



ELSEVIER

Journal of Banking & Finance 19 (1995) 693–711

Journal of
BANKING &
FINANCE

Capital requirements, loan renegotiation and the borrower's choice of financing source

Anjan V. Thakor, Patricia Furlong Wilson *

School of Business, Indiana University, Bloomington, IN 47405, USA

Abstract

The main objective of this paper is to theoretically examine the impact of bank capital requirements on a borrower's choice of financing source. Our focus is on the tension between regulatory taxes, such as bank capital requirements (that reduce the value of a bank loan to a borrower), and the bank's incentive to renegotiate debt terms with financially distressed borrowers (that increases the value of a bank loan to a borrower). We show that borrowers that approach banks are necessarily of *intermediate* quality. This set of borrowers diminishes as bank capital requirements increase. Surprisingly, this happens not only because bank capital requirements increase loan prices and hence reduce the value of the loan to the borrower, but also because they weaken the bank's incentive to restructure troubled loans, thereby causing a dampened loan *demand*. Additionally, holding quality fixed, growth-oriented borrowers are more likely to prefer the capital market than borrowers expecting high cash flows early when facing a sufficiently high capital requirement. Finally, the effect of capital requirement increases is asymmetric – growth-oriented borrowers are more likely than 'cash cows' to migrate from banks to the capital market when banks confront higher capital requirements.

Keywords: Banks; Capital requirements; Loan renegotiation

JEL classification: G21; G28

* Corresponding author. Tel.: (1) (812) 855-8568. Fax: (1) (812) 855-5875.

1. Introduction

The adoption of risk-based capital requirements under the Basle Accord has led to considerable discussion about the effect of this regulatory initiative on aggregate bank lending. While empiricists disagree on whether the documented reductions in bank lending since 1989 are due to lower loan demand or a curtailed supply of bank credit,¹ theoretical explanations have been provided to rationalize a cutback in bank credit in the face of risk-based capital requirements (see, for example, Thakor (1993)). There has been little theorizing, however, about the ramifications of heightened bank capital requirements on the *borrower's* choice of financing source. When bank capital requirements increase, are more borrowers likely to prefer direct capital market access to bank loans, even if the financial condition of borrowers remains unchanged? Moreover, is the effect of capital requirements on a borrower likely to depend on the borrower's intertemporal cash-flow profile?

Our main objective is to provide answers to these questions. One might argue that, in a competitive banking system, the answer to the first question should transparently be in the affirmative. An increase in bank capital requirements causes an escalation in the bank's cost of funding a loan. Since a bank's participation constraint holds tightly in a competitive equilibrium, this higher funding cost must be passed along to the borrower, so that a drop in demand is predictable with a downward sloping demand curve.

While this effect is present in our analysis, we also encounter the more interesting result that there is a loan demand curve corresponding to each level of bank capital requirements. Thus, when capital requirements increase, loan demand need not simply slide down a fixed demand curve that defines a relationship between the loan demand and the loan interest rate; it may *jump* down to a lower demand curve. This implies that relatively small increases in bank capital requirements could precipitate sharp drops in loan demand. In our model, this decline in bank loan demand represents a shift from bank borrowing to direct capital market access. That is, our model predicts that when bank capital requirements increase, there should be: (i) a reduction in aggregate bank lending (due to lower demand), and (ii) a surge in funds raised through private placements with non-bank financial intermediaries, and capital market debt issues.

Renegotiations of loan contracts between banks and borrowers in financial distress represent the principal propagation mechanism linking bank capital requirements and loan demand in our model. Although there is a variety of reasons

¹ For example, Bernanke and Lown (1991) suggest that reduced bank lending merely reflects lower loan demand or a deterioration in the financial strength of borrowers. Jacklin (1993) provides evidence that suggests that the phenomenon is supply-driven, whereas Berger and Udell (1994) provide evidence that risk-based capital did not cause a credit crunch in the U.S.

why banks play a special role in credit allocation (see, for example, Allen (1990), Diamond (1984), Millon and Thakor (1985), and Ramakrishnan and Thakor (1984)), we focus on the greater ability of banks to restructure debt contracts (as in Berlin and Mester (1992)). The benefit of a bank loan is that interim-efficient outcomes can be preserved through restructuring that is unavailable in the capital market due to coordination problems among multiple creditors. There is a tension between this benefit of bank financing on the one hand and the higher cost of bank financing due to bank capital requirements on the other. When bank capital requirements are increased, there are two effects. First, holding fixed the probability that a financially distressed borrower's loan will be restructured, the competitive loan interest rate rises. Second, the bank is less likely to restructure the loan, thereby reducing the bank's uniqueness in credit allocation. Both effects work in the same direction, making the capital market relatively more attractive. A striking result is that the overall effect of higher bank capital requirements is more adverse for growth-oriented borrowers who are likely to take relatively long to recover from financial distress than it is for borrowers who can be expected to recover more quickly from financial distress.

Our work is related to three strands of the literature. The most obvious link is to the research on capital requirements. While this literature is vast (see Bhattacharya and Thakor (1993) for a review), the main points are as follows. First, capital requirements by themselves cannot deter bank risk taking (Kahane (1977)) and may even exacerbate the problem (Besanko and Kanatas (1994)). Second, risk-based capital requirements can increase credit rationing by banks and hence depress credit supply (Thakor (1993)). Our contribution to this literature is to highlight the potential that bank capital requirements have to depress credit demand.

The second strand of the literature to which our paper is related is that on a borrower's choice of financing source (e.g., Allen (1993), Chan et al, (1990), Diamond (1991), Rajan (1992), and Wilson (1994))². This literature has shown that a variety of factors – the borrower's reputation, the nature of intrafirm incentive problems for the borrower, and the nature of the borrower's future investment opportunities – impinge on the decision of whether to borrow from a bank or the capital market. To this, our contribution is the finding that *bank-specific* factors can also influence the borrower's decision. Moreover, unlike previous analyses, we show that borrowers that approach banks are necessarily of intermediate quality, and that, holding quality fixed, the 'growth prospects' prefer the financial market and the 'cash cows' prefer banks.

The third relevant strand of the literature is that on loan renegotiations. Berlin and Mester (1992) show that borrowers likely to receive significant post-lending

² There are also papers on optimal contracting that do not focus on explaining the financing source choice, but have implications in that regard. See, for example, Hirshleifer and Suh (1992).

information prefer banks due to their relative advantage in restructuring ex post inefficient contracts. Chemmanur and Fulghieri (1994) present a choice-of-financing-source model in which banks devote more resources to renegotiations than do public providers of debt because of reputational concerns. Gorton and Kahn (1993) consider the effects of bank loan renegotiation risk taking. The basic premise of these papers, that banks are better suited to renegotiate loans, is our starting point.

What follows is organized in four sections. Section 2 contains a development of the model. The analysis appears in Section 3. The model is extended in Section 4. Section 5 concludes.

2. The model

The key players in the model are banks, borrowers and the capital market. Every borrower can choose whether to borrow from a bank or go to the capital market. We assume universal risk neutrality.

2.1. *The capital market*

Credit is available to borrowers at perfectly competitive terms, where r is the riskfree rate. This financing is provided by numerous investors, and coordination difficulties are assumed to make it impossible to renegotiate any debt contracts. In particular, we assume that individual investors have the incentive to free ride by letting *other* investors provide the additional financing to a distressed borrower that is needed to make all borrowers better off, and that nonbanks cannot resolve this free-rider problem.

2.2. *Banks*

The banking industry is perfectly competitive, so that interbank competition ensures that each bank prices each loan to earn zero expected profit over the entire planning horizon (not necessarily every period). Deposits are available to banks in perfectly elastic supply at a subsidized, below-market interest rate, reflecting the possibly unique transactions attributes of deposits. Deposit insurance is assumed to be complete, so deposits are riskfree and would yield r if they were viewed purely as an investment vehicle by depositors. Given the other attributes of deposits, however, we assume they yield less than r , and normalize the deposit interest rate at zero. Capital is available to banks at competitive terms, so that r is the expected return demanded by capital providers. Each bank is subject to a capital requirement that mandates that each dollar loaned must be funded with at least ψ capital. One could think of this as a risk-based capital requirement in that it applies only to loans. For simplicity, however, we assume that banks can invest only in loans. Additionally, banks face the cost C per dollar on all funds raised, whether from

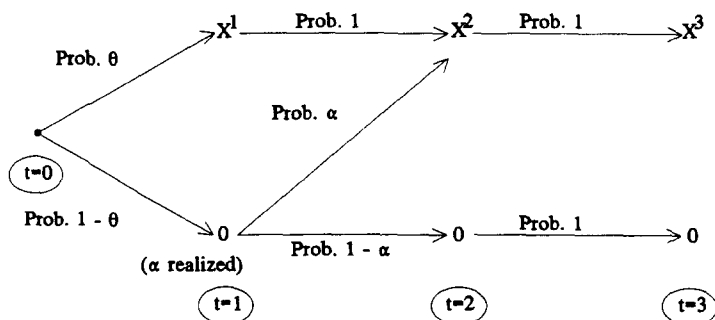


Fig. 1. Intertemporally correlated project payoffs.

deposits or capital. This is the cost for 'being a bank' and includes compliance and business restrictions.³ We can now specify the marginal cost of bank funds as τ . The required expected return, $1 + \tau = (1 - \psi) + \psi(1 + r) + C$, is the fraction of deposits $(1 - \psi)$ multiplied by the cost of deposits, the fraction capital (ψ) multiplied by the cost of capital $(1 + r)$, and the regulatory cost C . Thus, $\tau = \psi r + C$. We consider the case, $\tau > r$, so that bank financing is more costly than capital market financing, *ceteris paribus*. Note that τ is increasing in ψ as shown by the following:

$$\frac{\partial \tau}{\partial \psi} = r > 0. \quad (1)$$

Banks are assumed to be specialists in renegotiating loans when it is efficient to do so.⁴ We elaborate on this later.

2.3. Borrowers

The borrowing firm operates over three time periods delineated by four points in time, and has three distinct projects it can invest in over those three periods. Each project has a two-state payoff and requires a \$1 investment. At $t = 0$ (the start of the first period), the firm borrows \$1 from either a bank or the capital market to finance a risky single-period project. At $t = 0$ it is common knowledge that the first-period project will succeed and pay off $x^1 > 1$ at $t = 1$ with probability (w.p.) $\theta \in (0, 1)$; w.p. $1 - \theta$ the project will fail and pay off nothing. There is cross-sectional heterogeneity in θ , with each borrower's θ at $t = 0$ being common knowledge.

³ Thakor and Beltz (1993, 1994) show that regulatory compliance cost impose a significant burden on banks.

⁴ We ignore the potential costs and benefits of bankruptcy. We are implicitly assuming that the costs are sufficiently high so that future funding after bankruptcy is not possible.

Project payoffs are intertemporally correlated as shown in Fig. 1. If x^1 is realized at $t = 1$, then the second-period project succeeds and pays off $x^2 > 1 + r$ at $t = 2$ w.p. 1. And success on the second-period project at $t = 2$ means that the third-period project succeeds and pays off $x^3 > 1 + r$ w.p. 1 at $t = 3$. On the other hand, if the first-period project fails *and* the firm is able to borrow \$1 to invest in the second-period project, then the second-period project succeeds and pays off x^2 w.p. $\alpha \in (0,1)$ at $t = 2$ and fails (zero payoff) w.p. $1 - \alpha$. Viewed at $t = 0$, α is a random variable that is realized at $t = 1$ and has a probability density function $q(\alpha|\theta)$ and cumulative distribution function $Q(\alpha|\theta)$. Let $q(\alpha|\theta) > 0 \forall \alpha \in A(\theta)$ and 0 everywhere else. Moreover, $\lim_{\theta \rightarrow 0} Q(\alpha|\theta) = 1$. We assume that θ orders the Q 's in a first-order stochastic dominance (FOSD) relationship, with $Q(\hat{\alpha}|\theta_1) < Q(\hat{\alpha}|\theta_2)$ for $\theta_1 > \theta_2$ and a fixed $\hat{\alpha}$. If the second-period project succeeds at $t = 2$, then a \$1 investment in the third-period project at $t = 2$ results in success and a payoff of x^3 at $t = 3$ w.p. 1. If the second-period project fails at $t = 2$, then the third-period project fails w.p. 1 at $t = 3$.

At each point in time, the firm has the option to either invest the \$1 it borrows in a project or to consume it right away. Consumption results in certain default on the borrowing. We assume that consumption-induced default is dissipative, so that a consumption of \$1 yields the borrower a net utility of $\delta \in (0,1)$.

2.4. The information structure and contracts

All borrowing takes place through single-period, \$1 loan contracts. At $t = 0$ the capital market offers a loan contract requiring a repayment of R_c^1 at $t = 1$, and banks offer loan contracts requiring a repayment of R_b^1 at $t = 1$. Each firm chooses whether to borrow from a bank or the capital market.

The outcome of the first-period project is common knowledge at $t = 1$. If the project succeeds, the firm repays its first-period loan, consumes the excess of the project payoff over the repayment obligation (this consumption is nondissipative), and seeks a \$1 loan for its second-period project. If it fails, then it can either terminate at $t = 1$ or attempt new borrowing. Any new financing raised at $t = 1$ must first be used to pay off the first-period loan.

Since the first-period project outcome is common knowledge, everybody knows whether the firm can invest in a safe project at $t = 1$ that will surely pay off x^2 at $t = 2$ or it can only invest in a risky project that will pay off x^2 at $t = 2$ only w.p. α . The success probability α is common knowledge. If the firm is able to raise financing for its risky second-period project, then the project outcome is again publicly observed. We assume, however, that the outcomes are not verifiable so that long term contingent loan contracts are not possible. Fig. 2 presents the sequence of events.

Note that in the preceding discussion we have implicitly assumed that the borrower will invest (rather than consume) whenever it obtains external financing.

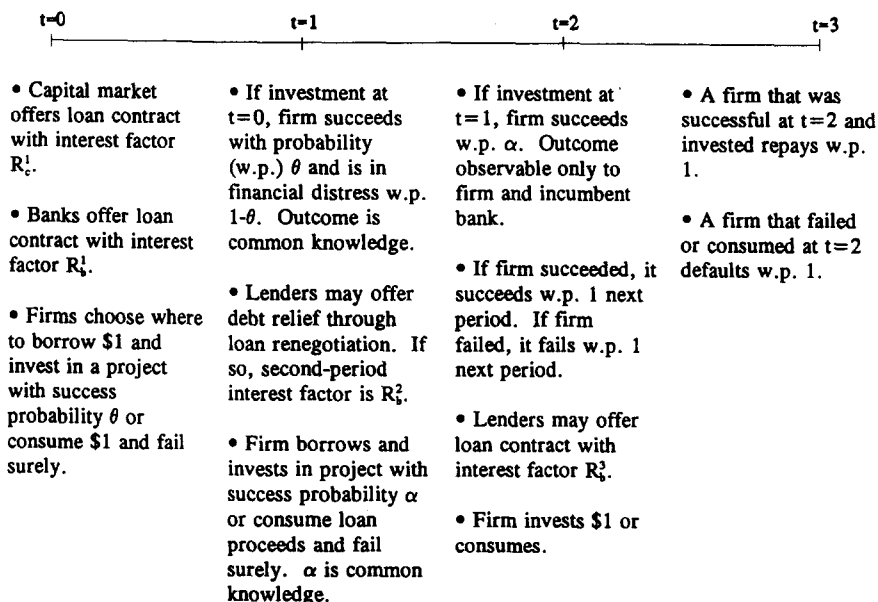


Fig. 2. Sequence of events.

In the ensuing analysis, we will have to examine the incentive compatibility conditions that ensure this.

2.5. Formal structure of the game

The game proceeds as follows. In each period, the capital market and banks publicly announce a lending rate or offer no loan for that period. After observing each lending rate, borrowers determine their funding-source choices. Any existing debt overhang is assumed to be senior to new debt unless it is forgiven (partially or completely) through renegotiation.

2.6. Additional assumptions

We will assume that a firm that fails at $t = 1$ can never hope to cover *all* of its debt repayments (including that on the first-period loan) from its payoffs on the second- and third-period projects. That is,

$$\alpha * \left(x^2 + \frac{x^3}{1+r} \right) < \alpha * (1+r)^2 + (1+r) + \alpha * \tag{R-1}$$

where $\alpha^* = \text{Sup} \{ \alpha \in A(\theta) | \theta \in (0,1) \}$ and the relationship is written in time $t = 2$ dollars. For later use, let $\alpha^*(\theta)$ be the maximal element in $A(\theta)$. Conditional on first-period failure, the success probability of the second-period project can be no higher than α^* . Thus, $\alpha^*[x^2 + x^3/(1+r)]$ is an upper bound on the $t = 2$ expected second- and third-period payoffs, whereas $\alpha^*(1+r)^2 + (1+r) + \alpha^*$, the right hand side of (R-1), is the $t = 2$ expected payment to be repaid on the three loans the firm takes. Further, we assume that in the second and third periods, the payments are sufficient to repay $1 + \tau$ and give the borrower incentive to invest. Thus,

$$\text{Min} \left\{ x^2, \frac{x^3}{1+r} \right\} > 1 + \tau + \frac{\delta}{\alpha}. \quad (\text{R-2})$$

3. Analysis

To ensure subgame perfection, we will use the backward induction approach of dynamic programming and begin with the third period first.

3.1. The third period

Consider first the case of the firm that failed in both the first and second periods. Because it will fail with certainty in the third, it receives no loan.

Now consider the case of the firm that succeeded in the second period. This firm will succeed with certainty in the third period. Therefore, competition among banks and capital market participants results in loan rate offers of $1 + r$ by the capital market and $1 + \tau$ by the banks, including the incumbent bank. Since $r < \tau$, the firm borrows from the capital market if and only if $x^3 > (1+r)(1 + \delta/\alpha) + d$, where d is any debt overhang from the incumbent bank's second-period loan.⁵ Restrictions on d will be stated in a later section.

3.2. The second period

We will first assume that the second-period cash flow is large enough to cover the second-period debt repayment, so that there is no debt overhang in the third period. Later we will relax this assumption.

Consider first the firm that succeeded in the first period. It is now common knowledge at $t = 1$ that this firm will succeed in the second and third period, if it

⁵ At this point, if $r = \tau$, the firm is indifferent between bank debt and capital market debt.

invests. The firm raises second-period financing from the capital market because it is cheaper. It is clearly in the firm's interest to invest rather than consume at $t = 1$ since it receives δ from consuming and $x^2 - 1 + x^3/(1+r) - 1$ from investing,⁶ which by (R-2) we know is greater than δ .

Consider next a firm that failed in the first period. This failure is common knowledge. If the incumbent bank denies this firm credit, then its expected profit over the second and third periods is zero. If the bank provides second-period credit, then a borrower who invests the \$1 will succeed w.p. α . Note that (R-1) implies that no *new* lenders will be willing to provide this firm credit because the first-period lender has a prior claim on the firm's cash flows. (R-1) says that this initial debt overhang problem makes it impossible for a new lender's participation constraint to be satisfied at $t = 1$. The decision of the incumbent bank is different, though, since it treats its first-period loan as a *sunk cost* at $t = 1$. It can afford to provide the firm debt relief on the first-period loan by negotiating a second-period loan that does not recover all of the repayment obligation on the first-period loan. Let R_b^2 be the second-period interest factor charged by the incumbent bank.

Since outside lenders are unwilling to extend the firm credit, R_b^2 is not constrained by interbank competition. Rather, it is constrained by the incentive compatibility constraint that the firm prefers investing to consumption. That is, we need

$$\alpha \left[(x^2 - R_b^2) + \frac{1}{1+r} (x^3 - R_c^3) \right] \geq \delta, \quad (2)$$

where $R_c^3 = 1+r$ from the previous subsection. The profit-maximizing incumbent bank will set R_b^2 so as to satisfy the incentive compatibility constraint tightly. This yields

$$R_b^2 = x^2 + \frac{x^3}{1+r} - 1 - \frac{\delta}{\alpha} \quad (3)$$

as the maximum interest factor the firm can be charged in the second period.

Since we initially assume that there is no debt overhang from the second to the third period, we restrict x^3 so that

$$x^3 \leq (1+r) \left(1 + \frac{\delta}{\alpha} \right). \quad (R-3)$$

⁶ The net payoff to the firm from the second-period project is $x^2 - (1+r)$ and from the third-period project is $x^3 - (1+r)$ since the second- and third-period loans are for \$1 each and riskless, and the riskless rate is zero. Note that both the second- and third-period loans are from the capital market.

We will assume for now that (R-3) holds for $\alpha = \alpha^*$, which ensures that it holds for all α . In the next section, the implications of relaxing it are examined.

Proposition 1: The incumbent bank renegotiates with the firm and offers debt relief on the first-period loan by extending a \$1 second-period loan at an interest factor of R_b^2 given by (3) if and only if

$$\alpha \left(x^2 + \frac{x^3}{1+r} - 1 - \frac{\delta}{\alpha} \right) - (1 + \tau) \geq 0. \quad (4)$$

Proof: We have already proved that the maximum interest factor the incumbent bank can charge is given by (3). The bank will charge this interest factor if it can earn a nonnegative expected profit over the second and third periods. The bank's expected profit over these two periods is given by:

$$\alpha R_b^2 - (1 + \tau). \quad (5)$$

Note that the bank receives repayment on the second-period loan only if the firm's second-period project succeeds; this happens w.p. α . Moreover, because the capital market makes any third period loan and we assume there is no debt overhang in the third period the bank receives no payment in that period. The bank's funding cost is $1 + \tau$ on the second-period loan. Substituting for R_b^2 from (3) and setting the expression in (5) to be nonnegative yields (4). \square

The second-period loan is priced in such a way that the firm's expected utility over the second and third periods is precisely $\delta > 0$ (because (2) binds in equilibrium). However, the firm is still strictly better off than it would be without loan renegotiation (in which case its expected utility is zero). The incumbent bank's expected payoff over the second and third periods is given by (4). The bank's payoff partially offsets its loss on the first-period loan.

There is a critical value of α , call it α_c , such that the incumbent bank is willing to renegotiate and offer second-period credit if $\alpha \geq \alpha_c$ and unwilling to renegotiate if $\alpha < \alpha_c$. Setting (4) equal to zero, we see that

$$\alpha_c = \frac{1 + \tau + \delta}{x^2 + \frac{x^3}{1+r} - 1}. \quad (6)$$

We now have the following result.

Proposition 2: The probability, assessed at $t = 0$, that a firm will be able to renegotiate and obtain second-period credit after first-period default declines as the bank's capital requirement increases.

Proof: From (6) it is transparent that $\partial\alpha_c/\partial\tau > 0$. At $t = 0$, the probability that a defaulting firm's loan will be renegotiated at $t = 1$ is given by $\Pr(\alpha > \alpha_c) = 1 - Q(\alpha_c|\theta)$, which is decreasing in α_c . Finally, by (1), $\partial\tau/\partial\psi > 0$. Thus, $\Pr(\alpha > \alpha_c)$ is decreasing in ψ . \square

3.3. The first period

In this period, banks and the capital market compete. Firms choose the financing source that maximizes their expected net payoff over the three-period horizon.

Consider first capital market pricing. The capital market has no potential to earn any incumbency rents in the future because it cannot coordinate debt relief. Thus, it competes each period on the basis of public information. The competitive (zero-expected) condition for the capital market is:

$$\theta R_c^1 - (1+r) = 0, R_c^2 - (1+r) = 0, \text{ and } R_c^3 - (1+r) = 0, \quad (7)$$

where R_c^p is the interest factor in the capital market in period $p \in \{1,2,3\}$. Competition in the second and third periods guarantees that $R_c^2 = R_c^3 = 1+r$. Thus, (7) yields $R_c^1 = (1+r)/\theta$.

The bank's offer, however, considers the possible future rents from renegotiation and incumbency. Competition among banks at $t = 0$ forces the bank's total expected profit over three periods to be zero. That is,

$$\begin{aligned} & \theta R_b^1 - (1+\tau) \\ & + \frac{1-\theta}{1+r} \int_{\alpha_c}^{\alpha^*(\theta)} \left[\alpha \left(x^2 + \frac{x^3}{1+r} - 1 \right) - (1+\tau) - \delta \right] q(\alpha|\theta) d\alpha = 0. \end{aligned} \quad (8)$$

Note that we have used (6) to write the bank's expected profit over the second and third periods in the above equation.⁷ We can simplify (8) to write:

$$\begin{aligned} R_b^1 &= \frac{1+\tau}{\theta} \\ & - \frac{1-\theta}{\theta(1+r)} \int_{\alpha_c}^{\alpha^*(\theta)} \left[\alpha \left(x^2 + \frac{x^3}{1+r} - 1 \right) - (1+\tau) - \delta \right] q(\alpha|\theta) d\alpha. \end{aligned} \quad (9)$$

⁷ Eq. (8) and all subsequent profit comparisons are stated in time $t = 1$ dollars.

We now consider the firm's choice at $t = 0$ between first-period bank debt and first-period capital market debt. The firm's net expected payoff from going to the capital market is:

$$NP_c = \theta \left[x^1 + \frac{x^2}{1+r} + \frac{x^3}{(1+r)^2} - R_c^1 - 1 - \frac{1}{1+r} \right]. \quad (10)$$

To see how (10) is arrived at, recall that the sum of the firm's repayment obligations on its second- and third-period loans is $1+r$ in each period and we discount back to $t = 1$. Moreover, $R_c^1 = (1+r)/\theta$.

The firm's net payoff from borrowing from a bank is given by

$$NP_b = \theta \left[x^1 + \frac{x^2}{1+r} + \frac{x^3}{(1+r)^2} - R_b^1 - 1 - \frac{1}{1+r} \right] + \frac{(1-\theta)}{1+r} [1 - Q(\alpha_c|\theta)] \delta, \quad (11)$$

where we recognize that if the firm fails in the first period, then its expected utility over the second and third periods is δ . Moreover, R_b^1 is given by (9). We can rewrite (11) as:

$$NP_b = \theta \left[x^1 + \frac{x^2}{1+r} + \frac{x^3}{(1+r)^2} - 1 - \frac{1}{1+r} \right] - (1+\tau) + \frac{1-\theta}{1+r} \int_{\alpha_c}^{\alpha^*(\theta)} \left[\alpha \left(x^2 + \frac{x^3}{1+r} - 1 \right) - (1+\tau) \right] q(\alpha|\theta) d\alpha. \quad (12)$$

The choice between bank debt and capital market financing is determined by a comparison of (10) and (12). This comparison shows that the firm prefers bank debt if $NP_b - NP_c \geq 0$, or

$$(r-\tau) + \frac{(1-\theta)}{1+r} \int_{\alpha_c}^{\alpha^*(\theta)} \left[\alpha \left(x^2 + \frac{x^3}{1+r} - 1 \right) - (1+\tau) \right] q(\alpha|\theta) d\alpha \geq 0. \quad (13)$$

We first state a result that defines the 'benchmark' case with the capital requirement sufficiently low that the cost of funds to banks does not exceed the cost to the capital market.

Proposition 3: Firms always prefer bank debt to capital market debt when the cost of bank financing is no more than that of capital market funds, (i.e. if $\tau \leq r$, then (13) holds).

Proof: The left side of (13) can be shown to be positive. This is because $1-\theta \in (0,1)$, and $\alpha[x^2 + x^3/(1+r) - 1] - (1+\tau) > 0$ in the range $\alpha \in [\alpha_c, \alpha^*(\theta)]$ since from (6) we know that $\alpha[x^2 + x^3/(1+r) - 1] - (1+\tau) - \delta > 0$. Thus, with $\tau \leq r$, (13) is always satisfied. \square

Now consider the impact of a sufficiently high capital requirement, $\tau \leq r$. The result given below shows that it is intermediate quality firms that prefer bank financing.

Proposition 4: With ψ such that $\tau > r$, \exists critical levels of θ , say θ^* and θ^{**} , with $\theta^* < \theta^{**}$, such that all firms with $\theta < \theta^*$ and all firms with $\theta > \theta^{**}$ prefer capital market financing. Moreover, θ^* is nondecreasing and θ^{**} is nonincreasing in ψ . For ψ such that $\tau - r > 0$ small enough, \exists a subset of $[\theta^*, \theta^{**}]$, defined as Θ_b , with positive Lebesgue measure, such that firms with $\theta \in \Theta_b$ prefer bank financing. The measure of Θ_b declines as ψ increases.

The intuition is as follows. For firms with sufficiently high θ 's the value of 'renegotiation insurance' is low because they are not very likely to fail at the end of the first period and need renegotiation. These firms are unwilling to pay the higher cost of bank financing and thus go to the capital market. Similarly, firms with sufficiently low θ 's recognize that their realizations of α are likely to be so low that their incumbent banks will not agree to renegotiate at $t = 1$ if their first-period projects fail. Thus, they too attach a relatively low value to 'renegotiation insurance' and prefer capital market financing. Although we can say that *some* firms in the intermediate quality range will prefer bank financing, we cannot rule out the possibility that other firms in this intermediate range will prefer capital market financing. Moreover, the measure of the set of firms that prefer capital market financing is nondecreasing in τ .⁸

An increase in the bank's capital requirement increases τ and reduces the attractiveness of bank financing in three ways. First, it increases the bank's cost of funding and this is passed along to the borrower in a competitive equilibrium. This effect is the standard 'sliding down' a downward sloping demand curve. Second, it reduces the likelihood of debt renegotiation in the event that the firm fails in the first period. And third, it reduces the *value* of the debt renegotiation to the firm when such renegotiation occurs. This means that the very reason for approaching a bank diminishes in importance as bank capital requirements increase. These last two effects suggest that a small increase in capital requirements could cause a large decline in demand, i.e., it is akin to a jump to a lower demand curve. We can thus visualize different downward sloping demand curves for different levels of τ . For any given τ , demand decreases as the loan interest rate increases, but an increase of sufficient magnitude in τ causes a shift to a lower demand curve.⁹ See Fig. 3.

⁸ The formal proof of Proposition 4 is in the Appendix.

⁹ Although we have focused on capital requirements, our analysis is applicable to any regulatory tax.

4. Growth firms vs. cash cows

We have assumed thus far that there is no debt overhang for a firm entering the third period. This imposes a constraint on how large the third-period cash flow can be, as reflected in (R-3). We relax that assumption now. That is, for all θ and all $\alpha \in A(\theta)$, the third-period cash flow is now

$$\hat{x}^3 > (1+r) \left(1 + \frac{\delta}{\alpha}\right). \quad (\text{R-3}')$$

We wish to hold the total value of the second- and third-period cash flows the same as in the previous case. So we define $X \equiv x^2 + x^3/(1+r) = \hat{x}^2 + \hat{x}^3/(1+r)$. Thus, $\hat{x}^3 > x^3$ and $\hat{x}^2 < x^2$. This permits us to compare two firms, one with high cash flows in the more distant future after renegotiation, a growth firm, and the other with high cash flows in the near future, a cash cow. The question is: which firm is more likely to obtain a renegotiation of its debt burden at $t = 1$ after failing in the first period?

We work back from the third period. The debt overhang from the second period is $R_b^2 - \hat{x}^2$. From the previous section, $R_c^3 = 1+r$ and from (3), $R_b^2 = \hat{x}^2 + \hat{x}^3/(1+r) - 1 - (\delta/\alpha)$. Thus the debt overhang existing in the third period is restricted to

$$\text{Max} \left\{ 0, \frac{\hat{x}^3}{1+r} - 1 - \frac{\delta}{\alpha} \right\} \quad (14)$$

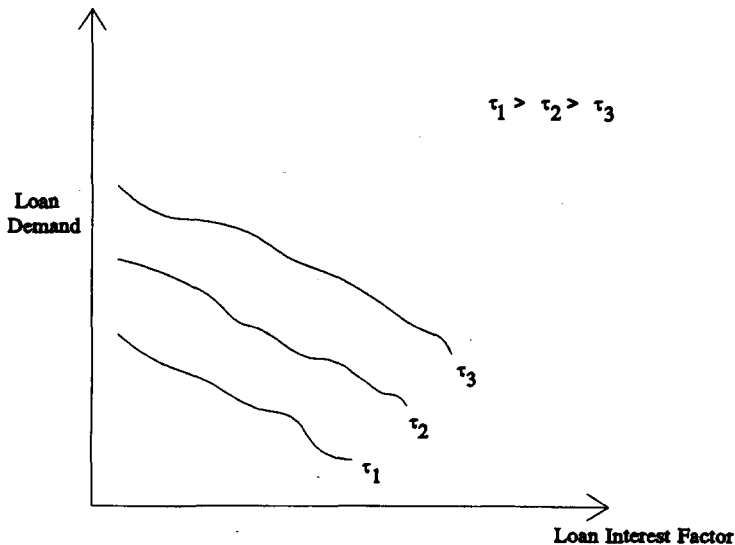


Fig. 3. Loan demand curves.

We now examine the bank's incentive to renegotiate. To do this, we solve for the critical $\hat{\alpha}_c$ such that the bank will renegotiate at $t = 1$ if $\alpha \geq \hat{\alpha}_c$ and decline otherwise. Since the bank extends a second-period loan of \$1 to be repaid partially at $t = 2$ and the remainder to be repaid at $t = 3$. This is effectively a one-period loan and a two-period loan. We can rewrite (4) as

$$\alpha \left[\hat{x}^2 + \left(\frac{\hat{x}^3}{1+r} - 1 - \frac{\delta}{\alpha} \right) \right] \left(\frac{1+r}{1+\tau} \right) - (1+\tau) \geq 0 \quad (15)$$

Setting (15) equal to zero gives

$$\hat{\alpha}_c = \frac{1 + \tau + \delta \left(\frac{1+r}{1+\tau} \right)}{\hat{x}^2 + \left(\frac{\hat{x}^3}{1+r} - 1 \right) \left(\frac{1+r}{1+\tau} \right)} \quad (16)$$

Note that (16) is the critical α for any firm with $\hat{x}^3 \geq (1+r)(1+\delta/\alpha)$. Therefore, by using (16) we can show which firms are more severely hurt by high bank capital requirements. For expositional ease, we refer to firms with high second-period and low third-period cash flows as 'cash cows' and firms with low second-period and high third-period cash flows as 'growth prospects' in terms of their assessment at $t = 1$. This leads us to our final result.

Proposition 5: Within the set of firms with identical first-period and total cash flows values, the assessed probability at $t = 0$ that there will be loan renegotiation at $t = 1$ following first-period default is higher for a cash cow than for a growth prospect. Consequently, cash cows have a stronger preference for bank financing. Moreover, an increase in bank capital requirements has a stronger impact on the growth prospects than on the cash cows in that the former switch to the capital market before the latter do. \square

The proposition is proved by showing that $\hat{\alpha}_c$ increases with increases in bank capital requirements, $\partial \hat{\alpha}_c / \partial \psi > 0$; that $\hat{\alpha}_c$ increases with the delays in cash flows, holding X fixed, $\partial \hat{\alpha}_c / \partial \hat{x} > 0$; and finally that the increase in $\hat{\alpha}_c$ from an increase in bank capital requirements is greater for firms with larger late cash flows than firms with greater early cash flows, $\partial \hat{\alpha}_c^2 / \partial \hat{x}^3 \partial \psi > 0$. As in Proposition 2, the probability that a firm obtains loan renegotiation after a first period default is given by $\Pr(\alpha > \hat{\alpha}_c) = 1 - Q(\hat{\alpha}_c | \theta)$, which is decreasing in $\hat{\alpha}_c$.¹⁰

This result implies that not only are growth prospects more likely than cash cows to seek direct capital market access for a given bank capital requirement, but they are also more adversely affected by an increase in capital requirements and thus, more likely to reduce their demand for bank financing when banks are faced

¹⁰ The formal proof of Proposition 5 is in the Appendix.

with higher capital requirements. The intuition is as follows. When the second-period cash flow is reduced and the third-period cash flow is increased, the incumbent bank finds itself unable to recover the entire amount owed to it on the second-period loan because the second-period cash flow is lower than the repayment obligation. This creates a debt overhang which is carried to the third period. Any lender must now lend \$1 for the third-period project plus an amount to cover the debt overhang. Capital must therefore be posted against the additional third-period loan to cover the overhang. This is costly for the bank. The bank's reduced profit over the second and third periods causes it to set a higher quality hurdle at $t = 1$ for growth prospects than for cash cows. Thus, an unintended distortion introduced by bank capital requirements is that growth-oriented investments are made worse off relative to those that pay off earlier.

Note that $\hat{\alpha}_c = \alpha_c$ when $\tau = r$. So it is the higher cost of bank financing that makes the debt overhang costly. With no cost differential, both types of firms prefer bank debt. However, as the differential becomes positive and increases, growth firms are hurt more than cash cows.

5. Conclusion

We have considered a setting in which the uniqueness of banks in credit allocation lies in the greater ability of banks as monolithic lenders to renegotiate the debt contracts of financially distressed borrowers. In this setting, borrowers of intermediate quality prefer bank financing, whereas borrowers at both extremes of the quality spectrum prefer to go to the capital market. Bank capital requirements have a potentially significant impact on the borrower's choice of financing source. An increase in capital requirements induces a shift in loan demand from banks to the capital market. Moreover, the effect of this increase is felt asymmetrically as growth-oriented firms switch to the capital market before the 'cash cows' do.

From a policy standpoint, our paper highlights the possibility that the adoption of risk-based capital requirements may have contributed to a contraction in bank lending *even if all the contraction was demand-induced*. It may therefore be irrelevant to distinguish between supply and demand effects in discussions relating to the link between bank capital requirements and the documented decline in bank lending.

At a more fundamental level, our paper exposes a tension between regulatory initiatives (such as capital requirements) to limit safety-net moral hazards and the desire to sustain the level of banks' participation in overall credit allocation in the economy. The purpose of providing banks with a safety net is to help sustain the role of banks in allocating credit (see, for example, Bhattacharya and Thakor (1993)). Ironically, regulatory measures to cope with the moral hazards engendered by the safety net can diminish banks' role in credit allocation and thereby have a countervailing effect.

Acknowledgements

A.V. Thakor is INB National Bank Professor of Finance; P.F. Wilson is Assistant Professor of Finance. We thank an anonymous referee, Franklin Allen, Todd Milbourn, Kathleen Petrie and participants at the Wharton Conference on The Role of Capital in Financial Institutions, for helpful comments. Only the authors are responsible for the contents of this paper.

Appendix

Proof of Proposition 4: Note that the limit of the left side of (13) as $\theta \rightarrow 0$ is clearly negative since $\lim_{\theta \rightarrow 0} \int_{\alpha_c}^{\alpha^*(\theta)} [\alpha(x^2 + \frac{x^3}{1+r} - 1) - (1 + \tau)]q(\alpha|\theta)d\alpha = 0$. Thus, (13) is violated. Thus, by continuity we see that $\exists \theta^*$ sufficiently close to 0 such that all firms with $\theta < \theta^*$ prefer capital market financing. Now consider the limit of the left side of (13) as $\theta \rightarrow 1$. Once again the left side of (13) is negative, so that (13) is violated. Thus, by continuity $\exists \theta^{**}$ sufficiently close to 1 such that all firms with $\theta > \theta^{**}$ prefer capital market financing. It is transparent that as τ increases, (15) becomes more difficult to satisfy, and θ^* is nondecreasing and θ^{**} nonincreasing in τ . Finally, note that by Proposition 3 we know that bank financing is preferred by all borrowers when $\tau = r$. By continuity then, $\exists \tau - r > 0$ sufficiently small such that bank financing is preferred by a subset of θ 's, call it Θ_b , that has positive measure. By the earlier arguments in this proof, Θ_b must be contained in $[\theta^*, \theta^{**}]$. Since the borrower's expected utility declines as τ increases and by (1), $\partial\tau/\partial\psi > 0$, the measure of Θ_b is decreasing in ψ . \square

Proof of Proposition 5: First, we show that the critical level of $\alpha, \hat{\alpha}_c$ increases as the capital requirements increase above r , $\partial\hat{\alpha}_c/\partial\tau > 0$. Second we show that $\hat{\alpha}_c$ increases as \hat{x}^3 increases (and \hat{x}^2 decreases so that X remains unchanged), $\partial\hat{\alpha}_c/\partial\hat{x}^3 > 0$. Finally, we show that the increase in the capital requirement affects firms with higher late cash flows more than firms with lower late cash flows, $\partial^2\hat{\alpha}_c/\partial\hat{x}^3\partial\psi$.

(1) From (16) we have:

$$\hat{\alpha}_c = \frac{1 + \tau + \delta \frac{1+r}{1+\tau}}{\hat{x}^2 + \left(\frac{\hat{x}^3}{1+r} - 1 \right) \frac{1+r}{1+\tau}} \tag{A1}$$

The partial derivative of $\hat{\alpha}_c$ with respect to ψ can be written as: $\partial\hat{\alpha}_c/\partial\psi = \partial\hat{\alpha}_c/\partial\tau \partial\tau/\partial\psi$. We know that $\partial\tau/\partial\psi > 0$ from (1). Thus, $\partial\hat{\alpha}_c/\partial\psi$ has the same sign as $\partial\hat{\alpha}_c/\partial\tau$;

$$\frac{\partial\hat{\alpha}_c}{\partial\tau} = \frac{\left(1 - \frac{\delta(1+r)}{(1+r)^2}\right) \left[\hat{x}^2 + \left(\frac{\hat{x}^3}{1+r} - 1\right) \frac{1+r}{1+\tau} \right] + \left(1 + \tau + \delta \frac{1+r}{1+\tau}\right) \left(\frac{\hat{x}^3}{1+r} - 1\right) \frac{1+r}{(1+\tau)^2}}{\left[\hat{x}^2 + \left(\frac{\hat{x}^3}{1+r} - 1\right) \frac{1+r}{1+\tau} \right]^2} > 0 \quad (\text{A2})$$

The denominator of (A2) is clearly positive, and all terms of the numerator are positive because $\hat{x}^3/(1+r) > 1$ and $\delta < 1$. Thus $\partial\hat{\alpha}_c/\partial\tau > 0$.

(2) Using $X = \hat{x}^2 + \hat{x}^3/(1+r)$, we can rewrite $\hat{\alpha}_c$ as:

$$\hat{\alpha}_c = \frac{1 + \tau + \delta \frac{1+r}{1+\tau}}{X - 1 - \left(\frac{\hat{x}^3}{1+r} - 1\right) \frac{\tau - r}{1+\tau}} \quad (\text{A3})$$

$$\frac{\delta\hat{\alpha}_c}{\delta\hat{x}^3} = \frac{\left(1 + \tau + \delta \frac{1+r}{1+\tau}\right) \left(\frac{\tau - r}{(1+r)(1+\tau)}\right)}{\left[X - 1 - \left(\frac{\hat{x}^3}{1+r} - 1\right) \frac{\tau - r}{1+\tau}\right]^2} > 0 \quad (\text{A4})$$

$\partial\hat{\alpha}_c/\partial\hat{x}^3 > 0$ since again the denominator is clearly positive and the numerator is positive because $\tau > r$.

(3) The cross partial derivative of $\hat{\alpha}_c$ with respect to ψ and \hat{x}^3 can be written as: $\partial^2\hat{\alpha}_c/\partial\hat{x}^3\partial\psi = \partial^2\hat{\alpha}_c/\partial\hat{x}^3\partial\tau \partial\tau/\partial\psi$. As before, we know that $\partial\tau/\partial\psi > 0$ from (1). Thus, $\partial^2\hat{\alpha}_c/\partial\hat{x}^3\partial\psi$ has the same sign as $\partial^2\hat{\alpha}_c/\partial\hat{x}^3\partial\tau$;

$$\frac{\partial^2\hat{\alpha}_c}{\partial\hat{x}^3\partial\tau} = \frac{\left[\frac{1}{1+r} - \frac{\delta}{(1+\tau)^2} + \frac{2\delta(1+r)}{(1+\tau)^3} \right]}{\left[\hat{x}^2 + \left(\frac{\hat{x}^3}{1+r} - 1\right) \frac{1+r}{1+\tau} \right]^2} + 2 \frac{\left[\frac{1+\tau}{1+r} - 1 + \frac{\delta}{1+\tau} \left(1 - \frac{1+r}{1+\tau}\right) \right] \left[\left(\frac{\hat{x}^3}{1+r} - 1\right) \frac{1+r}{(1+\tau)^2} \right]}{\left[\hat{x}^2 + \left(\frac{\hat{x}^3}{1+r} - 1\right) \frac{1+r}{1+\tau} \right]^3} > 0 \quad (\text{A5})$$

$\partial^2 \hat{\alpha}_c / \partial \hat{x}^3 \partial \tau > 0$ since all terms are positive; $\delta < 1$, $(1 + \tau)/(1 + r) > 1$, and $\hat{x}^3/(1 + r) > 1$. \square

References

- Allen, F., 1990, The market for information and the origin of financial intermediation, *Journal of Financial Intermediation* 1, 3–30.
- Allen, F., 1993, Stock Markets and Resource Allocation, in *Capital Markets and Financial Intermediation*, C. Mayer and X. Vives, eds. (Cambridge University Press), 81–107.
- Berger, A.N. and G.F. Udell, 1994, Did risk-based capital allocate bank credit and cause a 'credit crunch' in the U.S., *Journal of Money, Credit, and Banking*, 26, 585–628.
- Berlin, M. and L. Mester, 1992, Debt covenants and renegotiation, *Journal of Financial Intermediation* 2, 95–133.
- Bernanke, B.S. and C.S. Lown, 1991, The credit crunch, *Brookings Papers on Economics Activity*, 205–247.
- Besanko, D. and G. Kanatas, 1994, The regulation of bank capital regulations: do capital standards promote bank safety?, working paper, Northwestern University.
- Bhattacharya, S. and A.V. Thakor, 1993, Contemporary banking theory, *Journal of Financial Intermediation* 3, 2–50.
- Chan, Y.-S., D. Siegel and A.V. Thakor, 1990, Learning, corporate control and bank capital requirements, *International Economic Review* 31, 365–381.
- Chemmanur, T.J., and P. Fulghieri, 1994, Reputation, renegotiation, and the choice between bank loans and publicly traded debt, *Review of Financial Studies* 7, 475–506.
- Diamond, D.W., 1984, Financial intermediation and delegated monitoring, *Review of Economic Studies* 51, 393–414.
- Diamond, D.W., 1991, Monitoring and reputation: the choice between bank loans and directly placed debt, *Journal of Political Economy* 99, 689–721.
- Gorton, G. and J. Kahn, 1993, The design of bank loan contracts, collateral, and renegotiation, working paper, Wharton School and University of Rochester.
- Jacklin, C.J., 1993, Bank capital requirements and incentives for lending, working paper, Stanford University.
- Hirshleifer, D. and Y. Suh, 1992, Risk, managerial effort, and project choice, *Journal of Financial Intermediation* 2, 308–345.
- Kahane, Y., 1977, Capital adequacy and the regulation of financial intermediaries, *Journal of Banking and Finance* 1, 207–218.
- Millon, M. and A.V. Thakor, 1985, Moral hazard and information sharing: a model of financial information gathering agencies, *Journal of Finance* 40, 1403–1422.
- Rajan, R., 1992, Insiders and outsiders: the choice between informed and arm's-length debt, *Journal of Finance* 47, 1367–1400.
- Ramakrishnan, R.T.S. and A.V. Thakor, 1984, Informational reliability and a theory of financial intermediation, *Review of Economic Studies* 51, 415–432.
- Thakor, A.V., 1993, Capital requirements, monetary policy, and aggregate bank lending, working paper, Indiana University.
- Thakor, A.V. and J. Beltz, 1994, A 'barter' theory of bank regulation and credit allocation, *Journal of Money, Credit and Banking*, 26, 679–705.
- Thakor, A.V. and J. Beltz, 1993, An empirical analysis of the cost of regulatory compliance, in: *The Proceedings of the Conference on Bank Regulation and Compliance*, Federal Reserve Bank of Chicago.
- Wilson, P., 1993, Public ownership, delegated project selection and firms' source of debt financing, working paper, Indiana University.