Credit Market Equilibrium with Bank Monitoring and Moral Hazard

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We characterize a credit market equilibrium in which banks coexist with capital markets and firms obtain funding from both sources. An incentive problem exists between the firms's insiders and outside providers of capital. Banks can provide not only credit but also monitoring services. We show that when banks cannot precommit to a particular level of monitoring, there is a unique credit market equilibrium with firms being financed with a combination of bank credit aud external capital In this equilibrium, a margiual substitution of bank creditfor capital market financing would raise the firm's stock price.

Theories of financial intermediation have suggested two alternative roles for banks. The more traditional view [e.g., Niehans (1978) and Fama (1980)] describes banks as being "special" in that their demand deposit liabilities provide transactions services. More recently, however, the focus has shifted to the lending function of banks.' As Fama (1985) notes, bank reserve requirements impose costs that appear to be borne by the

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[1]See, for example, Leland and Pyle (1977). Campbell and Kracaw (1980). Chan (1983). Diamond (1984). and Ramakrishnan and Thakor (1984).

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bank's borrowers, implying that there must be something "special" about bank loans relative to other credit contracts. Empirical support is provided by James (1987), who finds that a firm's announcement of a new bank loan leads to significantly positive abnormal stock returns while a firm that announces a bond issue or a private placement of debt for the purpose of retiring a bank loan experiences a significantly negative abnormal stock return. After examining borrower size and default risk, loan maturity, and purpose of borrowing, James concludes that his results concerning the stock price reactions cannot be attributed ". . . solely to differences in characteristics of the loan or characteristics of the borrowers" (p. 234). Further, he concludes that it appears that ". . . banks provide some special service not available from other lenders" (p. 234).

The more recent view of the role of banks emphasizes informational imperfections and suggests that it is the provision of monitoring services in conjunction with lending that is "special." Monitoring is important because of the well-known agency problem that exists between a firm's insiders and its outside investors [see Jensen and Meckling (1976) or Barnea, Haugen, and Senbet (1985)]. An entrepreneur with a limited endowment must seek external financing in order to undertake a project. Limited liability induces the entrepreneur to make decisions that differ from those outside investors desire and that the entrepreneur himself would choose if he were able to self-finance. Various features of credit markets have been interpreted as being designed to address this agency problem. For example, Grossman and Hart (1982) describe the issuing of risky debt by the entrepreneur/manager as a means of "bonding" his behavior, which is made credible by a personal bankruptcy cost borne by the manager in the event of default. Easterbrook (1984) and Jensen (1986) view corporate cash disbursement as a mechanism that mitigates this agency problem by removing from insiders' control "excess" cash that could be used inefficiently or converted to perquisite consumption, and by forcing the firm to the capital market for funding where it must supply information on its activities.

An alternative mechanism for controlling insider moral hazard is reliance on bank loans coupled with bank monitoring of borrower activities. The information that a bank acquires on its borrowers-for example, through the bank's supervision of a borrower's collateral assets such as its accounts receivable-enables the bank to monitor borrower actions as well as more directly control relevant borrower decisions. Consequently, bank loans can be viewed as "inside" debt-that is, debt financing provided by a party with inside information

about the borrower, in contrast to bonds or equity issued to an anonymous capital market.[2]

A bank's role in monitoring borrower behavior has been described in several articles. Diamond (1984) describes a financial intermediary as a delegated monitor of entrepreneurial projects when the profitability of such projects is not publicly observable. While the existence of financial intermediaries in Diamond (1984) that can fund and monitor projects precludes direct lending, intermediaries in Berlin and Loeys (1988) are monitors that do not lend. In that article, the firm's choice between offering loan covenants or employing a monitor is examined when the firm must acquire funds from a capital market. In contrast, intermediaries in Seward (1990) and Diamond (1991) coexist with capital markets and both fund and monitor borrowers. However, while it is possible in Seward (1990) for firms to use bank and capital market financing simultaneously, entrepreneurs in Diamond (1991) are assumed to rely entirely on bank debt or entirely on the capital market.[3]

In this article, we add to this literature by analyzing the interrelationship between the lending and monitoring decisions of the bank and the effect of these monitoring decisions on the terms under which the firm can acquire additional funds from the capital market. Seward (1990) and Diamond (1991) also study the firm's choice between external financing and bank loans that involve monitoring, but the notion of monitoring in these articles is quite different from ours. In these articles, monitoring allows the bank to observe the return on the borrower's project, a return that is unobservable to the external capital markets. In our model, an entrepreneur with a limited initial endowment undertakes effort that influences the probability of success of a risky project. The project's return is publicly observable, but the entrepreneur's effort level is not observable to the outside capital markets. Monitoring allows a bank to observe the entrepreneur's effort and to force the entrepreneur to supply a level of effort that exceeds the level that would be supplied if effort were unobservable. In our model, the bank chooses the intensity with which it monitors the borrower, which in turn determines the extent to which the bank is able to improve the borrower's effort choice.

In contrast to Seward (1990) and Diamond (1991), in which the level of a bank's monitoring activity is exogenous, we explicitly model

[2]Hoshi, Kashyap, and Schatfstein (1991) present evidence from Japan to support the conjecture that banks help alleviate the information/incentive problems that firms face in raising external capital. They find that investment by firms that have an established banking relationship (i.e., those firms that are expected to he able to avoid external financing) appears to be less sensitive to liquidity considerations than investment by firms without such banking contracts.

[3]The focus of Diamond (1991) differs from that of the other literature in that its *aim is* to analyze borrowers' intertemporal change in demand between bank and capital market funding and how it is affected by reputational considerations.

the bank's choice of monitoring intensity. In doing so, our analysis highlights a potentially important moral hazard problem between the bank and the external credit markets: the bank chooses the level of its monitoring activity to maximize bank profits, but the external capital market would prefer that the bank choose the level of monitoring that maximizes the expected net present value of the project. This moral hazard problem would not arise if the bank could contractually commit to a given level of monitoring; in that case, competition among banks would result in a bank providing a level of monitoring that maximizes borrower utility, which, given zero profit conditions for the bank and the outside market, is equivalent to the maximization of the expected net present value of the project. But the more plausible case is when a bank cannot contractually commit to monitoring. In this case, a bank will choose its monitoring to maximize bank profits, given the terms of the credit contract, rather than choosing the level of monitoring that maximizes borrower utility. This moral hazard problem creates a cost to using the bank as a monitor, and in equilibrium works to limit reliance on bank debt.

In Seward (1990) and Diamond (1991), bank debt does not necessarily dominate external capital market financing either, but the reasons for this are quite different than in our model. In Diamond, capital market financing is less costly than bank financing, and firms switch to capital market financing in order to free ride on the certification provided by banks. In Seward, the equilibrium may involve both bank loans and equity because the verification of realized returns by the bank occurs only in the "low-tail" of the return distribution. The bank holds a claim that is large enough to ensure optimal monitoring of the borrower in these states; the rest of the needed funds are provided by equity. In our model, by contrast, the trade-off between bank loans and outside financing is driven by the interplay of two distinct moral hazard problems. There is a standard moral hazard problem due to the unobservability of the entrepreneur's effort decision. In addition, there is a moral hazard problem due to the inability of the bank to contractually commit to monitoring. In the absence of bank credit, the standard moral hazard problem can lead to market failure (i.e., the traditional agency cost may be sufficiently great to limit the capital provided to less than that needed to finance the project). Market failure can also occur with bank credit, but it occurs less often. That is, there is a set of parameter values such that the project would not be financed without bank credit but would be financed when bank credit is available. With the bank credit, the conjunction of entrepreneurial moral hazard and bank moral hazard results in a unique interior optimal combination of bank debt and external capital that finances the entrepreneur's project. Entrepre-

neurial moral hazard creates a role for bank debt, while bank moral hazard creates a role for external capital market financing.

We also analyze the effect of the firm's financing mix on its stock price. We show that in a competitive bank loan market, an exogenous substitution of a dollar of bank credit for external financing will raise the firm's stock price in equilibrium. That is, because insiders maximize their own welfare rather than that of all stockholders, projects are financed in equilibrium with a level of bank credit that is less than that which maximizes the firm's stock price.

The article is organized in four sections. In Section 1, we develop and describe the model. In Section 2, we characterize the competitive equilibrium in absence of bank lending. In Section 3, we characterize the competitive equilibrium when banks function as lenders and monitors. In Section 4, we conclude with a discussion of how our results would be altered if the banking market were imperfectly competitive. Proofs of all propositions appear in the Appendix.

1. The Model

Our model consists of three classes of agents-ex ante identical entrepreneurs, perfectly competitive banks, and outside investors. All agents are assumed to be risk neutral. Events in the model occur at two dates: date 0 and date 1. At date 0, an entrepreneur secures financing for a risky project, which requires an initial outlay of \$1. At date 1, the project return is realized, the firm is liquidated, and investors and creditors are paid off. The risky project yields $Q > 1$ if successful and 0 otherwise. The entrepreneur is assumed to have no initial endowment, so he must rely on external financing in order to undertake the project.[4]

The probability that the project succeeds is denoted by θ. The probability θ is determined by the entrepreneur through the expenditure of effort, and $D(\theta)$ denotes the nonpecuniary disutility of the effort required to achieve a success probability θ. We take $D(\theta)$ to be quadratic,

$$D(\theta) = \theta^2/2\beta, \qquad \text{for } \theta \in [0, 1],$$

where β is a parameter greater than zero. For convenience, we refer to θ as the entrepreneur's effort. There is moral hazard in that the entrepreneur's effort θ is not observable by the market.

The first-best effort level θ^F maximizes

$$\theta Q/r_f - D(\theta) - 1, \tag{1}$$

[4]Because of technological indivisibilities, the project cannot be scaled down, so the entrepreneur must raise \$1 in financing in order to undertake the project.

where r_f is the riskless interest factor (1 plus the riskless rate). With a slight abuse of terminology, we refer to expression (1) as the project's net present value (NPV).

The first-best effort level is given by

$$\theta^F = \begin{cases} Q\beta/r_f, & \text{if } Q\beta/r_f \leq 1, \\ 1, & \text{if } Q\beta/r_f > 1. \end{cases}$$

To simplify notation, we assume $Q\beta/r_f \leq 1$. The maximized NPV of the project, denoted by NPV^F, is

$$\text{NPV}^F = \frac{\theta^F Q}{r_f} - \frac{(\theta^F)^2}{2\beta} - 1 = \frac{\beta Q^2}{2r_f^2} - 1,$$

and we assume that NPVF is strictly positive.[5]

Financing for the project can come from two sources: banks and outside investors. Given the two-point support of the entrepreneur's payoff, there is no substantive difference between outside equity and outside (publicly traded) debt. Consequently, the funding provided by outside investors will be referred to as *outside financing*. If the entrepreneur uses outside financing, outsiders have a claim Con the net cash flows of the firm in the successful state. The market value of this claim at date 0 is denoted by *E*. Although outsiders cannot observe θ, we assume that the market is characterized by rational expectations. Thus, in equilibrium, outsiders will correctly conjecture the equilibrium value of θ and correctly price the equity claim *C*.

A credit contract from a bank specifies a loan amount *B* and a repayment obligation *T*. The difference between bank debt and outside financing is that a bank is assumed to have a comparative advantage at monitoring and controlling the actions of the entrepreneur. This advantage may arise because the bank is better able to resolve the public goods problem than outside investors (i.e., there are a large number of outsiders but only one bank) or because the bank specializes in a monitoring technology that can be used on many borrowers simultaneously, as well as over time.

We assume that monitoring enables the bank to force the entrepreneur to undertake the agreed-upon effort level (a level that will be determined in equilibrium), thereby eliminating entrepreneurial moral hazard. The monitoring cost to the bank of achieving the desired effort is an increasing, convex function of the difference between the effort level specified by the bank (and actually undertaken) and the effort level the entrepreneur *would have* chosen in the absence of bank monitoring. This latter level of effort, referred to as the *no-*

[5] A necessary condition for $\beta Q^2/2r_f^2 > 1$ and $Q\beta/r_f \leq 1$ to hold simultaneously is that $Q > 2r_f$.

monitoring level of effort, will depend on the bank loan and outside financing and is thus endogenous. For tractability, we assume that the monitoring cost is given by

$$M(\theta - \theta_0) = \begin{cases} (\theta - \theta_0)^2/2m, & \theta \geq \theta_0, \\ 0, & \theta < \theta_0, \end{cases}$$

where θ is the effort level enforced by the bank, θ_0 is the no-monitoring effort level, and m is a positive constant. The difference $\theta - \theta_0$ represents the incremental effort induced by the bank through its monitoring, and the specification (2) implies that monitoring costs are an increasing, convex function of this increment. The idea behind this specification is that it is less costly to force the entrepreneur to meet an effort target θ the closer that target is to the entrepreneur's preferred level of effort θ_0. Because there is a one-to-one correspondence between the increment $\theta - \theta_0$ and the bank's monitoring expenditures, we refer to $\theta - \theta_0$ as the level of bank monitoring and characterize an increase (decrease) in $\theta - \theta_0$ as an increase (decrease) in bank monitoring activity.

To ensure needed second-order conditions, we assume that $m < \beta/2$. This assumption puts a lower bound on the marginal cost of monitoring. Note that while we have explicitly assumed that monitoring costs are zero for $\theta \leq \theta_0$, it is evident that θ_0 would never exceed θ. That is, the bank would never prefer that the entrepreneur exert less effort than that which the entrepreneur would desire, given the bank loan and outside financing.

We assume that a bank's monitoring expenditures are *unobservuble* to the outside market and to third parties such as the courts. Thus, analogous to the inability of the entrepreneur to contract on his effort, a bank is unable to contract upon its level of monitoring. It follows that a bank's monitoring expenditure must be subgame perfect (i.e., it must maximize the bank's profit, given the loan size T and the repayment obligation B). Thus, while bank monitoring eliminates entrepreneurial moral hazard, the noncontractibility of a bank's monitoring expenditure creates a moral hazard problem that will limit reliance on bank monitoring as a control mechanism in equilibrium.

Note that we do not rule out the possibility of a credit contract in which $B = 0$ but $T > 0$. This can be interpreted as a situation in which the bank monitors but does not lend, as in Berlin and Loeys (1988). In this case, T would be a contingent fee paid by the entrepreneur for the bank's monitoring services (a fixed fee for monitoring can be folded into B). We will see that in equilibrium, this type of credit contract will not arise; the bank will provide both monitoring services and credit.

To abstract from regulatory considerations and focus entirely on the effects of monitoring and moral hazard, we assume that a borrower is small relative to the overall size of a bank's loan portfolio. Thus, the failure of a given borrower will not force a bank into default. Because all entrepreneurs are identical, a bank will seek to maximize expected profit per borrower, which is given by

$$\theta T/r_f - M(\theta - \theta_0) - B.$$

If the total financing $B + E$ is less than the entrepreneur's net investment requirement of \$1, or if the entrepreneur's expected utility from undertaking the project is negative, the project is not undertaken, and the funds B and E are returned to the bank and investors, respectively.[6] If the total financing $B + E$ is equal to or exceeds 1, and if the entrepreneur's expected utility from proceeding with the project is positive, the project is undertaken, and the entrepreneur consumes the difference $B + E - 1$.[7] After the financing has been secured, a bank expends resources on monitoring. This determines the effort level θ. Recall that the monitoring cost for the bank of enforcing effort θ depends on the difference between θ and the no-monitoring level of effort θ_0. Given the claims T and C, the no-monitoring effort level $\theta_0^*(T, C)$ is

$$\theta_0^*(T, C) = (\beta/r_f)(Q - C - T). \tag{3}$$

Given the loan and outside financing contracts, profit-maximizing bank monitoring is then

Note that a bank's monitoring increases in its exposure T.

The equilibrium bank loan and external financing contracts $\{(B, T), (E, C)\}$ maximize the entrepreneur's utility subject to zero-profit conditions in the bank and outside financing markets and the budget constraint that the bank loan plus the outside funding covers the cost of the project. With the first-order conditions for θ and θ_0 impounded in the functions $\theta^*(T, C)$ and $\theta_0^*(T, C)$, this utility maximization problem can be stated as Problem CE:

$$\underset{B,T,C,E}{\text{maximize}}\ \theta^*(T, C)\left[\frac{Q - T - C}{r_f}\right] + (E + B - 1) - \frac{[\theta^*(T, C)]^2}{2\beta}, \tag{5}$$

subject to

$$B = \frac{\theta^*(T, C)T}{r_f} - \frac{[\theta^*(T, C) - \theta_0^*(T, C)]^2}{2m}, \tag{6}$$

[6] Thus, we are assuming that banks and outsiders can observe whether the project is undertaken.

[7] As will be shown below, in a competitive equilibrium this will not occur.

$$E = \frac{\theta^*(T, C)C}{r_f}, \tag{7}$$

$$E + B \geq 1, \tag{8}$$

$$T + C \leq Q, \tag{9}$$

$$C \geq 0, \tag{10}$$

$$B \geq 0, \tag{11}$$

$$T \geq 0. \tag{12}$$

Equation (5) is the expected present value of the entrepreneur's future and present consumption minus the disutility of effort. Condition (6) is a bank's zero-profit condition. Note that a bank's return T *must* be sufficient to cover the opportunity cost of its funds plus its monitoring costs. Condition (7) is the outside market's zero-profit condition. Condition (8) is the entrepreneur's budget constraint. Condition (9) is a feasibility condition, requiring that the entrepreneur's total repayment obligations to the bank and outsiders not exceed the total available cash flow on the project."

Our approach is to simplify Problem CE by substituting constraints (6) and (7) into the objective function and into the other constraints, thereby eliminating B and E from the problem. We also define a new variable, $R \equiv C + T$, which denotes the entrepreneur's *aggregate* repayment *obligation* to the bank and outside investors. Carrying out these steps yields an equivalent representation of Problem CE:

$$\underset{R,T}{\text{maximize}}\ U(R, T) \equiv \text{NPV}^F - \left(\frac{\beta}{2}\right) r_f^{-2} \left\{ \left[R - \left(\frac{m}{\beta}\right) T \right]^2 + \left(\frac{m}{\beta}\right) T^2 \right\}, \tag{5'}$$

subject to

$$\beta QR - \beta R^2 + mTR - (m/2)T^2 \geq r_f^2, \tag{8'}$$

$$R \leq Q, \tag{9'}$$

$$R \geq T, \tag{10'}$$

$$\beta R - (m/2)T \leq \beta Q, \tag{11'}$$

$$T \geq 0. \tag{12'}$$

To interpret this problem, constraints (8')-(12') are the equivalent representations of constraints (8)-(12) in the original version of Problem CE. In particular, constraint (10') is equivalent to $C \geq 0$, and if (10) is binding, C and E are zero-the entrepreneur finances the

[8] We should also impose the constraints $\theta^*(C, T) \in [0, 1]$ and $\theta_0^*(C, T) \in [0, \theta^*(C, T)]$. However, the assumption that $Q\beta/r_f \leq 1$ ensures that at the equilibrium these constraints will be slack.

project entirely with bank debt. Condition (11') is equivalent to $B \geq 0$, and if (11') is binding, then the entrepreneur relies entirely on outside financing.

The term in the curly braces of the entrepreneur's objective function is the sum of the agency costs of outside equity and of bank debt. The agency costs consist of two components: $(m/\beta)T^2$ is the cost of monitoring; $[R - (m/\beta)T]^2$ is the agency cost of outside financing. In the absence of monitoring, this agency cost would depend only on the borrower's total repayment obligation R because it is the latter that drives the wedge between the project's return and the borrower's return and thus reduces effort. However, monitoring lessens the agency problem of outside financing, thereby leading to the adjustment term $(m/\beta)T^2$.

2. Competitive Equilibrium with No Bank Financing

To provide a benchmark against which to analyze the role of bank funding, we first consider the competitive equilibrium when there is no bank debt. This equilibrium can be characterized by analyzing Problem CE with the additional constraint that $B = T = 0$. That problem reduces to[9]

$$\underset{R \geq 0}{\text{maximize}}\ \text{NPV}^F - (\beta/2)r_f^{-2}R^2, \tag{5''}$$

subject to

$$\beta QR - \beta R^2 \geq r_f^2. \tag{8''}$$

The competitive equilibrium outside claim $R = C$ will be the smallest claim satisfying the budget constraint (8").

It may be that there exists no competitive equilibrium in which the project is undertaken. This will occur if the budget constraint (8") cannot be satisfied. The necessary and sufficient condition for existence of a solution to (8") is

$$\beta Q^2/4r_f^2 \geq 1. \tag{13}$$

The failure of the project to be financed arises because as the entrepreneur issues claims to outsiders, his incentive to exert effort declines. This is anticipated by the market, reducing the price of the external claim. This requires that more shares of stock (or more bonds) be issued to finance the project, worsening the incentive problem. When (13) does not hold, an entrepreneur would be unable to generate the funds needed to finance the project. Condition (13) is more

[9] In this case, the repayment obligation R is simply the equity claim C.

stringent than the condition $\beta Q^2/2r_f^2 > 1$ that the project has a positive NPV, so the agency problem can lead to a market failure in which *positive* NPV projects are not undertaken because an entrepreneur is unable to obtain capital.

3. Competitive Equilibrium with Bank Financing

We now characterize the competitive equilibrium when banks function as lenders and monitors. The first step is to characterize conditions under which the project will be undertaken (i.e., conditions for Problem CE to have a feasible solution that yields a nonnegative expected utility for the entrepreneur). Our first proposition indicates a necessary and sufficient condition for this to occur.

Proposition 1. *At a competitive equilibrium, the project will be undertaken if and only if*

$$\beta Q^2/4r_f^2 \geq 1 - m/2\beta. \tag{14}$$

Proposition 1 is significant for two reasons. First, because $m < \beta$, condition (14) implies that, in equilibrium, a positive NPV project may not be undertaken if its return is too low. This would occur when $1 < \beta Q^2/2r_f^2 < 2 - m/\beta$, indicating that the agency problem of outside financing can lead to market failure even though monitoring is feasible. Second, condition (14) indicates that a project would be undertaken in a broader set of circumstances, the lower are the total and marginal costs of monitoring (i.e., the higher is the value of m). Thus, improved bank monitoring efficiency can mitigate the market failure due to moral hazard.

Because condition (14) is less stringent than condition (13)-the existence condition when there is no bank monitoring-there are positive net present value projects that would be undertaken when there is monitoring but that would not be undertaken in the absence of monitoring. Hereafter, we assume that condition (14) holds and that the project is undertaken in equilibrium. We now characterize that equilibrium.

Proposition 2. *A competitive equilibrium in which the project is undertaken is unique and has the following features.*

(a) The amount of bank debt B and the repayment obligation T* are strictly positive (i.e., B* > 0 and T* > 0).*

(b) The amount of outside financing E and the outsiders' claim C* are strictly positive (i.e., E* > 0 and C* > 0).*

(c) There is a positive amount of bank monitoring (i.e., $\theta^* - \theta_0^* > 0$*, where* $\theta^* \equiv \theta^*(C^*, T^*)$ *and* $\theta_0^* \equiv \theta_0^*(C^*, T^*)$*].*

(d) The total effort θ^* provided by the entrepreneur is strictly less than the best-first effort θ^F (i.e., $\theta^* < \theta^F$).

(e) The entrepreneur's budget constraint is binding in equilibrium (i.e., $E^* + B^* = 1$).

(f) At the competitive equilibrium, substituting bank financing for outside funding at the margin increases the firm's stock price [i.e., $(dP^*/dT)(T^*, R^*) > 0$, where P^* denotes the equilibrium stock price].

Parts (a) and (b) of Proposition 2 indicate that, in equilibrium, the entrepreneur chooses an *interior* combination of bank debt and outside financing. Parts (c) and (d) indicate that there is a positive amount of monitoring in equilibrium, but that the level of monitoring leaves the entrepreneur's effort short of the first-best level. Part (e) of Proposition 2 states that the entrepreneur issues just enough bank debt and outside claims to finance the project. Finally, part (f) of the proposition indicates that, at equilibrium, outside claimants would prefer that the firm issue more bank debt and repurchase an equivalent amount of outside claims. The entrepreneur does not do this, however, because the additional bank credit would result in more monitoring by the bank and consequently greater entrepreneurial effort. Because effort is personally costly to the entrepreneur, the equilibrium level of bank debt will be less than that preferred by the firm's outside claimants.

Part (a) of Proposition 2 is noteworthy because it indicates that, in equilibrium, a bank will supply both monitoring services and credit, rather than specializing in lending without monitoring or monitoring without lending. Surprisingly, this arises because monitoring costs are convex in monitoring effort. To develop this point, note first that if a bank monitors but does not supply credit ($T > 0$, $B = 0$), its profit is

$$\pi = \theta^* T/r_f - M(\theta^* - \theta_0^*), \tag{15}$$

where, recall, $M(\cdot)$ denotes the total cost of monitoring. Now, $\theta^* - \theta_0^*$ is given by the bank's first-order condition

$$T/r_f = M'(\theta^* - \theta_0^*).$$

Solving this expression for T and substituting into (15), the bank's expected profit can be expressed as

$$\pi = (T/r_f)[(1 - \eta)\theta^* + \eta\theta_0^*] > 0, \tag{16}$$

where

$$\eta \equiv \frac{M(\theta^* - \theta_0^*)/(\theta^* - \theta_0^*)}{M'(\theta^* - \theta_0^*)}$$

is the ratio of the *average cost* of monitoring to the *marginal cost* of monitoring. Inequality (16) holds because the convexity of the monitoring cost function $M(\cdot)$ implies $\eta \in (0, 1)$. Thus, an intermediary that offers only monitoring services would earn a positive expected profit, rendering itself vulnerable to entry by banks offering both monitoring services and credit. This argument does not depend on the quadratic form of monitoring costs; all that is required is that these costs be convex and that the bank choose its monitoring effort to maximize profits.

Proposition 2 indicates that in a competitive equilibrium, the entrepreneur chooses an interior combination of outside financing and bank debt to minimize agency costs, subject to the budget constraint. If the entrepreneur faced no debt obligation (i.e., $T = 0$), no monitoring would occur, and the entrepreneur would not benefit from the increase in productive effort that results from such monitoring. Thus, it is because bank monitoring can eliminate *entrepreneurial moral hazard* that there is positive equilibrium bank debt in our model.

But this intuition begs a question: If bank debt has the advantage that it eliminates entrepreneurial moral hazard, why does the entrepreneur not rely entirely on bank debt? We can develop an answer to this question by examining the role that *bank moral hazard* plays in the analysis. To do this, let us now imagine that a bank can contractually precommit to a given level of monitoring effort. A comparison of the equilibrium in this case with the equilibrium characterized in Proposition 2 should shed light on the role played by bank moral hazard in the analysis.

Proposition 3. *If banks can contractually commit to monitoring (i.e., there is no bank moral hazard), then there exists a competitive equilibrium in which the entrepreneur finances the project entirely with bank debt.*

Taken together, Propositions 2 and 3 imply that it is the conjunction of entrepreneurial moral hazard and bank moral hazard that is crucial to the result in Proposition 2 that there is a unique interior optimal financing mix of bank and external credit. Entrepreneurial moral hazard makes bank loans valuable, while bank moral hazard limits their use in equilibrium. When a bank cannot contractually precommit to a particular level of monitoring, its monitoring effort is chosen as a function of its exposure T. When the entrepreneur substitutes outside funds for bank credit, it induces a reduction in bank monitoring but also reduces its interest costs. Starting from a situation in which the entrepreneur is financing entirelywith bank debt, the latter effect is dominant, at the margin. This trade-off *does not* arise when

the bank can precommit to monitoring effort. In that case, competition among banks makes a bank's equilibrium monitoring effort an increasing function of the borrower's return Q, not the bank's return T. In effect, the absence of bank moral hazard induces a separation between a bank's lending terms and its monitoring activity. In equilibrium, all that is required is that the repayment obligation T be large enough to cover the bank's monitoring costs. This can be accomplished when the entrepreneur finances entirely with bank debt.

4. conclusions

Capital market securities are imperfect substitutes for bank loans. This appears to be the emerging view in financial economics. However, while the "special" role of bank lending is becoming recognized, there is less agreement on why it is special. We present a model in which banks offer credit and monitoring services and coexist with capital markets. The key feature of our model is that the entrepreneur's incentive for improving the success probability of the project depends on his stake in the firm. External financing reduces the entrepreneur's expected payoff, and consequently reduces his effort at improving the likelihood of project success. We analyze the competitive equilibrium in which entrepreneurs will optimally finance their projects with both bank credit and external capital; in addition, banks will provide monitoring of entrepreneurs. Such monitoring increases entrepreneur effort and thereby improves the project's success probability. The equilibrium levels of bank debt and monitoring are less than the levels preferred by outside investors. If the borrower's capital structure relied on more bank debt and less external financing, the borrower's stock price would be higher than the equilibrium stock price because of the beneficial impact of bank monitoring on the borrower's effort level.

We have assumed that the capital markets are competitive and that banks compete with each other in the provision of bank credit and monitoring services. It is useful to consider how our results would change if banks did not compete in their roles as monitors; we maintain our assumption of a competitive external capital market. Now, bank contracts would maximize bank profits and reduce the entrepreneur's utility to its reservation level. The latter would be the level that the entrepreneur could achieve if the project were undertaken with all financing provided by the capital markets and no bank monitoring. The bank would minimize the size of its loan in order to reduce its funding costs, choose a profit-maximizing level of monitoring, and price it in the repayment obligation (i.e., the bank would offer a low amount of credit but a high loan rate). Monitoring would

provide both direct and indirect benefits to the bank. The direct benefit would be the improvement of the likelihood of the borrower fulfilling his payment obligation to the bank. The bank's other benefit is that the extent of its monitoring is priced in the securities the entrepreneur sells in the capital market for funding. A greater degree of monitoring reduces the entrepreneur's cost of funding the project, and this cost reduction is captured by the bank in setting the borrower's repayment obligation. Thus, we would expect that in an imperfectly competitive bank credit market, the equilibrium level of monitoring and the borrower's repayment obligation are higher but the bank loan size is *smaller* than in a competitive bank market. An implication of this result is that the competitive bank's loan portfolio is riskier than that of a monopoly bank. While this argument has been made before, our focus on the role of the competitive capital markets and bank monitoring in obtaining this result is new.[10]

Appendix: Proofs of Propositions

Proof of Proposition 1

The function *U(R, T)* is continuous, bounded, and strictly concave in *(R, T).* Assuming that it is nonempty, the feasible set can be shown to be compact and convex in R^2. [Convexity follows because the left-hand side of (8') is concave in *(R, T);* this is ensured by the assumption in $m < \beta/2$.] Thus, a solution to Problem CE exists if and only if the feasible set is nonempty.

We first show that if (14) holds, there exists a feasible solution to Problem CE that results in positive expected utility to the entrepreneur. Thus, (14) implies that a competitive equilibrium will exist in which the project is undertaken.

Consider the solution

$$R = T = (\beta/(2\beta - m))Q < Q.$$

When (14) holds, it is readily established that this solution is indeed feasible for Problem CE. To verify that the entrepreneur's expected utility is positive under this solution, substitute the solution into *U(R, T)* to get

$$U(R, T) = 3\beta^2Q^2(\beta - m)/2r_f^2(2\beta - m)^2 - 1.$$

But, from (14), $\beta^2Q^2/2r_f^2 \geq (2\beta - m)$,

$$U(R, T) \geq 3(\beta - m)/(2\beta - m) - 1 > 0,$$

where the last inequality follows because $m < \beta/2$.

[10]The conclusion of Chan, Greenbaum, and Thakor (1986) is the same as ours, although they do not consider the banks' coexistence with capital markets.

We now prove the converse: if the project is undertaken in a competitive equilibrium, condition (14) must hold. Suppose, to the contrary, that (14) does *not* hold. Now, it is easily verified that

$$\frac{\beta^2 Q^2}{2(2\beta - m)} = \max_{R,T}\left\{\beta QR - \beta R^2 + mTR - \frac{m}{2}T^2\right\},$$

If (14) does not hold,

$$\max_{R,T}\{\beta QR - \beta R^2 + mTR - (m/2)T^2\} < r_f^2,$$

and there exists no feasible combination of equity and bank loans that is sufficient to finance the project. This is a contradiction.

Q.E.D.

Proof of Proposition 2

(a) Proof that $B^* > 0$, $T^* > 0$. Substituting the expressions for $\theta^*(T, C)$ and $\theta_0^*(T, C)$ into (6), we have

$$B = (T/r_f^2)[\beta Q - (\beta R - (m/2)T)]. \tag{A1}$$

Condition (9') implies

$$\beta Q \geq \beta R \geq \beta R - (m/2)T. \tag{A2}$$

Thus, (A1) and (A2) imply that $B^* > 0$ if, at the optimal solution, $T^* > 0$.

To show that the optimal solution does indeed involve $T^* > 0$, suppose, to the contrary, that $T^* = 0$. At this solution, we must have $R^* > 0$, for otherwise (8') would not be satisfied.

Now note that

$$\frac{\partial U}{\partial T}(R^*, 0) = \frac{mR^*}{r_f^2} < 0.$$

Denoting the left side of (8') as $\psi(R, T)$,

$$\frac{\partial \psi}{\partial T}(R^*, 0) = mR^* > 0.$$

Thus, at the purported optimal solution, a slight increase in T, holding R fixed, will increase the objective function value without violating constraints (7') and (9')-(12').[11] But that contradicts the optimality of a solution with $T^* = 0$. Thus, $T^* > 0$ and $B^* > 0$. Q.E.D.

[11] When $T^* = 0$, note that $\theta^* = \theta_0^* = (\beta/r_f)[Q - R^*]$. Because $\beta Q/r_f \leq$, it follows that $\theta^* < 1$. Thus, a slight increase in Twill not violate the constraint (not explicitly included) that $\theta^* \leq 1$

(b) Proof that $C^* > 0$, $E^* > 0$. To establish this result we must show that $R^* > T^*$. Given the result in part (a), the relevant constraints for Problem CE are (8')-(10'). Let λ, τ, and ξ, respectively, be the multipliers for these constraints. The Kuhn-Tucker necessary conditions (which, given the concavity of the object function and the convexity of the feasible set, are sufficient) can be written as

$$R: \quad \frac{-\beta}{r_f^2}\left[R^* - \frac{m}{\beta}T^*\right] + \lambda(\beta Q - 2\beta R^* + mT^*) - \tau + \xi = 0; \quad \text{(A3)}$$

$$T: \quad \frac{m}{r_f^2}\left[R^* - \frac{m}{\beta}T^*\right] - \frac{m}{r_f^2}T^* + \lambda(mR^* - mT^*) - \xi = 0; \quad \text{(A4)}$$

$$\lambda\left[\beta Q R^* - \beta(R^*)^2 + mT^*R^* - \frac{m(T^*)^2}{2} - r_f^2\right] = 0,$$

$$\lambda \geq 0; \quad \text{(A5)}$$

$$\tau[R^* - Q] = 0,$$

$$\tau \geq 0; \quad \text{(A6)}$$

$$\xi[R^* - T^*] = 0,$$

$$\xi \geq 0. \quad \text{(A7)}$$

If $R^* = T^*$, then (A4) reduces to

$$-m^2T^*/\beta r_f^2 = \xi,$$

which is a contradiction since $T^* > 0$. Q.E.D.

(c) Proof that $\theta^* - \theta_0^* > 0$. This follows from (4) and the result that $T^* > 0$. Q.E.D.

(d) Proof that $\theta^* < \theta^F$. Conditions (3) and (4) imply

$$\theta^* = \theta_0^* + mT^*/r_f$$

$$= \theta^F - \beta R^*/r_f + mT^*/r_f.$$

But $R^* > T^*$ and $\beta > m$, so it follows $\theta^* < \theta^F$. Q.E.D.

(e) Proof that $E^* + B = 1$. If $E^* + B^* > 1$, then $\lambda = 0$ in the Kuhn-Tucker conditions above. Since $R^* > T^*$, $\xi = 0$, from (A7). But $R^* > T^* > (m/\beta)T^*$, so the left-hand side of (A3) is negative, a contradiction. Q.E.D.

(f) Proof that $(dP^*/dT)(T^*, R^*) > 0$. In equilibrium, the stock price $P^*(T, C)$ must equal the discounted expected value of the

entrepreneur's share:

$$P^*(T, C) = \frac{\theta^*(T, C)[Q - T - C]}{r_f}.$$

Using the expression for $\theta^*(T, C)$ in (4), and recalling that $R = T + C$, we can rewrite the stock price as

$$P^*(T, R) = \beta r_f^{-2} \{(Q - R)^2 + (m/\beta) T(Q - R)\}.$$

Now, suppose the firm substitutes bank financing for equity at the margin. In effect, the entrepreneur must increase T and adjust R so as to preserve (8') as an equality. The marginal impact of increasing bank debt is thus given by

$$dP^* = \frac{\partial P^*}{\partial R} dR + \frac{\partial P^*}{\partial T} dT,$$

where

$$\frac{dR}{dT} = \frac{-m(R - T)}{\beta Q - 2\beta R + mT}$$

is the marginal rate of substitution of R for Talong budget constraint (8'). Evaluating the partial derivatives and rearranging yield

$$\frac{dP^*}{dT} = m r_f^{-2} \left\{ \frac{(2\beta Q - 2\beta R + mT)(R - T)}{(\beta Q - 2\beta R + mT)} + Q - R \right\}.$$

We know

$$Q \geq R^*,$$

$$R^* > T^* > 0,$$

$$2\beta Q - 2\beta R^* + mT^* > 0.$$

Hence, if we can show that $\beta Q - 2\beta R^* + mT^* > 0$, we will have proven the proposition. From (A3) (noting $R^* > T^*$, so $\xi = 0$), we have

$$\lambda(\beta Q - 2\beta R^* + mT^*) = \frac{\beta}{r_f^2} \left(R^* - \frac{m}{\beta} T^* \right) + \tau.$$

But $R^* > T^* > (m/\beta) T^*$ (since m < β), so

$$\beta Q - 2\beta R^* + mT^* > 0,$$

and thus $dP^*/dT > 0$. Q.E.D.

Proof of Proposition 3

The effect of eliminating bank moral hazard is to eliminate Equation (4) as a constraint in Problem CE. That is, instead of requiring that

monitoring expenditures maximize bank profit, we now choose monitoring expenditures (along with the other contract terms) to maximize the entrepreneur's utility. The optimization problem, analogous to Problem CE, that characterizes the equilibrium now becomes

$$\underset{\theta,B,T,C,E}{\text{maximize}}\ \theta\left[\frac{Q-T-C}{r_f}\right]+(E+B-1)-\frac{\theta^2}{2\beta},$$

subject to

$$B=\frac{\theta T}{r_f}-\frac{[\theta-\theta_0^*(T,C)]^2}{2m},\qquad E=\frac{\theta C}{r_f},$$
$$E+B\geq 1,\qquad T\leq Q,\qquad T+C\leq Q,\qquad B,T,C,E\geq 0.$$

Substituting B and E into the objective function and constraints yields the problem

$$\underset{R,T,\theta}{\text{maximize}}\ \frac{\theta Q}{r_f}-\frac{[\theta-\theta_0^*(R)]^2}{2m}-\frac{\theta^2}{2\beta}, \tag{A8}$$

subject to

$$\frac{\theta R}{r_f}-\frac{[\theta-\theta_0^*(R)]^2}{2m}\geq 1, \tag{A9}$$

$$R\leq Q, \tag{A10}$$

$$R\geq T, \tag{A11}$$

$$\frac{\theta T}{r_f}\geq\frac{[\theta-\theta_0^*(R)]^2}{2m}. \tag{A12}$$

As before, we have defined R = C + T, and we have exploited the fact that θ_0^* depends only on R. Let us refer to this problem as Problem CEC. We first note that a solution to CEC exists. The reason is that Problem CEC is a *less constrained* version of Problem CE [the constraint $\theta=\theta^*(T,C)$ has been dropped]. Since the feasible set for CE is nonempty, the feasible set for CEC will be nonempty as well.

Now consider a relaxation of CEC that *ignores* (A11) and (A12). Such a relaxation drops T from the problem, since the objective function and remaining constraints are independent of T. Let R, θ be the solution to this relaxation. Using the Kuhn-Tucker conditions, it is straightforward to show that (A9) must bind. But this implies that $T = R$ satisfies the additional constraints (A11) and (A12), so that there is an optimal solution to CEC that involves $T = R$. This implies that there exists a competitive equilibrium in which the entrepreneur finances exclusively with bank debt. Q.E.D.

References

Barnea. A., R. Haugen, and L. Senbet, 1985, *Agency Problems and Financial Contracting,* Prentice-Hall, Englewood Cliffs, NJ.

Berlin. M., and J. Loeys, 1988, 'Bond Covenants and Delegated Monitoring," *Journal of Finance,* 43, 397-412.

Campbell. T., and W. Kracaw, 1980, "Information Production, Market Signalling, and the Theory of Financial Intermediation," *Journal of Finance,* 35, 863-882.

Chan, Y. S., 1983. "On the Positive Role of Financial Intermediation in Allocation of Venture Capital in a Market With Imperfect Information," *Journal of Finance,* 38, 1543-1568.

Chart, Y. S., S. Greenbaum, and A. Thakor, 1986, "Information Reusability, Competition and Bank Asset Quality," *Journal of Banking and Finance,* 10, 243-253.

Diamond, D., 1984, "Financial Intermediation and Delegated Monitoring," *Review of Economic Studies,* 51. 393-414.

Diamond, D., 1991, "The Choice Between Bank Loans and Directly Placed Debt," *Journal of Political Economy,* 99, 689-721.

Easterbrook, F., 1984, "Two Agency Cost Explanations of Dividends," *American Economic Review,* 74, 650-659.

Fama. E.. 1980, "Banking in the Theory of Finance," *Journal of Monetary Economics,* 6, 39-57.

Fama. E.. 1985, "What's Different About Banks?" *Journal of Monetary Economics,* 15, 29-39

Grossman, S.. and 0. Hart, 1982, "Corporate Financial Structure and Managerial Incentives," in John McCall fed.), *Economics of Information and Uncertainty,* University of Chicago Press, Chicago.

Hoshi. T., A. Rashyap, and D. Scharfstein, 1991, "Corporate Structure, Liquidity, and Investment: Evidence from Japanese Industrial Groups," *Quarter1y Journal of Economics,* 106, 33-60.

James, C., 1987, "Some Evidence on the Uniqueness of Bank Loans," *Journal of Financial Economics,* 19, 217-235.

Jensen, M.. 1986, "Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers," American *Economic Review,* 76, 323-329.

Jensen, M., and W. Meckling, 1976, "Theory of the Firm: Managerial Behavior, Agency Costs and Capital Structure," *Journal of Financial Economics,* 3, 305-360.

Leland, H., and D. Pyle, 1977, "Informational Asymmetries, Financial Structure and Financial Intermediation," *Journal of Finance,* 32, 371-387.

Niehans, J.. 1978, *Theory of Money,* The Johns Hopkins University Press, Baltimore, Md.

Ramakrishnan, R., and A. Thakor, 1984, "Information Reliability and a Theory of Financial Intermediation," *Review of Economic Studies,* 51, 415-432.

Seward, J., 1990, "Corporate Financial Policy and the Theory of Financial Intermediation," *Journal of Finance,* 45, 351-377.