\lambda \leq \lambda^*$. For $\lambda > \lambda^*$, the upper line depicts the default probability per credit granted with deposit insurance and the lower line without deposit insurance. $X = 3$, $C(q) = \frac{1}{2}q^2$, and $\theta = 0$.

deposit rate ceilings are not an adequate measure to increase the health of a financial system as they increase competition in times when credit standards are low already.

6. Empirical Implications and Existing Empirical Evidence

The model has a number of empirical implications. In the following, these implications and existing empirical evidence are discussed.

6.1 Resources spent on borrower evaluation

The model predicts a variation in borrower evaluation efforts over the business cycle. Evaluation efforts should be lower in extreme economic situations, positive or negative. For example, in the context of its "Loan Quality Assessment Project," the Federal Reserve documented that from the second half of 1995 to the second half of 1997 in 20% to 30% of cases formal projections of future borrower performance were made and analyses of alternative scenarios using "stress" or "downside" conditions were rare. The model suggests that such activity varies systematically over the business cycle.

The described variation in screening should not only be observed over the business cycle, but also in a cross-sectional dimension, that is, with respect to different industries. Depending on the relative development of different industries, there should be a shift in the evaluation efforts for different industries. Evaluation efforts should move away from industries that are either in crisis or have excellent prospects toward industries with less extreme outlooks.

6.2 Credit standards and the quality of new loans and of loan portfolios

The model has implications for credit standards over the business cycle and across industries and firms. If the economy goes through a recession, not all industries are affected by it in the same way. Even within an industry there should be differences in the way a recession affects the creditworthiness of borrowers. Given this, the fraction of bank lending to relatively safe borrowers should increase during recessions. Consistent with these implications, a number of empirical articles document a "flight to quality" by banks in recessions. For example, Gertler and Gilchrist (1993) find that in recessions, bank loans to small manufacturing firms decrease relative to large firms. Lang and Nakamura (1995) document that the proportion of relatively high quality new loans (approximated by loans below an interest rate cutoff level) moves countercyclically.[12]

Since the model attributes the countercyclical variation of credit standards to individual behavior of banks in their competitive environment, it is

[12] See Bernanke, Gertler, and Gilchrist (1996) for an appraisal and extension of this literature.

especially interesting to examine results of studies that exploit data on individual loan decisions rather than on aggregate loan volumes. Asea and Blomberg (1998) use a panel dataset containing the contract terms of individual loans. They document a systematic variation in lending behavior over the business cycle that is consistent with the implications of the model. As interest rates increase during expansionary times, loan mark-ups don't change significantly, indicating that price competition during expansions is intense. As interest rates decline during recessions, loan mark-ups increase significantly, suggesting lessening competitive pressures. In addition, Asea and Blomberg find that as lending shifts toward more risky borrowers as the economic outlook improves, loan mark-ups decrease. This also is consistent with the claim of the model that price competition between lenders is most intense in expansions.

The model also predicts a change in the quality of loan portfolios over the business cycle and thus differing default rates of loans originated at different phases of the cycle. Default rates of loans originated in difficult times should be lower than those in better ones.

In the model, each bank has a similar acceptance of default risk when extending loans. Thus the change of bank behavior and portfolio quality should be similar across banks. This is different from Rajan (1994). In his model, poorly run banks attempt to appear as well-run ones, increasing loan volume beyond what is profitable for them in expansion periods. This implies that differences in loan quality across banks are most pronounced in expansion periods.

6.3 Informativeness of new loans

The analysis also predicts the variation in information included in new loan agreements over the business cycle. Since credit standards are high in bad times, new loan agreements include very good information. Lower lending standards when boom times are ahead imply that new loan agreements convey less positive information. This is consistent with the empirical observation that capital market reactions to new loan announcements are less pronounced when earnings expectations of firms have recently been adjusted upward [see Best and Zhang (1993)].

6.4 Market entry

Despite not being explicitly analyzed, the model has implications for entry into lending markets. Entry should occur in market segments that are most lucrative. For example, in times of expansion the ex ante safest loan segments are not the most lucrative ones; these segments are characterized by low margins and relatively high default rates despite good prospects in these areas. Thus if market entry occurs in these times, it should occur in the loan segments that are ex ante less safe than others because competition is lower and rents are higher.

6.5 Deposit insurance and risk taking

The model implies that deposit insurance fosters risk taking via increased competition when economic prospects are good. There exists a significant body of literature, both theoretical and empirical, on the effects of deposit insurance [see, e.g., Gorton and Winton (2002)]. One of the main arguments is that deposit insurance leads to risk-taking moral hazard, since government deposit insurance is not (at least not explicitly) based on the risk of an individual bank. High charter values, however, provide an incentive to avoid excessive risk taking by lenders because the charter is lost if a bank fails [Marcus (1984), Keeley (1990)]. Since charters are especially valuable in expansions when banks are not close to financial distress, the negative effects of deposit insurance should be least worrisome in economically good times. The result presented here demonstrates that deposit insurance leads to increased risk taking by banks even when economic prospects are good; in expansions, deposit insurance reduces deposit rates, thereby intensifying competition and increasing the acceptance of risk.

7. Conclusion

Credit standards vary countercyclically, and banks screen borrowers only superficially in expansion periods. Lower credit standards and the lack of thorough credit analysis in good times are not carelessness on the part of bankers; instead they are rational decisions that serve to maximize profits when the quality of the pool of applicants improves and price competition intensifies. An increase in price competition among banks occurs without any change in the number of banks, but rather because each bank is increasingly inclined to lend. Lower credit standards lead to higher default probabilities and — in conjunction with low margins — to low profits on loans originated in expansion periods.

Bank decisions not to spend considerable resources on screening each applicant in severe recessions are also an appropriate response to the circumstances. Although competition is low, the relatively low probability of detecting a creditworthy applicant in a worse-than-average pool deters banks from devoting much effort to evaluating firms. This behavior results in very restrictive bank lending policies. Although loans extended in recessions are on average highly profitable, the low volume of lending results in relatively low profits.

Banks prosper in times of high uncertainty. When the economy's future is unclear, information production is most lucrative. This is partly because high levels of information production have a dampening effect on price competition. The thorough credit evaluations in uncertain times keep default rates low.

It would be interesting to study the implications of the variation of lending standards on the business cycle itself. For example, restrictive credit policies in a recession may hamper a quick economic recovery. Such an analysis might provide important insights into the origins and dynamics of business cycles.

The simple model presented here may provide a basis for richer models that study additional aspects of bank competition. One way to extend the model is to allow the provision of collateral and study bank competition on both pricing and collateralization dimensions. Besides committing banks to monitor extended loans [see Rajan and Winton (1995)], one important function of collateral is that it provides protection for less-informed lenders. The results of this article would suggest that possible collateralization leads not only to less screening [see Manove, Padilla and Pagano (2001)], but also to a change in collateral requirements over the business cycle, depending on the degree of competition among lenders.

Appendix A: Proof of Lemma 1

(a) Suppose $s_i = B$. Offering credit can never lead to a positive payoff for the bank since no payments will be made by the borrower. Any offer by lender i that leads to a positive probability that is accepted implies strictly lower payoffs than refusing to make an offer. Suppose $s_i = G$. Offering credit leads to a nonnegative profit for the bank as long as $b_i \geq \delta$. Thus it can do at least as well when offering credit with probability 1 than when denying credit with positive probability. A strict increase in payoffs can be achieved if the added probability of making an offer leads to an increased probability of the acceptance of an offer.

(b) Suppose bank $j \neq i$ offers credit with a probability strictly less than one on some signal. Then bank i's optimal strategy must include $\mu_i^B = 0$, since offering credit on $s_i = B$ yields strictly negative expected profits. Suppose bank j offers credit with probability one. Then, offering credit on $s_i = B$ is an optimal behavior as long as bank i's repayment objective is higher than bank j's. This cannot be an equilibrium, however, since bank j can strictly improve on such a situation by choosing $\mu_j^B = 0$.

Suppose lenders choose $\mu_i^G < 1$, $i = 1, 2$. Then lender i can increase profits by offering credit with the remaining probability, $1 - \mu_i^G$, and specifying X as the repayment objective. Suppose $\mu_j^G = 1$ and $\mu_i^G < 1$. In an equilibrium, the expected profits of lender j in case of $s_j = G$ must be positive, since specifying X as the repayment objective yields already positive profits. This excludes $b_j = \delta$. Then, lender i can increase profits by offering credit also with the remaining probability, $1 - \mu_i^G$, specifying the lowest repayment objective of lender j. ■

Appendix B: Proof of Proposition 1

First, μ^0 is assumed to be larger than zero. In a mixed-strategy equilibrium, every pure strategy that can occur must yield an identical payoff, since otherwise shifting density toward more profitable pure strategies increases payoffs. Then necessary conditions for a symmetric mixed-strategy equilibrium are

$$(b - \delta)[q[1 - F(b)] + (1 - q)((1 - \mu^0) + \mu^0[1 - H(b)])] = K \quad b \in [\underline{b}^F, \bar{b}^F], \tag{14}$$

$$-(1-\lambda)q\delta + (b-\delta)\lambda q[1-F(b)] + (\lambda b - \delta)(1-q)((1-\mu^0) + \mu^0[1-H(b)]) = K' \quad b \in [\underline{b}^H, \bar{b}^H], \tag{15}$$

where K and K' are nonnegative constants.

Lemma 3 simplifies further algebra:

Lemma 3. *In a symmetric equilibrium with* $0<q<1$, *we must have* $K'=0$.

Proof. Assume $K'>0$. This implies $\mu^0=1$. Note that $\bar{b}^H$ or $\bar{b}^F$ must equal X. In case of only $\bar{b}^H=X$, it follows from Equation (15) that $K'=-(1-\lambda)q\delta$, which is a contradiction. When $\bar{b}^F=X$, then using Equation (14) yields $K=0$. However, then there exists a $b'^F<\bar{b}^F$ in a neighborhood of $\bar{b}^F$ such that choosing b'^{F} leads to strictly positive expected profits. ■

Now possible equilibrium strategies are reduced.

Lemma 4. *In a symmetric equilibrium with* $0<q<1$ *and* $F(b)\in C^0([\delta,X])$ *and* $H(b)\in C^0([\delta,X])$, *the strategies are random variables with compact supports that do not overlap except at one point.*

Proof. Assume $b\in[\underline{b}^F,\ \bar{b}^F]\cap[\underline{b}^H,\ \bar{b}^H]$. Then Equations (14) and (15) can be solved for $F(b)$ and $H(b)$:

$$F(b)=\frac{1}{q}\Big(\frac{\lambda}{1-\lambda}-\frac{\delta}{b-\delta}\Big)K,$$
$$H(b)=\frac{1}{\mu^0}\frac{1}{1-q}\Big(1-\frac{\lambda}{1-\lambda}\frac{1}{\delta}K\Big).$$

$H(b)$ is a constant in the specified range. Hence supports cannot overlap except at boundary points. $F(b)$ is strictly increasing, and from $F(\underline{b}^F)=0$, one obtains $\underline{b}^F=\ \delta/\lambda$. For a positive measure of the random variable associated with $H(b)$ to lie below δ/λ, $\underline{b}^H<\delta/\lambda$ must hold.

Consider $b=\delta/\lambda-\varepsilon<\delta/\lambda$. Inserting this expression into Equation (15) yields the contradiction $-\lambda\varepsilon=0$. This shows that there exists a $\tilde{b}$ such that $\bar{b}^F\le\tilde{b}\le\underline{b}^H$. In equilibrium, $\bar{b}^F$ cannot be strictly smaller than $\underline{b}^H$. Consider a situation in which $\bar{b}^F<\underline{b}^H$. If a positive signal is obtained, choosing a repayment $\bar{b}^F$ yields an expected net revenue of $K=(\bar{b}^F-\delta)(1-q)$. Selecting $\bar{b}^F+\varepsilon\in(\bar{b}^F,\underline{b}^H)$ yields the strictly larger net revenue $(\bar{b}^F+\varepsilon-\delta)(1-q)$, since the probability of granting the loan does not decrease when increasing the repayment slightly. An analogous argument excludes that supports are not compact. Thus supports are compact and $\tilde{b}$ is unique. ■

Equations (14) and (15) can now be simplified to

$$(b-\delta)[q[1-F(b)]+(1-q)]=K\quad b\in[\underline{b}^F,\bar{b}^F], \tag{16}$$

$$-(1-\lambda)q\delta+(\lambda b-\delta)(1-q)((1-\mu^0)+\mu^0[1-H(b)])=0\quad b\in[\underline{b}^H,\ \bar{b}^H]. \tag{17}$$

Since $\bar{b}^H=X$ and $H(\bar{b}^H)=1$ it holds

$$\mu^0=1-\frac{(1-\lambda)\delta}{\lambda X-\delta}\frac{q}{1-q}<1. \tag{18}$$

The condition for the nonoptimality of providing credit upon an inconclusive result of the test can now be derived easily:

$$X\le\frac{1-\lambda q}{\lambda(1-q)}\delta\Leftrightarrow\lambda\le\frac{\delta}{q\delta+X(1-q)}.$$

$H(\underline{b}^H)=0$ yields

$$\underline{b}^H=\frac{1-\lambda q}{\lambda(1-q)}\delta=\Big(1+\frac{1-\lambda}{\lambda}\frac{1}{1-q}\Big)\delta=\bar{b}^F. \tag{19}$$

Plugging this into Equation (16) and using $F(\bar{b}^F)=1$ yields

$$K=\frac{1-\lambda}{\lambda}\delta. \tag{20}$$

This means that in a symmetric equilibrium the profit of each lender does not depend on the screening intensity of its competitor.

In addition, it holds that

$$\underline{b}^F=\frac{\delta}{\lambda}>1. \tag{21}$$

Plugging Equation (20) into Equation (16) and simple algebra yield the claimed cumulative distribution functions. It can easily be checked that it is not profitable to deviate from the described strategy by choosing a repayment outside the specified support (e.g., selecting b_i^F larger than $\underline{b}^H$).

The distribution function in the $\mu^0=0$ case can be obtained similarly. Now only the expected net return of lender i in case of a positive signal is relevant. Assuming $\mu_j^0=0$, it is now simplified to

$$p_i=\lambda q_i\int_{\underline{b}_i^F}^{\bar{b}_i^F}[(b_i-\delta)q_j[1-F_j(b_i)]+(b_i-\delta)(1-q_j)]dF_i(b_i)-C(q_i). \tag{22}$$

In case of a symmetric mixed-strategy equilibrium,

$$(b-\delta)q[1-F(b)]+(b-\delta)(1-q)=K \quad b\in[\underline{b}^F,\bar{b}^F] \tag{23}$$

must hold.

Using the boundary condition $\bar{b}^F=X$ and $F(\bar{b}^F)=1$, one obtains

$$K=(1-q)(X-\delta)>0. \tag{24}$$

$F(\underline{b}^F)=0$ yields

$$\underline{b}^F=\delta+(1-q)(X-\delta)=X-q(X-\delta). \tag{25}$$

The distribution function can be obtained immediately using Equations (23) and (24). ■

Appendix C: Proof of Proposition 2

Given the results in Proposition 1, it is first shown that the screening intensities given in the second part of the proposition necessarily hold in a symmetric equilibrium. Afterward the existence and the uniqueness of the symmetric equilibrium satisfying $F(b)$ and $H(b)\in C^0([\delta, X])$ are proven.

Lemma 5. *In a symmetric equilibrium with $F(b)$ and $H(b)\in C^0([\delta, X])$ in which Inequality* (3) *is satisfied, the test intensity, $q^{\mu^0=0}$, of each lender is uniquely defined by*

$$\lambda(1-q^{\mu^0=0})(X-\delta) = C'(q^{\mu^0=0}). \tag{26}$$

In a symmetric equilibrium with $F(b)$ and $H(b)\in C^0([\delta, X])$ in which Inequality (3) *is not satisfied, the test intensity, $q^{\mu^0>0}$, of each lender is uniquely defined by*

$$(1-\lambda)\delta = C'(q^{\mu^0>0}). \tag{27}$$

Proof. Again, first the equilibrium behavior in the $\mu^0>0$ case is studied. Since the integrals in the objective function of bank i, Equation (8), include only q_j and not q_i, it is clear that for

$F_j(b_j) = F^{\mu^0>0}(b_j)$ and $H_j(b_j) = H^{\mu^0>0}(b_j)$, the objective function can be written as

$$P_i^{\mu^0>0}(q_i) = \lambda q_i K - C(q_i) = (1-\lambda)q_i\delta - C(q_i). \tag{28}$$

The necessary and sufficient condition for an optimal test quality, $q_i^{\mu^0>0}$, is

$$(1-\lambda)\delta = C'(q_i^{\mu^0>0}). \tag{29}$$

One can easily see the strategic neutrality of test intensities. Using symmetry the result can be established.

Analogously one obtains the objective function of lender i for a given specification stage equilibrium in the $\mu^0 = 0$ case as

$$P_i^{\mu^0=0}(q_i) = \lambda q_i(1-q_j)(X-\delta) - C(q_i). \tag{30}$$

The necessary and sufficient condition for an optimal q_i, $q_i^{\mu^0=0}$, is

$$\lambda(1-q_j)(X-\delta) = C'(q_i^{\mu^0=0}). \tag{31}$$

One can see that test intensities are strategic substitutes:

$$\frac{\partial q_i^{\mu^0=0}}{\partial q_j} < 0. \tag{32}$$

Symmetry allows us to state the result. ■

Since Inequality (3) depends on the test intensity, the existence and the uniqueness of an equilibrium satisfying $F(b)$ and $H(b) \in C^0([\delta, X])$ are not obviously given. For each admissible constellation of λ, X, and $C(q)$, there are ex ante two candidates for an equilibrium: the one derived for the case in which Inequality (3) holds, and the one derived for the case in which Inequality (3) does not hold. To prove existence, it is necessary to show that for each admissible constellation, one of the two candidates indeed is compatible with the constellation of λ, X, and q it is derived for. To prove uniqueness, it is necessary to show that for each admissible constellation this holds for exactly one of the two candidates.

We analyze the situation in the $\lambda - q$ space for any admissible values for X. For every parameter constellation and a given q, there is a unique equilibrium in the pricing part of the game. The equation separating the regimes in the $\lambda - q$ space, $q^*(\lambda)$, is

$$q^*(\lambda) = 1 - \frac{1-\lambda}{\lambda}\frac{\delta}{X-\delta}. \tag{33}$$

The test qualities in the $\mu^0 = 0$ regime, $q^{\mu^0}=0$, and in the $\mu^0 > 0$ regime, $q^{\mu^0} > 0$, are implicitly determined by Equations (9) and (10), respectively. In the following it is shown that there is a unique intersection between any two of the three functions for $\lambda \in (0, 1)$ and that all these intersections occur at the same point. From the properties of the functions, it can then be concluded that an equilibrium exists and that it is unique.

Each of the three functions is continuous. $q^*(\lambda)$ is strictly increasing and strictly concave with $\lim_{\lambda\to 0} q^*(\lambda) = -\infty$ and $q^*(1) = 1$. $q^{\mu^0=0}(\lambda)$ is strictly increasing with $q^{\mu^0=0}(0) = 0$ and $q^{\mu^0=0}(1) \in (0, 1)$. $q^{\mu^0>0}(\lambda)$ is strictly decreasing with $q^{\mu^0>0}(0) \in (0, 1]$ and $q^{\mu^0>0}(1) = 0$. From these properties it is obvious that there is a unique intersection of $q^*(\lambda)$ and $q^{\mu^0>0}(\lambda)$, as well as of $q^{\mu^0=0}(\lambda)$ and $q^{\mu^0>0}(\lambda)$ for $\lambda \in (0, 1)$. It also can be seen that $q^*(\lambda)$ and $q^{\mu^0 s=0}(\lambda)$ intersect at least once. In this case, Equations (33) and (9) must be satisfied. Eliminating λ yields

$$\frac{(1-q)\delta(X-\delta)}{\delta+(1-q)}(X-\delta) - C'(q) = 0.$$

The first derivative of the left-hand side of the equation is

$$-\frac{\delta^2(X-\delta)}{[\delta+(1-q)(X-\delta)]^2}-C''<0,$$

that is, at each intersection q has the same value. Since both functions are strictly increasing, there can be at most one intersection.

All functions have a unique common point, because solving Equation (9) for C' and inserting it into Equation (10) yields Equation (33). Denote the value of λ at this point by λ^*. For $\lambda \in (0, \lambda^*]$, both $q^{\mu^0=0}(\lambda)$ and $q^{\mu^0>0}(\lambda)$ lie above $q^*(\lambda)$ and for $\lambda \in (\lambda^*, 1)$ below. This means that for all $\lambda \in (0, 1)$, $q^{\mu^0=0}(\lambda)$ and $q^{\mu^0>0}(\lambda)$ induce an equilibrium with respect to pricing in the two regimes. This proves both existence and uniqueness. ■

Appendix D: Proof of Proposition 6

The expected profits can be calculated by using the optimal decisions of each bank (Propositions 1 and 2).

The second result of the first part of the proposition is shown by using the partial derivative of the expected profit with respect to λ. It is given by

$$\frac{\partial P(\lambda, X, C(q))}{\partial\lambda}=\begin{cases}\left(1-q^{\mu^0=0}-\lambda\dfrac{\partial q^{\mu^0=0}}{\partial\lambda}\right)q^{\mu^0=0}(X-\delta) & \lambda<\lambda^*\\ -q^{\mu^0>0}\delta & \lambda>\lambda^*.\end{cases}$$

It is immediate that the expression is negative for $\lambda > \lambda^*$. The expression for $\lambda > \lambda^*$ is positive, if $1-q^{\mu^0=0}-\lambda\frac{\partial q^{\mu^0=0}}{\partial\lambda}>0$. Using Equation (9), $\frac{\partial q^{\mu^0=0}}{\partial\lambda}=\frac{(1-q^{\mu^0=0})(X-\delta)}{\lambda(X-\delta)+C''(q^{\mu^0=0})}$, which implies $1-q^{\mu^0=0}-\lambda\frac{\partial q^{\mu^0=0}}{\partial\lambda}=\frac{(1-q^{\mu^0=0})C''(q^{\mu^0=0})}{\lambda(X-\delta)+C''(q^{\mu^0=0})}>0$.

The last result is proved separately for the two regimes. Please note that when $\lambda > \lambda^*$, the expected net revenue per applicant decreases with λ. The probability of a bank offering credit in this regime is given by $\lambda_q + \mu^0(1-q)$, which is strictly increasing in λ. This implies that in a symmetric situation, each bank extends the loan with an increasing probability as λ increases. The increasing probability of extending a loan and the decreasing expected net revenue imply that the net revenue per loan granted is decreasing. For $\lambda < \lambda^*$, this line of argument is impossible, since the expected revenue does not decrease with λ. Thus the expected net revenue per loan extended is calculated explicitly. The expected probability of granting a loan is $0.5\lambda q$. Then the expected revenue per credit granted is $2(1-q)(X-\delta)$, which is decreasing in λ.

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