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COLLATERAL AND COMPETITION

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Federal Reserve Bank of Philadelphia

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Abstract

We examine the effects of changes in competitive conditions on the structure of loan contracts. In particular, we present conditions in which greater loan market competition reduces the stringency of contractual collateral requirements, a prediction that is consistent with anecdotal evidence from loan markets. We also analyze the interaction between the degree of competition and the efficiency of contractual renegotiation. Insufficiently competitive markets may lead to bargaining difficulties that reduce the efficiency of renegotiable contracts. At low levels of competition negotiable contracts remain feasible only if collateral levels are inefficiently low.

1 Introduction

In six out of seven quarters from Q4 1996 through Q3 1998, senior loan officers at U.S. banks reported to the Fed that new loans had been made at lower spreads, with less stringent collateral requirements, and with less restrictive covenants than in the previous quarter.[1] "More aggressive competition from other commercial bankers," was overwhelmingly the most common reason given for the easing of loan terms. This period was not atypical; there are numerous periods in which bankers have spoken of strong pressures to reduce collateral requirements and covenant restrictions in the face of strong competition.

No economist would be surprised to hear that competition leads to lower loan spreads. However, the claim that competition had forced lenders to lower collateral requirements or to make covenant restrictions less stringent is more mysterious. For the most part, contract theory views collateral and restrictive covenants as contractual mechanisms for overcoming incentive problems. According to standard models, collateral and covenants are bonding devices that reduce borrowers' cost of external funds in the presence of agency problems.[2] Although the theoretical literature relating contract structure to competitive conditions is sparse, the broader contracting literature offers little reason to predict a decline in the severity of agency problems when competition among lenders increases.[3]

[1] "Senior Officer Loan Survey on Current Bank Lending Practices," Federal Reserve Board, various issues.
[2] See Longhofer and Santos (2000) for a review of the literature on collateral and Gorton and Winton (2002) for a review of models of the structure of loan contracts.
[3] Two rejoinders immediately come to mind: (i) Agency problems may become less severe during a lending boom because default risk has declined. In this interpretation, both the increased supply of funds in the banking sector and the decline in agency problems have a common cause, a reduction in default risk. In this view respondents to the Fed survey are guilty of assigning a causal role to an endogenous variable. This may be true. In a companion paper we are examining empirically the relationship between competition and collateral requirements, controlling for default risk. That said, survey respondents are explicitly offered the opportunity to ascribe the easing of contract terms to factors related to default risk or their tolerance for risk,

In this paper we present two main results.[4] The first examines the bankers' claim that competitive pressures in loan markets compel them to soften contract terms, in particular, to lower collateral requirements or to relax covenant restrictions. We present a formal model in which an increasingly competitive market *can* lead to less stringent collateral requirements. In our model, banks produce information about borrowers to facilitate efficient renegotiation of contract terms, including selectively lowering collateral requirements for borrowers for whom the requirement binds inefficiently. More competition reduces the bank's payoff in negotiations, thereby reducing the bank's private return from monitoring. As long as the bank's profit-maximizing response to a decline in the net payoff to monitoring is to monitor less, an increase in competition reduces monitoring, which, in turn, reduces the accuracy of the information available to the lender should a borrower seek to have the collateral requirement waived. Since selective renegotiation of the collateral requirement is now a less efficient method of fine-tuning the initial contract, the initial contract includes a less stringent collateral requirement.

Our second main finding is that low levels of competition can lead to bargaining difficulties that affect contractual form. In a sense, this is the flip side of the previous result. In our

so it is likely that the loan officers themselves believe they are distinguishing competition and default risk; (ii) A credit rationing model might explain a positive relationship between loan rates and the stringency of loan terms. In a rationing equilibrium, loan rates might be unable to rise without exacerbating agency problems. In response, lenders might insist on other contractual provisions—collateral and covenants—to permit lending profitably. Thus, an increase in loanable funds could lead to both a decline in loan rates and a reduction in the stringency of other contractual restrictions. This makes sense theoretically, and, perhaps, empirically for some historical episodes. However, given the preceding years of rapid loan growth, it is difficult to view the 1996-98 period as one in which loan markets were exiting a rationing equilibrium.

[4] In its main outline, our model is related to that of an earlier paper on the choice between private and public debt, Berlin and Mester (1992). On one level, this paper may be viewed as an extension of the earlier paper to include: (i) endogenous monitoring; (ii) endogenous incentives to renegotiate; (iii) market competition.

model, borrowers can't simply wait for a contractual waiver to make significant production decisions. Borrowers breach collateral requirements in the expectation that the lender will grant a contractual waiver in subsequent negotiations. But this subjects the borrower to strategic risk. In bilateral negotiations, the incumbent lender can be expected to demand a substantial share of the bargaining surplus. Outside competition tends to limit the incumbent's bargaining power, but in a relatively noncompetitive market a borrower in breach of contract is likely to find itself with no competitive alternative. In turn, the borrower may simply prefer to honor the original contract—and make inefficient production decisions—rather than seek remedies through contractual negotiations. In this case, there are two contractual alternatives. The optimal contract may forgo renegotiation altogether. Alternatively, the contract may set collateral requirements inefficiently low so that renegotiation remains feasible.

1.1 Related literature (incomplete)

Although our motivation and analysis applies to bank loan markets, we view our paper as part of a broader literature on the relationship between competition and contractual form. Perhaps surprisingly, both the empirical and theoretical literature on this issue is small. Gompers and Lerner (1996) examine the covenants included in venture capital partnership agreements and present evidence that the supply of funds is inversely related to the number of covenants included. This evidence is broadly consistent with the anecdotal evidence from loan markets cited above. From a slightly broader perspective, other authors have found evidence for a relationship between the degree of competition and the production of information by bankers. Using survey data from German manufacturing, Fischer (2000) presents evidence that banks acquire more information in concentrated markets, consistent with the mechanism outlined in our model. Providing evidence that noncompetitive markets facilitate long-term lending relationships, Petersen and Rajan (1995) show that the lifetime profile of loan rates is flatter in concentrated markets.[5]

To our knowledge, the only theoretical paper that addresses the degree of competition and the use of collateral (or covenants) in loan contracts is Manove's, Padilla's, and Pagano's (2001) model of lazy banks. In their paper, high quality borrowers post collateral in competitive markets to distinguish themselves from low quality borrowers, and the endogenous revelation of borrower type may induce banks to forego monitoring. Interestingly, their main empirical prediction is diametrically opposed to ours; they predict that borrowers are *more* likely to post collateral in competitive loan markets than in loan markets where banks have monopoly power. In a model of venture capital contracts, Inderst and Müller (2002) examine the effects of supply and demand factors on optimal contract design. Among their many interesting results—which mainly focus on the relative merits of equity-like and debt-like contracts as lenders' and borrowers' bargaining power change—they find that monitoring is lower in a market where the supply of funds is plentiful. While this conclusion is similar to ours, the underlying reason is quite different. In their model a limited supply of "informed capital" places bounds on the use of contracts that rely on monitoring.

[5] We do not review the banking literature relating market structure and portfolio risk. In our model, more competition leads to less monitoring, and empirically, this would be associated with more loan losses. We do not emphasize this aspect of the model, and most studies concerned with competition and risk- taking focus on issues unrelated to our main concerns. See Gorton and Winton (2002) for a review of the literature on market structure and risk taking.

Our model is also related to a growing strand of the literature that relates lenders' incentive to screen borrowers in different market structures.[6] In these contributions the bank's incentive to produce information declines with more competition, a feature our model shares. Our paper differs from other contributions in this literature in a number of ways. Most notably, we are concerned with contract design, unlike other papers in this literature. Second, since this literature focuses on ex ante screening and credit granting decisions, the other papers don't analyze bargaining and renegotiation, a central element in our model, and, we believe, a central feature of bank lending.

Our result concerning the extent of competition and the possibility of bargaining difficulties is related to Rajan's (1992) result that a lender's ex post bargaining power reduces the borrower's incentive to take effort ex ante.

The paper proceeds as follows. We present the model in Section 2, and in Section 3 we examine competition, the interim bargaining game, and the firm's production decisions. In Section 4 we present our main results. Here we derive the optimal contract both when competition is strong and weak and discuss why the optimal contract is affected by the degree of competition. Section 5 concludes and presents directions for further research.

2 The model

2.1 The agents

The timing of the model is shown in Figure 1.

[6] See, among others, Caminal and Matutes (2002), Cao and Shi (2000), Hauswald and Marquez (forthcoming), and Tröge (2000).

There are two risk-neutral banks, indexed by $k \in \{1, 2\}$ and a single risk-neutral borrowing firm with a project but no wealth. All agents live for three periods, t = 0,1,2.

In period 0, \$1 flows to only one of the two banks; each bank receives the \$1 with equal probability. The bank that receives the funds will be the firm's initial lender. In period 1, the supply of funds is a random variable $F \in \{1, 2\}$, that is, the supply of funds in period 1 is either \$1 or \$2, with $prob(F = 2) = \lambda$ and $prob(F = 1) = 1 - \lambda$. For present purposes, we assume that if $F = 1$ in period 1, the bank that received funds in period 0 also receives the funds in period 1. If $F = 2$, only one of the banks will invest in the existing loan, while the other will invest in storage.

2.2 The production process

The firm has a project that requires \$1 of funds at the beginning of period 0 and which yields final payoffs in period 2. At the beginning of period 0, the firm approaches the bank for a loan. At this time, the firm and its lender know only that the firm will be one of two types, $j \in \{g, b\}$, where, $prob(j = g) = p$ and $prob(j = b) = 1 - p$. We refer to the type g firm as a *good firm* and a type b firm as a *bad firm.*

The firm makes a production decision in period 1 after learning its type but before the supply of funds is known. This decision requires the firm to allocate its resources between two mutually exclusive types of activities: *posting collateral* and *investing in growth opportunities.* We emphasize two (nonexclusive) interpretations of posting collateral. The first is literal: funds invested in liquid assets—inventories or accounts receivable—that can be readily seized by a lender. Less literally, the firm can choose production activities that generate immediate cash flows and guarantee repayment in period 2. Such activities are reflected in accounting measures of firm liquidity and profitability that are the basis for covenants in many loan contracts. This second interpretation reflects bankers' common parlance, in which the general assets of the firm are viewed as a source of collateral, even when a loan is not secured by particular assets. A firm of type j that posts x dollars of its funds as collateral produces revenues, $R^j(x)$,with certainty in period 2, where

$$R_x^j(x) > 0,\ R_{xx}^j(x) < 0,\ j = g, b. \tag{1}$$

Revenues are readily transferred to the lender, that is, they can't be hidden or consumed by the borrower.

Posting collateral reduces the value of growth opportunities, $K^j(x)$, for both types of borrowers,

$$K_x^j(x) < 0,\ K_{xx}^j(x) < 0,\ j = g, b. \tag{2}$$

For concreteness, think of these growth opportunities as intangible investments in R&D or marketing, which yield future payoffs, but which have little value as collateral. A key feature of these growth opportunities is that they are nontransferable within the model's time frame.[7] The future cash flows from assets may be nontransferable for a number of reasons. The realization of these opportunities may depend in an essential way on the human capital

[7] Note we are not claiming that it is impossible to sell financial claims on the cash flows to intangible assets. For our purposes, any cash flows that can be pledged should be included in revenues, and any cash flows that cannot be pledged should be included in growth opportunities.

or effort of the firm's employees, in which case the firm may be unable to credibly pledge payments to outsiders without destroying the value of the assets. Alternatively, the lender may be unable to hold very long-term contractual claims, perhaps because of regulatory restrictions on holding equity.

It is efficient for the good firm to dedicate all investment to growth opportunities and for the bad firm to post all of its funds as collateral:

$$R_x^g(x) + K_x^g(x) < 0, \; and \; R_x^b(x) + K_x^b(x) > 0. \tag{3}$$

In addition to investing in projects there is a storage technology yielding a zero return. A bank could never lend profitably to a known, bad firm, and lending to a known, good firm would be always be profitable, even if that firm invested completely in growth opportunities, that is,

$$R^g(0) > 1, \; and \; R^b(1) < 1. \tag{4}$$

At the outset of period 1, a type j firm can be liquidated to yield L^j,which we assume to be independent of x_j for simplicity alone. A bank would never choose to liquidate a firm known to be good with certainty, and it would always choose to liquidate a known, bad firm,

$$R^g(0) > L^g, \; and \; R^b(1) < L^b. \tag{5}$$

2.3 Information structure

2.3.1 The banks' information

At t=0, *before* the supply of funds has been directed to one of the two banks, each bank invests an amount, $q \in [0, 1]$, which permits it to observe a noisy indicator of the borrower's type in period 1, $s \in \{g, b\}$, at cost $c(q) = \frac{cq^2}{2}$.[8] The bank's expenditure on monitoring is noncontractible. We think of the expenditure as the cost of creating a general purpose monitoring apparatus that permits the bank to interpret information about borrowers. While this is a general purpose technology, observing the indicator for a particular firm requires direct contact with the firm.

There are two ways in which the firm and the bank may establish contact. First, if the bank makes the initial loan to the firm in period 0, it observes the indicator in period 1 as a matter of course. Alternatively, the firm may approach a new bank in period 1. In this case, the bank can examine the firm's books, have discussions with management, etc., permitting the bank to form a knowledgeable view of the firm's prospects. While there are many ways that we could model the information received by a new lender, we adopt a particularly simple formulation that captures the asymmetry between an incumbent lender and a new entrant without too much complicated machinery.

We assume that a new lender observes the *same* realization of the indicator as the initial lender—that is, the indicators observed by the incumbent and the entrant are perfectly correlated—but at an added cost to the borrowing firm, m. Thus, the incumbent and the entrant are symmetrically informed once the firm has been monitored by the entrant. The

[8] All of our results hold for general convex cost functions unless explicitly noted.

added cost reflects the extra time and resources required for the firm to find the new lender, prepare its books, and make its case that it is a profitable investment.[9]

2.3.2 The borrower's information

The borrower is assumed to observe its realization of s (as well as its type) before making his production choice. This assumption—and our assumption that the banks' indicators are perfectly correlated—are sensible if the underlying source of noise is the discrepancy between the firm's true condition and the inference about the firm's condition that would be drawn by a well-informed observer with ready access to the firm.

Imagine, for example, that the firm is introducing a new brand of detergent and that consumers' initial response has been favorable. It is reasonable to think that the firm has better information than any lender, because it has access to information that no lender will have, for example, that the detergent disintegrates clothes in a small minority of cases. It is also reasonable to think that the firm itself is the first to evaluate consumers' response—as measured by sales and questionnaires in particular test markets—and that the firm can predict lenders' likely interpretation of the results. Our assumptions are less convincing if we view the source of noise to be distinct agents having distinct information sets or idiosyncratic ways of making judgements.[10]

[9] The modelling device that the borrower, rather than the entrant, bears the cost is partly a matter of convenience. We avoid the untenable conclusion that entry is impossible, without resorting to unnecessarily complicated mixed strategies. At the same time, the assumption reflects the sensible economic claim that the lender's marginal costs of evaluating an additional borrower are low compared to the fixed costs (q) of initially setting up a monitoring apparatus.

[10] The issues that arise when lenders have imperfectly correlated information—especially the possibility that more competition may increase adverse selection—have been explored by Broecker (1990).

2.3.3 Parametric restrictions

We adopt the following simple parameterization. Let

$$\begin{aligned} prob(s &= g \mid j = g) = prob(s = b \mid j = b) = \frac{1+q}{2}, \\ prob(s &= b \mid j = g) = prob(s = g \mid j = b) = \frac{1-q}{2}, \end{aligned}$$

Thus, the precision of the banks' information increases with its initial monitoring expenditure.

The nature of the equilibrium depends on the informativeness of the indicator. Let $\phi_{j's'} \equiv prob(j = j' \mid s = s')$. By Bayes rule,

$$\begin{aligned} \phi_{gg} &= \frac{p(\frac{1+q}{2})}{p(\frac{1+q}{2}) + (1-p)(\frac{1-q}{2})},\ \phi_{gb} = \frac{p(\frac{1-q}{2})}{p(\frac{1-q}{2}) + (1-p)(\frac{1+q}{2})}, \\ \phi_{bg} &= \frac{(1-p)(\frac{1-q}{2})}{p(\frac{1+q}{2}) + (1-p)(\frac{1-q}{2})},\ \phi_{bb} = \frac{(1-p)(\frac{1+q}{2})}{p(\frac{1-q}{2}) + (1-p)(\frac{1+q}{2})}. \end{aligned} \tag{6}$$

We make the following parametric restrictions. Throughout, we assume that the equilibrium level of monitoring is high enough that a lender's liquidation decision would be swayed by the indicator observed. In particular, we assume,

$$\phi_{gg}R^g(x) + \phi_{bg}R^b(x) > \max\left[1,\ \phi_{gg}L^g + \phi_{bg}L^b\right],\ \forall x, \tag{7}$$

that is, a firm with a good indicator has higher expected revenues than either storage for another period or immediate liquidation. Similarly, we assume,

$$\phi_{gb}R^g(x) + \phi_{bb}R^b(x) < \min[1,\ \phi_{gb}L^g + \phi_{bb}L^b],\ \forall x, \tag{8}$$

which says that a firm with a bad indicator has lower expected revenues than either storage or immediate liquidation. In Section 4 we discuss the implications of these inequalities not holding.

2.4 Contracts

A period 0 contract, $\langle r_o, x_o \rangle$, has two terms, the loan rate factor, r_o, and the required collateral, x_o. The contract gives the lender the right to liquidate the firm in period 1 if the firm's collateral falls below its required level. We rule out short-term contracts, in which the lender can freely refuse to roll-over its first period loan.[11]

2.5 Competition

We adopt a simple model to capture the effect of competitive conditions on contractual form. Recently, a number of authors have explored models of Bertrand competition between informed and uninformed lenders.[12] Our model shares the main prediction of these models, that competition from an uninformed lender has a tendency to reduce the incumbent's incentive to monitor. The main lessons of our model are likely to be robust to changes in the precise model of interim competition chosen—as long as more competition yields lower rents

[11]Short-term contracts will never be efficient if growth opportunities are sufficiently valuable or if the information upon which liquidation decisions are made is sufficiently noisy.

[12]By assuming that an entrant can become informed at a cost, we adopt a different approach than some of the recent literature in which the incumbant remains better informed than the entrant. The original contributions in this literature include Englebricht-Wiggins, Milgrom and Weber(1982), Sharpe (1990), and Rajan (1992). More recent contributions include Von Thadden (2002), and those mentioned in footnote 6, among others. For our purposes, the alternative modeling choice of assuming competition between asymmetrically informed lenders in period 1 introduces an uninteresting complications:. contractual terms chosen in period 0 will affect the mixed-strategies of the borrowers and lenders in the period 1 competition. Note, our results require *only* that competition reduce an incumbent's ex post profits. They would continue to hold true if the incumbent received positive (but reduced) rents in the fact of competition, as predicted by other models of interim competition.

for the incumbent lender.

At the beginning of period 1 the supply of funds F is realized and observed by all market participants. If $F = 2$ there are 2 potential lenders, while if $F = 1$ there is only 1 potential lender, the firm's original bank. Whether or not the market is competitive, the firm's original bank makes a take-it-or-leave it offer (possibly random) to the firm.[13]

We model competition as a one-shot, simultaneous move game between the incumbent bank and the firm, with the potential entrant playing a largely passive role. After F has been realized, the incumbent bank quotes a loan rate (r') while the firm chooses whether to solicit a competing offer (r^e) from the entrant at added cost m.

3 Bargaining with and without competition.

Before stating the maximization problem explicitly it is convenient to solve for the equilibrium outcome in the interim competition game and to determine the firm's optimal choice of $x_{js},\ j = g, b,\ s = g, b.$

3.1 Competition

In this section we show that when funds are plentiful, that is, when F=2, competition between the entrant and incumbent yields an outcome in which: (1) Only firms with good indicators seek out competitive offers; (2) Competition ensures that lenders' profits are driven to zero. We state this formally in the following lemma:

[13]We adopt this formulation, which gives the bank all the bargaining power when the market is non-competititive, both for simplicity and because it retains symmetry between the bargaining games with and without competition. If the borrower had bargaining power in bilateral negotiations game our qualitative results would not change. However, the lender must have *some* bargaining power in the bilateral bargaining game, or else it will not monitor.

Lemma 1 *In the interim competition game, only a good firm with $s = g$ ever solicits an offer from the potential entrant. The firm's expected profits (π^f) and the incumbent bank's expected profits (π^i) are,*

$$\pi^f = R^g(x_{gg}) - 1 - m + K^g(x_{gg}), \text{ and} \quad (9)$$
$$\pi^i = 0. \quad (10)$$

The bad firm with $s = g$ always remains with the incumbent lender. This equilibrium exists if and only if:

$$R^g(x_{gg}) - 1 - m + K^g(x_{gg}) \geq R^g(x_o) - r_o + K^g(x_o) \quad (11)$$

Proof: It is immediate from inequality (8) that any firm with $s = b$ would never benefit from approaching a new bank, because the indicator is sufficiently informative that the bank would never make a loan to such a borrower. Now consider a bad firm with $s = g$. By inequality (4), the bad firm always defaults in period 2, whatever its loan rate, so (denoting $min[a, b]$ by $[a, b]^-$ and $max[a, b]$ by $[a, b]^+$),

$$[R^b(x) - r', 0]^+ + K^b(x) = [R^b(x) - r^e, 0]^+ + K^b(x) = K^b(x),$$

for any x. It is clearly unprofitable for such a firm to pay a cost (m) to seek a lower loan rate that doesn't increase its expected profits, except possibly in a pure-strategy equilibrium, in which bad firms with a positive indicator feel compelled to mimic good firms with a positive indicator.[14] However, no pure-strategy equilibrium is possible as long as firms actually solicit offers, as we show below. Thus a bad firm with $s = g$ always remains with the incumbent lender.

To see where the profit expressions come from, consider an equilibrium in which the firm plays a mixed strategy {solicit competitive offer (r^e), don't solicit a competitive offer} with probabilities $\{\delta, 1 - \delta\}$. The incumbent's best response must be drawn from the pair of loan

[14] We assume that it is impossible for a lender to observe the probability distribution governing the borrower's mix of strategies.

rates $\{R^g(x_{gg}), r^e\}$, with probabilities $\{\eta, 1-\eta)$. In the event the firm doesn't solicit an offer, the incumbent would only be losing profits if it demanded less than the full revenue, $R^g(x_{gg})$. In the event the firm does solicit an offer, the incumbent bank can charge no more than the rate offered by the competitor without losing the customer. Since the added cost of approaching a new lender is born by the firm, the rate will be the competitive rate, that is, $r^e = 1$.

The game can be represented as follows.

		Incumbent Bank	
		Monopoly rate	**Competitive rate**
	Solicit offer	0	1
Firm		$R^g(x_{gg}) - 1 - m + K^g(x_{gg})$	$R^g(x_{gg}) - 1 - m + K^g(x_{gg})$
	Don't solicit offer	$R^g(x_{gg})$	1
		$K^g(x_{gg})$	$R^g(x_{gg}) - 1 + K^g(x_{gg})$

Examination of the game shows that there is no pure strategy equilibrium. If the firm solicits an offer from the incumbent, the bank's best response is to offer the competitive rate, but if the bank offers the competitive rate the firm's best response is to save the cost of soliciting an offer.[15] In a mixed-strategy equilibrium, the firm must be indifferent between soliciting a competing offer and not soliciting an offer, that is,

$$[R^g(x_{gg}) - 1 - m + K^g(x_{gg})] = \eta K^g(x_{gg}) + (1-\eta)[R^g(x_{gg}) - 1 + K^g(x_{gg})],$$

[15]Note that this logic also rules out a pooling equilibrium in which bad firms also solicit offers with positive probability. That is, any pooling equilibrium in which the bad firm mimicked good firms would also involve mixed strategies. But since the strategy can't be observed, the bad firm would have no incentive to solicit competitive bids by our preceeding argument.

and the incumbent bank must be indifferent between charging the monopoly rate and the competitive rate,

$$(1-\delta)R^g(x_{gg}) = 1.$$

Solving these two equations yields profit expressions (9) and (10) in Lemma 1.

Intuitively, each of the players has a pure strategy with a payoff that is independent of the other's strategy. If the borrowing firm chooses 'solicit' its payoff is always $R^g(x_{gg}) - 1 - m + K^g(x_{gg})$, and if the incumbent lender chooses 'competitive rate' its payoff is always 1. Since the agents are indifferent between the strategies in a mixed-strategy equilibrium, these must be the agents' expected profits.

It is immediate that the firm will seek a competitive offer with positive probability only if m satisfies

$$R^g(x_{gg}) - 1 - m + K^g(x_{gg}) \geq R^g(x_o) - r_o + K^g(x_o).$$

(Note that we are assuming that $R^g(x_o) > r_o$, as we shall throughout the rest of the paper.) Otherwise, the good firm would prefer to simply honor the original contract and stay with the incumbent. **QED**

3.2 The firm's production decision

In this section we show how the bargaining environment affects equilibrium production choices. Firms with bad indicators will always honor the original contracts, whatever the bargaining environment. However, firms with good indicators must make a choice. In particular, a good firm with a positive indicator must decide whether to make an efficient production decision and breach the contract or simply to honor the original contract. The decision will depend on the likelihood of a favorable bargaining environment, which, in turn, depends on the likelihood that competition will strengthen the firm's bargaining position.[16]

First consider a firm with a bad indicator, i.e., $s = b$. Given inequality (8), the incumbent bank would prefer to liquidate the firm (if possible) and a new entrant would prefer to invest any new funds in storage than to make a loan, whatever the firms choice of $x_{jb},\ j = g, b$.[17] Thus, any firm with $s = b$ will always choose to honor the initial contract, that is,

$$x_{jb} = x_o,\ j = g, b. \tag{12}$$

Thus, the collateral requirement reduces agency costs. Without the collateral constraint, the bad firm would always inefficiently choose $x_{bs} = 0$—which is inefficient by assumption (3)—because the firm knows that it will retain its growth opportunities $K^b(x_{bs})$, even though it will always default in period 2. It is in the bad firm's best interest to maximize the value of its growth opportunities even though this inefficiently reduces its period 2 revenues. Thus, a collateral constraint, enforced by a credible threat to liquidate the firm in the event of breach, forces the bad firm to produce more revenues that it otherwise would.

Now consider a firm with $s = g$. From inequality (7), the incumbent bank would always prefer to make an offer to the firm, as would an entrant bank, whatever the firm's choice of x_{gg}. The firm will choose between two values:

[16] Bad firms with positive indicators simply make the same production decision as the good firm with a positive indicator.

[17] If inequality (8) is not satisfied for any x, the contract is unenforceable because the collateral requirement will be ignored by the borrower. If it is satisfied for some $x' < x_o$, then the contract will set the collateral requirement at x'.

$$x_{gg} = \begin{cases} 0 \; if \; \lambda[R^g(0) - 1 - m + K^g(0)] + (1-\lambda)K^g(0) \geq R^g(x_o) - r_o + K^g(x_o) \\ x_o, \; otherwise. \end{cases} \tag{13}$$

To see why this must be true, note first that the $x_{gg} = 0$ maximizes joint surplus, given assumption (3).[18] However, the good firm places itself in a strategically vulnerable position whenever it breaches the contract by choosing $x_{gg} < x_o$. With probability λ the market is competitive and the firm captures the full contractual surplus (minus the added costs, m, of reducing the informational asymmetry between the incumbent bank and the potential entrant). However, with probability $1-\lambda$, the firm will be engaged in a bilateral bargaining game with the incumbent bank and—given our polar assumption that the lender has all the bargaining power—the firm retains only the (nontransferable) growth opportunities in the event of breach. The equilibrium outcome then depends on the probability of a plentiful supply of funds (λ) generating ex post competition, among other factors. Under competitive market conditions (high λ), the inequality is likely to hold and the firm will breach the contract in the expectation that it will capture a sufficiently large share of the contractual surplus. In a noncompetitive market (low λ), the firm expects to keep little beyond its growth opportunities. In the following section we discuss inequality (13) in more detail.

Since it plays no further role in our analysis, it is convenient to assume that $m \approx 0$ and to drop the term from here on in.

[18]If inequality (7) holds only for some $x > 0$, then the firm with a good indicator will choose this level, as long as it is less than the contractual collateral requirment. This wouldn't change anything in the analysis.

4 Optimal Contracts

In this section we present our main results. After stating the general contracting problem, we consider two separate regimes. First we assume that the inequality in (13) doesn't bind, so the expected benefits of renegotiation to the borrower outweigh the costs of placing himself in a strategically vulnerable position when in breach of the contract. As we show, the inequality in (13) doesn't bind when the market is sufficiently competitive, so we refer to this region as one of *strong competition.* When competition is strong, an increase in competition reduces the stringency of the collateral requirement (under reasonable conditions). We then examine the relationship between the degree of competition and agents' incentive to bargain. First we show that the the inequality in (13) becomes less binding as λ increases. When competition is weak contracts must contain inefficiently low collateral requirements to induce the borrower to bear the strategic risk of remedying contractual inefficiencies through renegotiations. In this case, nonnegotiable contracts may dominate negotiable contracts. We also show that when competition is weak an increase in the degree of competition leads to a decline in the stringency of the negotiable contract (again, under reasonable conditions).

In general, the optimal renegotiable contract solves the following problem:

$$\begin{aligned}
\max_{\langle r_o, x_o\rangle} \Pi^f(r_o, x_o) \quad = \quad & p\left(\frac{1+q_o}{2}\right)\{\lambda[R^g(0) - 1 + K^g(0)] + (1-\lambda)K^g(0)\} \\
& +(1-p)\left(\frac{1-q_o}{2}\right)\{[R^b(0) - r_o, 0]^+ + K^g(0)\} \\
& +p\left(\frac{1-q_o}{2}\right)\{[R^g(x_o) - r_o, 0]^+ + K^g(x_o)\}
\end{aligned}$$

$$+(1-p)\left(\frac{1+q_o}{2}\right)\{[R^b(x_o)-r_o,0]^+ + K^b(x_o)\} \quad (14)$$

s.t.

$$\begin{aligned}
\Pi^b(r_o,x_o) &= p\left(\frac{1+q_o}{2}\right)(1-\lambda)\{R^g(0)-1\} \\
&+(1-p)\left(\frac{1-q_o}{2}\right)\{[R^b(0),r_o,]^- - 1\} \\
&+p\left(\frac{1-q_o}{2}\right)\{[R^b(x_o),r_o]^- - 1\} \\
&+(1-p)\left(\frac{1+q_o}{2}\right)\{[R^b(x_o),r_o]^- - 1\} - \frac{cq_o^2}{2} \geq 0, \quad (15)
\end{aligned}$$

$$q_o = \arg\max_q \ \Pi^b(r_o,x_o), \quad (16)$$

and

$$\lambda[R^g(0)-1+K^g(0)] + (1-\lambda)K^g(0) \geq R^g(x_o) - r_o + K^g(x_o). \quad (17)$$

Expression (14) denotes the firm's expected profits, expression (15) denotes the bank's participation constraint, expression (16) is the incentive compatibility condition for the bank's level of monitoring, and inequality (17) ensures that the borrower with $s = g$ chooses $x_{jg} = 0$ and seeks to renegotiate the contract. Remember that each bank chooses its monitoring level in period 0 *before* the firm approaches one of the banks for a loan. Since the banks are completely symmetric at this point, it is convenient to drop the scaling term 1/2.

Expressions (14) and (15) incorporate the results of the last two sections that a firm with $s = g$ chooses $x_{jg} = 0$ and either renegotiates the contract with the initial lender or signs a contract with a new lender, while a firm with $s = b$ honors the initial contract. They also incorporate Lemma 1; in particular, the first term of expression (15) incorporates the result that the initial lender receives zero profits when it faces competition.

4.1 Optimal contracts when competition is strong

In this subsection we assume that inequality (17) doesn't bind. We present (reasonable) conditions under which the optimal loan contract requires less collateral when the market becomes more competitive.

Proposition 2 *Assume that inequality (17) doesn't bind: (i) Then an increase in the degree of competition reduces the stringency of the collateral constraint if and only if an increase in the steepness of the monitoring cost function decreases the equilibrium expenditure on monitoring.*

$$\left\{\frac{dx_o}{d\lambda} < 0\right\} \Longleftrightarrow \left\{\frac{dq_o}{dc} < 0\right\}. \tag{18}$$

(ii) Both conditions are true if and only if,

$$\begin{aligned} &\{-c(1-q_o)\}\left\{p\left(\frac{1+q_o}{2}\right)[R^g_{xx}+K^g_{xx}] + p\left(\frac{1-q_o}{2}\right)[R^g_{xx}+K^g_{xx}]\right\} \\ > \;& \left\{\left(\frac{1-p}{2}\right)R^b_x\right\}\left\{-\frac{p}{2}[R^g_x+K^g_x] + \left(\frac{1-p}{2}\right)[R^b_x+K^b_x]\right\} \end{aligned} \tag{19}$$

Proof: In Appendix A.

The intuition behind Proposition 2 is as follows. The optimal collateral requirement maximizes the bank's and the firm's expected joint profits—*given* the bank's level of monitoring. This yields the very intuitive first-order condition for x_o,

$$p\left(\frac{1-q_o}{2}\right)[R^g_x(x_o)+K^g_x(x_o)] + (1-p)\left(\frac{1+q_o}{2}\right)[R^b_x(x_o)+K^b_x(x_o)] = 0. \tag{20}$$

This first-order-condition clearly displays the main trade-off that determines the optimal level of collateral. Given assumption (3), the first term (the marginal cost of the collateral requirement) is negative and the second term (the marginal benefit of the collateral requirement) is positive. The collateral requirement balances the marginal cost—lost growth opportunities for a good buyer that has been misclassified—against the marginal benefit—greater control over a bad borrower that has been correctly identified. Note that the expected marginal cost of the collateral requirement is decreasing in the accuracy of the indicator, while the expected marginal benefit is increasing in the accuracy of the indicator

In a more competitive market the bank's expected rents from negotiations are lower; thus, the bank's marginal return to monitoring is lower at any given level of required collateral. This follows, since the bank receives these rents only when the good firm is correctly identified, and then, only to the extent that these rents are not captured by the firm through competition—that is, with probability $p\left(\frac{1+q_o}{2}\right)(1-\lambda)$. If the substitution effect of a change in the net payoff to monitoring dominates the income effect—the intuition underlying the requirement that $\frac{dq_o}{dc} < 0$ in (18)—the bank monitors less when its bargaining rents are lower. (In the proof of Proposition 2 in the appendix, we show that $\frac{dq_o}{d\lambda} < 0 \iff \frac{dq_o}{dc} < 0$.) Since the indicator is less accurate at lower levels of monitoring, the marginal cost of the collateral requirement rises and the marginal benefit of the collateral requirements falls as monitoring declines. Accordingly, the optimal collateral requirement is lower when competition is stronger.

Condition (19) makes more precise the conditions in which substitution effect in the net payoff to monitoring dominates the income effect. Consider the two bracketed terms on the left-hand side of condition (19). If the monitoring cost function is relatively steep, a small reduction in monitoring leads to a large decline in the cost of monitoring. When the curvature of the firm's payoff function in the collateral level is high, only a small decline in the collateral requirement is needed reduce the inefficiencies arising from a less precise indicator. Thus, the optimal contract adjusts to a decline in the net return to monitoring by inducing a lower level of monitoring and reducing the stringency of the collateral constraint.[19]

4.2 Optimal contracts when competition is weak

First, we present conditions in which constraint (17) is violated for the contract that maximizes (14) subject to (15), and (16). Our main result is that the constraint becomes less binding as market becomes more competitive, so this contract may be infeasible when the loan market is sufficiently noncompetitive. We also show that when competition is weak, the covenant level must be set inefficiently low to satisfy constraint (17), so as to induce the borrower to seek to renegotiate the contract.

Our main result concerning the relationship between the degree of competition and the feasibility of negotiations is the following proposition.

Proposition 3 *Let $\langle r_o(\lambda), x_o(\lambda)\rangle$ maximize (14) subject to (15), and (16). If $\frac{dx_o}{d\lambda} < 0$, there exists $\tilde{\lambda}$ such that,*

$$\{\lambda[R^g(0) - 1 + K^g(0)] + (1-\lambda)K^g(0) < R^g(x_o(\lambda)) - r_o(\lambda) + K^g(x_o(\lambda))\} \Longleftrightarrow \left\{\lambda < \tilde{\lambda}\right\}. \tag{21}$$

Proof: In Appendix A.

[19] While condition (19) is reasonable, it is not satisfied automatically. If the inequality is reversed, an increase in competition leads to less monitoring and lower collateral requirements. The condition would not hold, for example, if the monitoring function were linear.

The expression in left brackets is simply constraint (17) reversed. Part of the intuition behind Proposition 3 is obvious from an inspection of the left-hand side of the inequality. When the borrower expects that bargaining rents will flow mainly to the bank (λ low), the decision to breach the contract and to seek a remedy through renegotiation, will appear less attractive; that is, the left-hand side of the inequality in the left brackets is declining in λ. But the matter is slightly more subtle than this. We know from Proposition 2 that the collateral requirement is more stringent at low levels of competition, and examination of the right-hand-side of the inequality shows that—holding the loan rate constant—the *initial* contract is *also* unattractive to a borrower constrained by a stringent collateral requirement. So, both sides of the inequality are low when competition is weak (λ low).

Of course, the loan rate doesn't remain constant as the level of competition changes. At low levels of competition, the initial lender expects to capture substantial rents in negotiations, both because of its bargaining power in bilateral negotiations and because the indicator will accurately identify the good borrower much of the time. (Remember, monitoring—and, thus, the accuracy of the indicator—increases as competition decreases.) The greater accuracy of the indicator means that the bank captures a larger share of its payoffs from borrowers who have been correctly identified, that is, from: (i) renegotiations with good borrowers—with probability $p\left(\frac{1+q_o}{2}\right)(1-\lambda)$; and from (ii) bad borrowers forced to produce revenues by the initial collateral requirement—with probability $p\left(\frac{1+q_o}{2}\right)$. It also captures a smaller share of its revenues through the loan rate, which is paid only by good borrowers who are inefficiently constrained—with probability $(1-p)\left(\frac{1-q_o}{2}\right)$. Thus, when competition is weak, a relatively low loan rate satisfies the bank's participation constraint, and the right-hand-side of the inequality is relatively high even though the collateral requirement is stringent. In a fundamental sense, the level of monitoring is *too high* to sustain renegotiation.[20]

We say that competition is weak if $\lambda < \tilde{\lambda}$, . When competition is weak the optimal renegotiable contract no longer maximizes the borrower's and lender's joint profits (given the incentive compatible level of monitoring). With a slight abuse of notation, let $\langle x_\lambda, r_\lambda \rangle$ denote the optimal renegotiable contract when competition is weak. This contract satisfies:

$$\lambda[R^g(0) - 1 + K^g(0)] + (1-\lambda)K^g(0) = R^g(x_\lambda) - r_\lambda + K^g(x_\lambda), \tag{22}$$

the bank's zero profit constraint, (15), and the incentive compatibility condition for monitoring, (16). The main features of this contract are contained in the following proposition,

Proposition 4 *(i) When competition is weak the collateral requirement is lower than the level that maximizes the borrower's and lender's joint profits (given the bank's chosen level of monitoring), that is, $x_\lambda < x_o(\lambda)$. (ii) In this region an increase in the degree of competition reduces the stringency of the collateral constraint if and only if an increase in the steepness of the monitoring cost function decreases the equilibrium expenditure on monitoring, that is,*

$$\left\{ \frac{dx_o(\lambda)}{d\lambda} < 0 \right\} \Longleftrightarrow \left\{ \frac{dq_o}{dc} < 0 \right\}. \tag{23}$$

Proof. In Appendix A. ■

The intuititon behind this result follows immediately from the discussion following Proposition 3. When competition is weak the borrower's strategic vulnerability inhibits renegotiation. The initial contract must be designed to induce the good borrower to make an efficient production choice and seek to remedy the contract breach through negotiations.

[20]However, note that q_o is *below* the level that would be chosen if the contract and monitoring level were chosen to maximize expected joint profits in period 0.

This requires an inefficiently low collateral requirement to reduce the lender's incentive to monitor, since we know that $x_o(\lambda)$ and $q_o(\lambda)$ were *too high* to satisfy constraint (17). Of course, there is a loss of efficiency when the constraint binds. On the one hand, monitoring is further below the first best level. In addition,

$$p\left(\frac{1-q_\lambda}{2}\right)\left[R_x^g(x_\lambda)+K_x^g(x_\lambda)\right]+(1-p)\left(\frac{1+q_\lambda}{2}\right)\left[R_x^b(x_\lambda)+K_x^b(x_\lambda)\right]>0, \tag{24}$$

because $x_\lambda < x_o$. Compare this with the first order condition (20) when competition is strong. When competition is weak, the collateral requirement imposes too little control over the bad borrower.

A potentially interesting implication of the preceding analysis is that competitive conditions affect the value of the option to renegotiate contracts. In the case of a quadratic cost function, when (21) holds a renegotiable contract always dominates a contract without renegotiation.[21] This is no longer true when (21) is violated, because the constraint imposes a second restriction in addition to the incentive compatibility condition for the bank's level of monitoring, the inefficiently low collateral requirement. In Appendix B, we describe the optimal nonnegotiable contract.

Empirically, the model suggests that when the supply of funds to the banking sector is very tight, we are likely to observe two types of contractual adaptations. Some borrowers retain a close lending relationship with their bank—in the sense that the borrower can expect the lender to take seriously requests to renegotiate contractual clauses. However,

[21]For any continuous cost function where $c(0) = 0$, the first-order condition for x_o in the renegotiable contract approaches that of a nonnegotiable contract. (See condition (20)). For a cost function with $c(0) > 0$, a nonnegotiable contract might dominate for suffciently high fixed cost. However, the main point—that a lax collateral constraint designed to satisfy (17) makes the option to negotiate less valuable—is general.

collateral requirements and covenants are high for these borrowers and the bank's required compensation for adjusting contracts through renegotiation is also high. Other borrowers may shift to nonbank sources—for example, finance companies—for which renegotiation is difficult or impossible.

5 Conclusion and directions for future research

In this paper we present two main results. The first examines a claim often made by bankers that competitive pressures in loan markets compel them to soften contract terms, in particular, to lower collateral requirements and to relax covenant restrictions. We present a formal model in which an increase in competition *can* lead to less stringent collateral requirements. In our model, initial contracts are designed to be very stringent, in the expectation that they can be renegotiated in light of evolving information. But renegotiation requires the lender to produce information about the borrower, and the lender's monitoring effort is chosen to maximize its own profits. More competition reduces the lender's bargaining rents, thereby reducing the bank's private return to monitoring. When lenders monitor less their information is less accurate, and fine-tuning the initial contract through renegotiation becomes more difficult. In turn, the initial contracts are optimally less stringent.

Our second finding is that that low levels of competition can lead to bargaining difficulties. Borrowers put themselves at strategic risk when they breach a contract in the expectation that the breach will be remedied through renegotiation. When competition is weak, borrowers may prefer to honor the original contract, rather than risk being put at a bargaining disadvantage in bilateral negotiations. When the likelihood of receiving an offer from a competing lender is too low, renegotiable contracts impose inefficiently lax collateral requirements, that is, the level of collateral is lower than the level that maximizes the borrowers's and lender's joint profits (conditional on the level of monitoring). This inefficiency makes renegotiable contracts relatively less profitable, and some borrowers may shift to funding sources where renegotiation is impossible.

While the model might be enriched in many ways, our main goal is to empirically test the relationship between competitive conditions and contractual form. Although this paper has taken the anecdotal and survey evidence at face value, market participants may well be drawing false inferences when they report that loan terms are less stringent because of competitive forces. The main challenge in this investigation is to distinguish the effects of competitive conditions and the default risk; specifically, periods in which the supply of funds increases are also periods in which default risk decreases. In a companion paper, we are using the Federal Reserve System's Survey of Terms of Bank Lending to examine the extent the relationship between the use of collateral and the degree of competition.

6 Figure: The timing of the model

Period 0

Both banks invest q in monitoring.

\$1 of funds arrives at one of the banks.

Loan Contract is signed

Between Period 0 and Period 1

Firm learns type $j \in \{g, b\}$.

Firms and banks observe indicator $s \in \{g, b\}$.

Firm makes production choice x_{js}

The supply of funds ($F \in \{1, 2\}$) is realized.

Period 1

Firm chooses whether to approach new lender.

Firm may negotiate new contract.

Incumbent may liquidate firm in breach of contract.

Period 2

Firm produces revenues and makes loan payments.

7 Appendix A

Proof of Proposition 2:

Maximizing the bank's expected profits with respect to q_o—assuming that $R^g(x) > r_o$ and given $R^g(x) < r_o$—we obtain the first-order condition for q_o,[22]

$$\frac{p}{2}(1-\lambda)R^g(0) - \left(\frac{1-p}{2}\right)R^b(0) - \frac{p}{2}r_o + \left(\frac{1+p}{2}\right)R^b(x_o) - cq_o = 0. \tag{25}$$

Solving (15) and (25) for $\frac{p}{2}r_o$ we obtain,

$$\Pi^B(r_o, x_o) \equiv \frac{p}{2}(1-\lambda)[R^g(0)-1] + \left(\frac{1-p}{2}\right)[R^b(x_o)-1] - \left[\frac{cq_o^2}{2} + cq_o(1-q_o)\right] = 0. \tag{26}$$

An optimal contract that maximizes the borrower's expected profits subject to a zero profit constraint for the lender—given the bank's prior choice of q— must maximize joint profits. Using expressions (14) and (15) we have an expression for joint profits:

$$\begin{aligned}\Pi^J(r_o, x_o) \quad = \quad & p\left(\frac{1+q_o}{2}\right)[R^g(0)+K^g(0)] \\ & +(1-p)\left(\frac{1-q_o}{2}\right)[R^b(0)+K^b(0)] \\ & +p\left(\frac{1-q_o}{2}\right)[R^g(x_o)+K^g(x_o)] \\ & +(1-p)\left(\frac{1+q_o}{2}\right)[R^b(x_o)+K^b(x_o)] - 1 - \frac{cq_o^2}{2}\end{aligned} \tag{27}$$

Maximizing this expression with respect to x_o we get,

[22] The first-order approach is appropriate because the probability distribution prob$(s = j' \mid j = j')$ obeys first-order stochastic dominance. That is, $p(s = g \mid t = g)$ and $p(s = b \mid t = b)$ are both increasing in q.

$$\Pi_x^J = p\left(\frac{1-q_o}{2}\right)[R_x^g(x_o)+K_x^g(x_o)] + (1-p)\left(\frac{1+q_o}{2}\right)[R_x^b(x_o)+K_x^b(x_o)] = 0. \qquad (28)$$

Note that the first-order condition for x_o contains no term that includes λ or c; as long as conditions (7), (8), and the inequality in (13) hold, only firms with $s = b$ actually hold collateral.

Equations (26) and(27) can be solved for x_o and q_o. To establish Proposition 1, totally differentiate equations (26) and(27). The relevant partial derivatives are,

$$\begin{aligned}
\Pi_{xx}^J &= p\left(\frac{1+q_o}{2}\right)[R_{xx}^g + K_{xx}^g] + p\left(\frac{1-q_o}{2}\right)[R_{xx}^g + K_{xx}^g] < 0,\ \textit{by (1) and (2)},\\
\Pi_{xq}^J &= -\frac{p}{2}[R_x^g + K_x^g] + \frac{1-p}{2}[R_x^b + K_x^b] > 0,\ \textit{by (3)},\\
\Pi_{x\lambda}^J &= 0,\\
\Pi_{xc}^J &= 0,\\
\Pi_{qx}^B &= \left(\frac{1-p}{2}\right)R_x^b > 0,\ \textit{by (1)},\\
\Pi_{qq}^B &= -c(1-q_o) > 0,\\
\Pi_{q\lambda}^B &= -\frac{p}{2}[R^g(0)-1] < 0,\ \textit{by (4)}.\\
\Pi_{qc}^B &= -[cq_o - q_o(1-q_o) < 0. \qquad (29)
\end{aligned}$$

Then, using Cramer's rule we obtain,

$$\left\{\frac{dx_o}{d\lambda} = A^{-1}\Pi_{q\lambda}^B\Pi_{xq}^J < 0\right\} \Longleftrightarrow \{A > 0\}, \qquad (30)$$

where,

$$A \equiv \Pi_{xx}^J\Pi_{qq}^B - \Pi_{xq}^J\Pi_{qx}^B. \qquad (31)$$

We also have

$$\left\{\frac{dq_o}{dc} = -A^{-1}\Pi^B_{qc}\Pi^J_{xx} < 0\right\} \Longleftrightarrow \{A > 0\}\,, \tag{32}$$

and for use in the proof of Proposition 2,

$$\left\{\frac{dq_o}{d\lambda} = -A^{-1}\Pi^B_{q\lambda}\Pi^J_{xx} < 0\right\} \Longleftrightarrow \{A > 0\} \tag{33}$$

$A > 0$ requires that the curvature of the payoff functions, $R^j_{xx} + K^j_{xx},\ j = g, b$, and of the monitoring function, c, be large compared to the cross partials, Π^J_{xq} and Π^B_{qx}.

QED

Proof of Proposition 3:

Rearrange the first-order condition for q_o, equation (25), to get,

$$(1-\lambda)R^g(0) - r_o = \frac{2}{p}cq_o - \lambda - \frac{1-p}{p}\left[R^b(x_o) - R^b(0)\right]. \tag{34}$$

Add $R^g(0)$ to both sides of inequality (21) to get,

$$[R^g(0) + K^g(0)] - [R^g(x) + K^g(x)] - \lambda = (1-\lambda)R^g(0) - r_o \tag{35}$$

Substituting (34) into (35) and rearranging yields the condition that $x_{gg} = 0$ if and only if

$$\frac{p}{2}[(R^g(0) + K^g(0)) - (R^g(x_o) + K^g(x_o))] + \left(\frac{1-p}{2}\right)\left[R^b(x_o) - R^b(0)\right] - cq_o \geq 0. \tag{36}$$

We must show that the left-hand-side of this inequality is increasing in λ. Differentiating this with respect to λ,

$$\left(-\frac{p}{2}(R^g_x + K^g_x) + \frac{1-p}{2}R^b_x\right)\frac{dx_o}{d\lambda} - c\frac{dq_o}{d\lambda}, \tag{37}$$

and substituting for $\frac{dx_o}{d\lambda}$ and $\frac{dq_o}{d\lambda}$from (30) and (33) this expression can be rewritten

$$\left(\frac{\Pi^B_{q\lambda}}{A}\right)\left\{\left[-\frac{p}{2}[R^g_x+K^g_x]+\left(\frac{1-p}{2}\right)[R^b_x+K^b_x]\right]\left[-\frac{p}{2}[R^g_x+K^g_x]+\left(\frac{1-p}{2}\right)R^b_x\right]+c\Pi^J_{xx}\right\}. \tag{38}$$

Since the first expression is negative, given (29), and since $A > 0$, this is increasing in λ if and only if,

$$-c\Pi^J_{xx} > \left(-\frac{p}{2}[R^g_x+K^g_x]+\left(\frac{1-p}{2}\right)[R^b_x+K^b_x]\right)\left(-\frac{p}{2}[R^g_x+K^g_x]+\left(\frac{1-p}{2}\right)R^b_x\right). \tag{39}$$

Using (29) and (31), the condition for $A > 0$ can be written,

$$-c(1-q_o)\Pi^J_{xx} > \left(-\frac{p}{2}[R^g_x+K^g_x]+\left(\frac{1-p}{2}\right)[R^b_x+K^b_x]\right)\left(\frac{1-p}{2}\right)R^b_x. \tag{40}$$

Inequality (39) can be rewritten,

$$\frac{-c\Pi^J_{xx}}{-\frac{p}{2}[R^g_x+K^g_x]+\frac{1-p}{2}[R^b_x+K^b_x]} > -\frac{p}{2}[R^g_x+K^g_x]+\left(\frac{1-p}{2}\right)R^b_x, \tag{41}$$

and inequality (41) can be rewritten,

$$\frac{-c\Pi^J_{xx}}{-\frac{p}{2}[R^g_x+K^g_x]+\frac{1-p}{2}[R^b_x+K^b_x]} > \frac{\left(\frac{1-p}{2}\right)R^b_x}{1-q_o}. \tag{42}$$

Then, inequality (42) is more binding than inequality (41) if,

$$\frac{\left(\frac{1-p}{2}\right)R^b_x}{1-q_o} > -\frac{p}{2}[R^g_x+K^g_x]+\left(\frac{1-p}{2}\right)R^b_x, \tag{43}$$

or, rearranging,

$$\left(\frac{1-p}{2}\right)R^b_x > -p\left(\frac{1-q_o}{2}\right)[R^g_x+K^g_x]+(1-p)\left(\frac{1-q_o}{2}\right)R^b_x, \tag{44}$$

and using the first-order condition for x_o

$$\left(\frac{1-p}{2}\right) R_x^b > -(1-p)\left(\frac{1+q_o}{2}\right)[R_x^b + K_x^b] + (1-p)\left(\frac{1-q_o}{2}\right) R_x^b, \tag{45}$$

and rearranging,

$$(1-p)\left(\frac{q_o}{2}\right) R_x^b > -(1-p)\left(\frac{1+q_o}{2}\right)[R_x^b + K_x^b]. \tag{46}$$

This must be true, since the left-hand-side is positive and the right-hand-side is negative, given (1) and (3). Thus, we have shown that $\{A > 0\} \Longrightarrow \{\text{expression (37)} > 0\}$

QED

Proof of Proposition 4

From the proof of Proposition 3, we can write equality (22),

$$\frac{p}{2}[(R^g(0) + K^g(0)) - (R^g(x_\lambda) + K^g(x_\lambda))] + \left(\frac{1-p}{2}\right)\left[R^b(x_\lambda) - R^b(0)\right] - cq_\lambda = 0. \tag{47}$$

Differentiating this constraint and $\Pi^B(x_\lambda, r_\lambda)$—defined in (26)—with respect to $x, q, c,$ and λ, we calculate (using Cramer's rule),

$$\frac{dx_\lambda}{d\lambda} = \frac{c\left(\frac{p}{2}\right)[R^g(0)] - 1]}{-c(1-q_\lambda)\left[-\frac{p}{2}(R_x^g + K_x^g) + \left(\frac{1-p}{2}\right) R_x^b\right] + c\left(\frac{1-p}{2}\right) R_x^b}, \tag{48}$$

and,

$$\frac{dx_\lambda}{dc} = \frac{\frac{cq_\lambda^2}{2}}{-c(1-q_\lambda)\left[-\frac{p}{2}(R_x^g + K_x^g) + \left(\frac{1-p}{2}\right) R_x^b\right] + c\left(\frac{1-p}{2}\right) R_x^b}. \tag{49}$$

The numerators of expressions (48) and (49) are positive and the numerators are the same. Thus,

$$\left\{\frac{dx_\lambda}{dc}<0\right\} \iff \left\{\frac{dx_\lambda}{d\lambda}<0\right\} \iff$$
$$\left\{-c(1-q_\lambda)\left[-\frac{p}{2}(R_x^g+K_x^g)+\left(\frac{1-p}{2}\right)R_x^b\right]+c\left(\frac{1-p}{2}\right)R_x^b<0\right\} \quad (50)$$

This proves (ii). To see that (i) is true, use (36). Since inquality (17) is not satisfied at $\langle r_o(\lambda), x_o(\lambda)\rangle$, and since it is satisfied with equality at $\langle r_\lambda, x_\lambda\rangle$, we have.

$$\begin{aligned} cq_o(\lambda) &> \\ \frac{p}{2}[(R^g(0)+K^g(0))-(R^g(x_o(\lambda))+K^g(x_o(\lambda))]+\left(\frac{1-p}{2}\right)\left[R^b(x_o(\lambda))-R^b(0)\right] &> \\ \frac{p}{2}[(R^g(0)+K^g(0))-(R^g(x_\lambda)+K^g(x_\lambda))]+\left(\frac{1-p}{2}\right)\left[R^b(x_\lambda)-R^b(0)\right] &= cq_\lambda \end{aligned} \quad (51)$$

QED

8 Appendix B

8.0.1 The optimal contract without renegotiation

Here we now show that contract without renegotiation can't involve monitoring. Assume that the optimal contract does not involve renegotiation because the level of competition is too low. Let $\langle r_n, x_n\rangle$ denote the optimal contract without renegotiation. Then if

$$pR^g(x_n)+(1-p)R^b(x_n)<pL^g+(1-p)L^b, \quad (52)$$

the contract is enforceable without monitoring. Inequality (52) says that the expected revenues produced by a borrower who always honors the collateral requirement are lower than the expected liquidation value of the firm in period 1. In this case, the incumbent lender would prefer to liquidate any borrower j who chose $x_j < x_n$. Knowing this, the borrower would choose $x_j = x_n$.

In this case the optimal contract is the solution to the problem:

$$\max_{\langle r_n, x_n \rangle} \Pi^f(r_n, x_n) = p\{[R^g(x_n) - r_n, 0]^+ + K^g(x_n)\} + (1-p)\{[R^g(x_n) - r_n, 0]^+ + K^g(x_n)\}, \quad (53)$$

s.t.

$$\Pi^b(r_n, x_n) = p\{[R^b(x_n), r_n]^- - 1\} + (1-p)\{[R^b(x_n), r_n]^- - 1\} \geq 0, \quad (54)$$

where expression (53) denotes the borrower's expected profits and expression (54) denotes the bank's participation constraint. Note, in this case the contract is unaffected by the degree of competition. To see this, imagine a competitor offered the borrower the best possible contract $\langle r_c, x_c \rangle$ that just breaks even, that is, $r_c = R^g(x_c)$, where,

$$pR^g(x_c) + (1-p)R^b(x_c) = 1.$$

Assuming $R^g(x_n) - r_n > 0$, the original contract satisfies,

$$pr_n + (1-p)R^b(x_n) \geq 1. \quad (55)$$

For the competitor's contract to be attractive to a firm, it must be the case that $x_c < x_n$, but this implies that $r^n > R^g(x_c)$, and thus, that inequality (55) is strict, contradicting the optimality of the original contract. Note, this argument doesn't depend on parametric assumption (52)—which guarantees that the original contract is enforceable—but only on the fact that the information available to either bank in period 1 is *identical* to the information available to the initial lender when the initial contract was signed. Said differently, there is nothing to negotiate about, because there is no new information.

Now assume that inequality (52) doesn't hold, that is, the optimal non-negotiable contract is unenforceable without monitoring. One might hope that by monitoring the lender could produce an indicator that would satisfy inequality (8) and give the lender a credible threat to liquidate borrowers with a bad indicator. But since the monitoring level is chosen by the lender to maximize its expected profits, it can't credibly precommit to monitor at such a level. To see this, assume that the borrower has chosen to honor the contract on the assumption that the lender has monitored. The lender's best response is not to monitor.

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