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Asymmetric Information, Bank Lending, and Implicit Contracts: A Stylized Model of Customer Relationships

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ABSTRACT

Customer relationships arise between banks and firms because, in the process of lending, a bank learns more than others about its own customers. This information asymmetry allows lenders to capture some of the rents generated by their older customers; competition thus drives banks to lend to new firms at interest rates which initially generate expected losses. As a result, the allocation of capital is shifted toward lower quality and inexperienced firms. This inefficiency is eliminated if complete contingent contracts are written or, when this is costly, if banks can make nonbinding commitments that, in equilibrium, are backed by reputation.

THIS PAPER DERIVES A dynamic theory of "customer relationships" in bank loan markets. The theory builds on a traditional view of bank lending behavior, first spelled out by Hodgman (1961) and Kane and Malkiel (1965) and later elaborated upon by Wood (1975). According to this view, an essential factor underlying a bank's loan pricing policy is its impact on the bank's stock of loyal customers, as well as on those customers' deposits. Rather than take relationships as a given, we examine the implications of the view expressed, for example, by Fama (1985), that they arise because of "inside information" generated by the history of bank-firm interactions.

In our theory, customer relationships arise endogenously as a consequence of the asymmetric evolution of information sets. In contrast with most theories of pricing under asymmetric information, though, the key informational asymmetry postulated here is that which arises between agents on the same side of the market. We exploit the presumption, made by Kane and Malkiel (1965) and Fama (1985), that a bank which actually lends to a firm learns more about that borrower's characteristics than do other banks. A fundamental consequence of this asymmetric evolution of information is the potential creation of ex post, or temporary, monopoly power.

If it is relatively costly for banks and firms to write multiperiod contingent contracts, this ex post monopoly power has undesirable effects on the allocation of capital. Even though banks earn zero expected profit over the lifespan of the average customer relationship, they are not disciplined by the market to offer

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better-performing customers "competitive" rates and, thus, can expect to earn economic profit on those customers. Due to competition, however, rents are competed away via lower interest rates on loans offered to all firms in their initial period, precisely when banks know the least about firms. As a result, low quality firms employ a greater proportion of the capital than in the standard symmetric information case.

This theory suggests that firms stay with the same bank not simply because the bank treats them particularly well, but because high quality firms are, in a sense, "informationally captured". Their own bank does make the best offer, but this is due to difficulties firms face in conveying information about their superior performance to other banks. Adverse selection makes it difficult for one bank to draw off another bank's good customers without attracting the less desirable ones as well.

These inefficiencies are shown to be reduced if lenders can develop reputations. If banks make nonbinding promises, and future market participants learn about the bank's propensity to keep its promises, "implicit contracts" arise. While they do not mimic optimal binding contracts, these commitments will be characterized by prices which more closely approximate the optimal prices and, thus, lead to a more efficient allocation of capital.

It is shown that, if the additional surplus generated by the more efficient use of experience information under implicit contracts is great enough, equilibrium with implicit contracts can be supported. Whether such an equilibrium exists, and how this surplus is split up between firm and bank, depends on the degree of informational advantage the bank has over its competitors, the speed of diffusion of reputation changes, and the bank's discount rate.

The formal conditions that characterize and guarantee the existence of implicit contracts in our paper are similar to those in the theory of Klein and Leffler (1981). They argue that, in markets for experience goods, in order for firms to have an incentive to produce and sell greater than the minimum observationally indistinguishable quality, they must be able to earn a stream of rents over time. That stream of rents must be greater in present value than the short-run profits to be earned from "cheating." Shapiro (1983) and Allen (1984) made the argument more formal by introducing a variable called "reputation," which was a function of both the firm's actions and consumer beliefs. A principal result in these papers is that price must depart from marginal cost in order to make the implicit (quality) contract self-enforcing.

The corresponding theoretical result in this paper is similar yet differs in the following respect. In the theory laid out below, the supplier (the bank) charges prices that exceed its marginal cost of funds, even though there is no asymmetric information concerning its product (credit). Rather than moral hazard, it is the potential for taking advantage of captive customers, by altering the terms of trade, that gives rise to a reputation equilibrium where competitors earn rents over time.

In comparison to the existing literature, this paper offers a new, though sometimes complementary, explanation for long-term bank-borrower relationships. Stiglitz and Weiss (1983) show how the threat of future credit rationing can reduce borrower moral hazard. In Boot and Thakor (1989), Boot, Thakor, and Udell (1988), Chan, Greenbaum, and Thakor (1986), and Such (1985), as in our model, borrower quality is assumed to display persistence through time. Such shows how multiperiod contracting with rationing can help to sort among borrower types. Boot and Thakor show how contingent commitments can be used to sort borrower types without the inefficiency engendered by rationing. Boot, Thakor, and Udell examine the effect of enforcement costs on intertemporal contingent contracting and show how the existence of large intermediaries may attenuate the enforcement problem. Finally, Chan, Greenbaum, and Thakor examine how a given level of competition, characterized by an exogenously given profit margin per loan, affects bank incentives to expend resources in the production of reusable information.

Section I develops the basic two-period model. In Section II, the subgame perfect equilibrium and the contingent contract equilibrium are derived and discussed. Section III extends the model to one with overlapping generations of firms and infinitely lived banks and then characterizes the implicit contract equilibrium. The conclusion summarizes the results and discusses some broader implications.

I. The Model

A. Firms

Each of a continuum of risk-neutral entrepreneurs, $f \in [0, M]$, is assumed to have the option of carrying out investment projects for up to two market periods. For a given firm, the one-period gross return is independently and identically distributed across periods. Thus, the return distribution is a fixed characteristic of the firm; on the other hand, it is assumed to vary across firms.

Specifically, the distribution of returns is assumed to be binary; whether the project is "successful" or not is independent of the size of the investment. A firm of type q, that invests I units of capital, earns a gross return of

$$g(I)\cdot I \text{ with probability } p_q,$$
$$0 \text{ with probability } 1 - p_q. \tag{1}$$

It is assumed that $g'(I) < 0$ and $g''(I) \leq 0$, conditions sufficient to assure concavity of the profit function. Equation (1) could be interpreted as the combination of a simple production process with a discontinuous inverse demand curve. For example, I units of working capital produce I units of output. If the product is not a flop, the firm can sell I units at a price $g(I)$; otherwise, demand is zero.

Though the results can be generalized to a market with many types, for simplicity's sake, it is assumed that $q \in \{H, L\}$, with $P_H > P_L$. Thus, there are two types of firms, high (H) and low (L) quality, where quality indexes the probability of success. Let θ be the fraction of firms that are of high quality; θM is thus the aggregate measure of high quality firms. In notable contrast to much of the asymmetric information literature, it is assumed here that firms know only the distribution of types, *not* their own type. While this assumption appears to conflict with standard assumptions in models of information asymmetries, the difference can really be seen as one of emphasis. It is surely the case that, in the process of running a firm, an entrepreneur—and perhaps his or her bank—garners new information about his or her ability to carry out projects.

Entrepreneurs are assumed to immediately consume any net profit earned on first-period projects; thus, they generate no additional collateral for subsequent operations. While perhaps unrealistic, the purpose of this assumption is straightforward. We desire a simple model in which a firm's cost of capital changes over time solely because of information arising from the firm's past performance.

B. Loan Supply and the Information Structure

It is assumed that firms own no capital and are only able to raise funds by borrowing from one of M banks in a "competitive" bank loan market. (Thus, for notational convenience, there is a mass of one firm per bank.) We assume that each bank has access to an unlimited quantity of capital at a cost of $\bar{r}$ per period.[1]

Like firms themselves, banks are also unable to observe a firm's quality and, at the beginning of the first period, know only θ, the proportion of high quality firms. It is assumed that a bank which lends to a firm is able to freely observe whether or not that firm's project is a success. Let $\gamma(f) \in \{S, F\}$ be the perfect signal of the outcome of firm f's project in period one, where $\gamma = S$ if the project succeeds and F if it fails.

Banks that did not lend to f in the first period, labeled "outside" banks with respect to f, observe only a noisy signal of the outcome, $\tilde{\gamma}(f) \in \{\tilde{S}, \tilde{F}\}$. This signal may or may not be observable to the actual lender; its conditional distribution function is given by

$$\begin{aligned} \text{prob}(\tilde{\gamma} = \tilde{S} \mid S) &= \text{prob}(\tilde{\gamma} = \tilde{F} \mid F) = (1 + \phi)/2, \\ \text{prob}(\tilde{\gamma} = \tilde{S} \mid F) &= \text{prob}(\tilde{\gamma} = \tilde{F} \mid S) = (1 - \phi)/2, \end{aligned} \tag{2}$$

where $0 \le \phi \le 1$. Finally, it is assumed that the signal $\tilde{\gamma}$ is fixed for any particular firm; all outside banks observe the same outcome of that signal, and they do so without cost. Thus, if $\phi = 0$, outside banks learn nothing about a firm's past performance. At the other extreme, if $\phi = 1$, outside bank information about the actual outcome is identical to inside information.

Implicit in the assumption of asymmetric outcome observability is the idea that the lender must expend some minimum level of resources to make sure that the borrower is doing what it promised to do, i.e., that it is not taking undue risk or wasting capital via the consumption of perks. In the process of this monitoring, the lender learns more about the success of the firm's operation than do outside banks.[2] As a result, the original lender should be in a better position to evaluate the firm's future performance. Furthermore, banks do not readily divulge

[1] More generally, $\bar{r}$ could be interpreted as the endogenously determined equilibrium rate of return in a market that faces an upward-sloping capital supply schedule. As long as each bank perceives itself as facing an infinitely elastic supply schedule, our results are unaltered.

[2] Labor economists have long recognized that much information relevant to the employment relationship is generated as a by-product of production activities, making verification on the part of unrelated third parties and, thus, explicit contracting, difficult. Parsons (1986) points this out in a discussion and review of the literature on employment relationships.

information concerning the profitability of current commercial clients. Clearly, such information sharing would help competing banks to bid away their best customers.[3]

II. Equilibrium Loan Contracts

We now examine the temporal pattern of equilibrium loan rates faced by firms in each of two regimes. In one, two-period contingent contracts are assumed to be enforceable; in the other, pre-commitments on the terms of the second-period contract are assumed to be unenforceable. An alternative interpretation is that contingent contracting bears high up-front costs; competitive bidding supports their use only if the joint benefits of such contracts outweigh these costs. This exercise allows us to characterize the relative advantages of contingent contracting.

In either regime, we assume that contract offers are built from standard single-period debt contracts. A single-period debt contract consists of an interest rate offer, $r_j(f)$, and the corresponding repayment schedule,

$$\begin{aligned} I\cdot[1 + r_j(f)] &\text{ if } \gamma(f) = S, \\ 0 &\text{ if } \gamma(f) = F, \end{aligned} \tag{3}$$

where I is the size of the loan chosen by the firm. A two-period, or contingent, contract will thus consist of an interest rate on a period-one loan plus a commitment on the terms of the period-two loan, that commitment being contingent on borrower performance in period one.[4]

A firm facing an interest rate of r in a given period chooses the investment level which solves

$$\max_I = [g(I) - (1 + r)]I\cdot p^e(f), \tag{4}$$

where $p^e(f)$ denotes the firm's (Bayesian) expected probability of success. The first-order condition yields the implicit investment demand function:

$$I^* = -[g(I^*) - (1 + r)]/g'(I^*). \tag{5}$$

Given our assumptions on $g(\cdot)$ in (1), it can easily be verified that the second-order condition holds and that both investment and profit are decreasing functions of the interest rate. On the other hand, investment is independent of the firm's expected probability of success.[5]

[3] Of course, in reality, past states of bankruptcy are relatively easy to observe by all. The assumption that outside banks do not observe "bankruptcy" is only a shorthand parameterization for the more complicated situation in which there exists a whole range of states for which debtors are able to satisfy their obligations but among which outsiders have difficulty distinguishing.

[4] This assumption on the feasible space of contracts is essentially a restriction that loan pricing be linear. As explained later, when the model is generalized to allow for a higher dimensionality of firm heterogeneity, the qualitative results do not depend upon this linear pricing restriction.

[5] This simplifies the analysis by precluding any possibility of screening by banks with quantity-price contract offers. In other words, lenders will be unable to write contracts which separate out, via self-selection, different quality firms in the second period. See Besanko and Thakor (1987) for a recent analysis of how screening might affect credit contracts.

Before describing the equilibrium, we first define several important benchmark loan rates. These benchmarks represent a bank's break-even loan rates, contingent on the information the bank may have about a firm. At a break-even loan rate, the gross cost of funds per unit loaned, $1 + \bar{r}$ equals, the bank's expected gross return; i.e., r satisfies $1 + \bar{r} = p^e(1 + r)$, where p^e is the bank's expectation of the firm's probability of success. Solving for r yields the formula:

$$r = \frac{\bar{r} + 1 - p^e}{p^e}. \tag{6}$$

Let r_p be defined as the break-even loan rate for a loan made to a randomly selected firm in the first period. In this case, $p^e = p \equiv [\theta p_H + (1 - \theta)p_L]$, the unconditional probability of success.

The break-even loan rate on a loan to a firm known to be successful in period one, r_S, differs from r_p only because of the new information upon which probability of success is conditioned. r_S is given by equation (6) for $p^e = p(S) = p_H\text{prob}(H|S) + p_L(1 - \text{prob}(H|S))$, where $\text{prob}(H|S) = \theta p_H/p$. The break-even rate for a loan to an unsuccessful firm, r_F, is similarly computed by setting $p^e = p(F)$, the probability of success in period two conditional on failure in period one. These loan interest rates (r_p, r_S, r_F) are called the "standard competitive rates" since these rates would prevail if all banks could observe all project outcomes.

We similarly characterize break-even rates based upon the observation of a noisy signal of first-period performance. For a randomly selected firm with $\tilde{\gamma}(f) = \tilde{S}$, the conditional probability of success and the break-even loan rate are defined as $p(\tilde{S})$ and $r_{\tilde{S}}$; $p(\tilde{S}) = p_H\text{prob}(H|\tilde{S}) + p_L(1 - \text{prob}(H|\tilde{S}))$, and

$$\text{prob}(H \mid \tilde{S}) = \frac{\theta[p_H(1+\phi) + (1-p_H)(1-\phi)]}{\theta[p_H(1+\phi) + (1-p_H)(1-\phi)] + (1-\theta)[p_L(1+\phi) + (1-p_L)(1-\phi)]}. \tag{7}$$

Finally, the break-even rate for a randomly selected firm with $\tilde{\gamma}(f) = \tilde{F}$ is defined to be $r_{\tilde{F}}$ and is similarly computed.

It is easy to verify and intuitive that $p(S) > p(\tilde{S}) > p > p(\tilde{F}) > p(F)$; the probability of success is greatest for a firm observed to be successful and lowest for one observed to fail. That probability for a firm which signaled a previous success, $p(\tilde{S})$, is greater than that for a firm picked at random from the entire pool, p. Finally, a randomly chosen firm is more likely to succeed than one which signaled a previous failure. Consequently, break-even loan rates can be ordered as follows:

$$r_S < r_{\tilde{S}} < r_p < r_{\tilde{F}} < r_F. \tag{8}$$

Furthermore, as ϕ converges to one, i.e., as the signal becomes more accurate, $r_{\tilde{S}}$ and $r_{\tilde{F}}$ converge to r_S and r_F, respectively.

Throughout, we also assume that $g(I)$, at $I = 0$, is large enough so as to induce an interior solution to the investment choice in the relevant range of r. More realistically, firms also have indivisible setup costs which induce increasing returns over the lower range of investment levels. In that case, I jumps to zero at a sufficiently high rate of interest.

A. Equilibrium with Multiperiod Binding Commitments

In this section, we show that, when banks can make enforceable two-period commitments, the interest rates and loan sizes associated with the equilibrium contingent contract echo those that prevail in the standard competitive case—the case where all banks are symmetrically informed. Because firms have no more knowledge of their own types than banks at the outset, contracts cannot play the role of a screening device. Furthermore, due to the assumption of all or nothing returns on projects, the probability of bankruptcy is unaffected by the size of the loan. Thus, reasons for nonlinear pricing, or rationing, discussed in the literature (e.g., Gale and Hellwig (1985) and Besanko and Thakor (1987)) are abstracted from in this model.

A simple way of demonstrating that the equilibrium contingent contract rates are identical to the non-contingent standard competitive rates involves constructing the maximization problem as if the firm and the lender were merged into a single entity. Let the fictional combined entity choose its investment levels, given that it faces the cost of capital $\bar{r}$, and assuming that it absorbs all gains and losses:

$$\max_{I^1,\ I^2(\gamma)} pg(I^1)I^1 + \sum_{\gamma} \text{prob}(\gamma)p(\gamma)g(I^2_\gamma)\cdot I^2_\gamma - (1 + \bar{r})[I^1 + \sum_{\gamma} \text{prob}(\gamma)I^2_\gamma], \qquad (9)$$

where prob(γ) is the probability that a representative firm signals γ and where p and $p(\gamma)$ are the unconditional and conditional probabilities of success. The first-order conditions for this problem are

$$\begin{aligned} I^1 &= \left[g(I^1) - \frac{\bar{r}+1}{p}\right] \Big/ g'(I^1), \\ I^2_\gamma &= \left[g(I^2_\gamma) - \frac{\bar{r}+1}{p(\gamma)}\right] \Big/ g'(I^2_\gamma), \quad \text{for } \gamma \in \{S, F\}. \end{aligned} \qquad (10)$$

By substituting the standard competitive rates (r_p, r_S, r_F given by (6)) into the firm's investment function (5), it is easy to confirm that the resultant levels of investment are identical to those in (10). Thus, the optimal, or joint-surplus maximizing, investment levels can be induced by a contingent contract $(r^1, r^2(\gamma))$ specifying the standard competitive rates:

$$\begin{aligned} r^1 = r_p,\ r^2(\gamma) &= r_S, \quad \gamma = S, \\ &r_F, \quad \gamma = F. \end{aligned}$$

Furthermore, banks earn zero profit under such a contract; therefore, this is the competitive equilibrium contingent contract.

B. Equilibrium Without Contingent Contracting

When contingent contracts are not possible, or too costly, the loan market is characterized as a two-period extensive form game. The sequential rules of the lending game are specified as follows.

In period one:

i) Banks simultaneously choose an interest rate at which credit is offered to each firm. For bank j, this offer is denoted r_j^1.
ii) Firms each randomly choose from among the best set of offers and then choose investment levels according to (4).
iii) Firms carry out projects and execute their debt contracts. Each bank observes $\gamma(f)$ of all those firms f to which it loaned funds.

In period two:

iv) Each bank j makes offers of credit $r_j^2(\gamma)$ to its previous customers, contingent upon the observed outcome γ.
v) Each bank j observes a signal $\tilde{\gamma}(f)$ of the first-period performance of those firms that borrowed from other banks. It also observes the lending policies $(r_h^2(\gamma))$ of their banks, but not individual offers. It then makes credit offers $(r_{jh}^2(\tilde{\gamma}))$ to customers of each bank $h \neq j$.
vi) Firms choose the best offer and then choose I. It is assumed that they remain at the same bank when indifferent, i.e., when offer rates are equal.
vii) Firms carry out their projects and execute their debt contracts.

In looking for equilibria with no commitment, one looks for equilibria in subgame perfect strategies. We do this by considering the second-period equilibrium first. Since it will be easy to verify that only symmetric equilibria exist, in constructing the second-period equilibria, we assume that all banks chose an identical strategy in the first period. Thus, by the beginning of the second period, all banks will have observed $\gamma(f)$ for an identical measure of firms (equal to one).

The equilibrium concept in the second period is similar to a price leader/competitive fringe story. A bank makes offers to its old customers first. Then outside banks offer contracts, behaving like Bertrand competitors with respect to each other. Constructing the second-period equilibrium thus involves constructing the (competitive) reaction function of outside banks and finding the optimal offer by the "inside" banks, all of whom face that reaction function.[6]

PROPOSITION 1: *If inside banks do not observe $\tilde{\gamma}$, equilibrium in the second period subgame is characterized by one of the following rate structures (and lending patterns):*

$$\text{(i)}\quad r_j(\gamma) = \begin{cases} r_{\tilde{S}}, & \gamma = S, \\ r_F, & \gamma = F, \end{cases} \qquad \textit{and } r_{jk}(\tilde{\gamma}) = r_F$$

(and firms all borrow from their old bank);

[6] It is implicitly assumed that competition always constrains banks to charge less than the monopoly loan rate. More precisely, we could define the monopoly rate $r_{m(S)}$ to be the interest rate a monopolist bank would charge a successful firm: $r_{m(S)} = \max_r I^*(r)[(1 + r)\cdot p(S) - (1 + \bar{r})]$. Then it is sufficient to assume that $r_{m(S)} < r_F$, which is satisfied as long as the firm's investment function is not too elastic.

(ii) $r_j(\gamma) = r_{\tilde{F}}, \quad \gamma = S, \qquad$ *and* $r_{jk}(\tilde{\gamma}) = r_{\tilde{S}}, \quad \tilde{\gamma} = \tilde{S},$

$\qquad r_F, \quad \gamma = F, \qquad\qquad r_F, \quad \tilde{\gamma} = \tilde{F}$

(*and only firms with* $\tilde{\gamma} = \tilde{F}$ *borrow from their old bank*).

Proof: See Appendix.

In the first case, banks are able to make positive expected profit in the second period on those customers that were successful in the first period. They offer rates low enough to deter outside banks from making profitable counteroffers. Outside banks observe the offer function but not the actual offers. Consequently, a lower counteroffer to firms that signal success is unprofitable because the outside bank making such an offer will also attract all the poor performers that appear to be good performers.

In the second case, banks make even larger expected profit margins on those successful customers that stay, but they lose some of their successful customers to outside banks making better counteroffers to all firms whose records suggest that they have been successful. In both cases, competition assures that banks cannot earn positive expected profit on second-period loans to those firms that were unsuccessful in the first period. Since there exists no lower quality category of customer, outside banks can offer the break-even rate r_F to any firm and not worry about adverse selection.

The second-period equilibrium rate structure is that structure, (i) or (ii), which yields the greatest profit for the inside bank. Given the reaction function of outside banks, each bank will choose the rate structure which yields maximum profits on second-period loans to old customers. Profits earned in cases (i) and (ii) are, respectively,

$$\pi(r_{\tilde{S}} \mid \phi) = [(1 + r_{\tilde{S}}(\phi))p(S) - (1 + \bar{r})] \cdot I^*(r_{\tilde{S}}(\phi)) \cdot p \tag{11}$$

and

$$\pi(r_{\tilde{F}} \mid \phi) = [(1 + r_{\tilde{F}}(\phi))p(S) - (1 + \bar{r})] \cdot I^*(r_{\tilde{F}}(\phi)) \cdot p \, \frac{1 - \phi}{2}. \tag{12}$$

Substituting the definition of $r_{\tilde{S}}$ and $r_{\tilde{F}}$, we get

$$\pi(r_{\tilde{S}}) = [p(S)/p(\tilde{S}) - 1](1 + \bar{r}) \cdot I^*(r_{\tilde{S}}) \cdot p \tag{13}$$

and

$$\pi(r_{\tilde{F}}) = [p(S)/p(\tilde{F}) - 1](1 + \bar{r}) \cdot I^*(r_{\tilde{F}}) \cdot p \, \frac{1 - \phi}{2}. \tag{14}$$

The first factor in each equation, $p(S)/p(\tilde{\gamma}) - 1$, is the percentage profit margin that banks earn per dollar loaned to their old successful customers (that remain at the bank). The last factor is the number of successful customers that remain at the bank. While profit margins are higher in equilibrium (ii), the number of successful firms that stay and the amount they borrow are both higher in (i). Which rate structure yields higher profit depends upon the parameters $(\phi, p_L, p_H, \theta))$ of the market as well as the specification of $g(I)$.

In either case, banks earn positive profit in the second period; however, because banks are Nash price competitors, such anticipated rents are competed away in the first period. More precisely, the equilibrium loan rate in the first period will be lower than r_p, the break-even rate on new customers (computed in (6)). Banks thus earn negative expected profits on each of their new customers. For instance, if $\pi(r_{\tilde{S}}) > \pi(r_{\tilde{F}})$, i.e, if case (i) is the second-period equilibrium, then the equilibrium interest rate in the first period, say $r_{\tilde{p}}$, is given as the solution to

$$[r_p - r_{\tilde{p}}]I(r_{\tilde{p}}) = p[p(S)/p(\tilde{S}) - 1](1 + \bar{r})\cdot I(r_{\tilde{S}}). \tag{15}$$

The less accurate the signal $\tilde{\gamma}$, the greater are profits made on captured customers and, thus, the lower the initial-period competitive equilibrium loan rate will be.

The standard competitive case ($\phi = 1$) provides a useful benchmark with which to compare these results. In that case, all banks have identical information, and the equilibrium rates are just the break-even rates: r_p in period one and r_S or r_F in period two, where $r_S < r_p < r_F$. As shown in the previous section, these rates are also the equilibrium loan rates under contingent contracting, regardless of ϕ. In comparison, when $\phi < 1$, loans made under subgame perfect contracting entail

a) lower interest rates and larger loans to all firms in period one;
b) higher second-period rates and smaller loans to successful firms;
c) in case (i), identical second-period rates to unsuccessful firms; in case (ii), *lower* second-period rates to those unsuccessful firms whose signal to outside banks inaccurately suggested success.

PROPOSITION 2: *If inside banks can observe $\tilde{\gamma}$, then there is a unique equilibrium in the second-period subgame, characterized by the following rate structure (and lending patterns):*

$$\begin{aligned} r_j(\gamma,\tilde{\gamma}) = r_{\tilde{S}}, &\quad \gamma = S, \quad \tilde{\gamma} = \tilde{S}, \quad \textit{and} \quad r_{jh}(\tilde{\gamma}) = r_F \\ r_{\tilde{F}}, &\quad \gamma = S, \quad \tilde{\gamma} = \tilde{F}, \\ r_F, &\quad \gamma = F, \quad \tilde{\gamma} \in \{\tilde{S}, \tilde{F}\}, \end{aligned}$$

(and firms all borrow from their old bank).

Proof: See Appendix.

The ability to predict outside bank evaluations of their customers gives the inside bank an even greater advantage, allowing it to essentially capture the best of both worlds (i) and (ii) under Proposition 1. Now, it can earn the higher margin ($r_{\tilde{F}} - r_S$) on the firms it retained in case (ii), without losing market share. Because it can discriminate on the basis of the noisy signal, it can prevent the loss of successful customers that signaled success by charging them the lower interest rate, $r_{\tilde{S}}$. Since expected second-period profits are higher than under both (i) and (ii), it must also be the case that the subgame perfect first-period interest rate is even lower (and first-period bank losses higher) when banks can discriminate based on the noisy signal.

Whether or not banks observe their own customers' noisy signal, due to the assumption of diminishing marginal returns of investment in any given project, asymmetric information among lenders results in a less efficient allocation of resources. Because the size of the loan taken by firms is responsive to the interest rate, too much capital is loaned out in the first period, when less is known about the quality of firms, while too little capital is borrowed in the second period by those firms that perform well. As a result, low quality firms consume a larger fraction of the capital loaned out, in comparison to the standard competitive case.[7]

Of course, if firms were allowed to satisfy their capital needs in the first period by borrowing from more than one bank, the ex post information monopoly would disappear. However, this is due to the assumption of Bertrand competition between banks. A less literal interpretation would suggest that the problem of ex post monopoly power arises because of the creation of a small number of insiders during the early phases of a firm's existence, compared to the more competitive situation initially.[8]

If there is some fixed cost per borrower for multiperiod contingent contracting, then whether or not contingent contracts are written will be endogenous to the characteristics of the market. The more difficult it is for outside banks to observe what actual lenders observe, the greater is the potential for ex post monopoly power and the greater are the associated distortions. Only when the expected value of the efficiency loss is greater than the cost of contingent contracting will loan market equilibria support such contracts.[9]

III. Implicit Contracts and Reputation

Although banks often retain much discretion to alter premiums they charge on loans, they may not, in fact, choose to take full advantage of this prerogative. Instead, as argued in this section, creditor-debtor relationships are likely to be governed by implicit agreements, or "implicit contracts," resulting in long-term ties and more efficient intertemporal pricing.[10]

In any legally nonbinding economic relationship, the rational enforcement mechanism needed is a desire by "contracting" parties to maintain a good

[7] On average (across firms and time), though, the amount of capital borrowed in this market is approximately the same in the subgame perfect and the contingent contracting regimes.

[8] There are several reasons to believe that the transactions costs of borrowing and lending rise significantly with the number of banks involved. Unless the banks collude (in which case the firm is not likely to benefit from multiple-source lending), they would all need to pay the implicit per-period cost of monitoring. Another reason one observes single-bank financing of projects or small firms is the complications that arise with multiple claims in the event of bankruptcy. Although these issues are important, we take them to be beyond the scope of this paper and a subject of future research.

[9] As a matter of fact, explicit performance-based contingent pricing is observed primarily on large high quality loans, made "under commitment." Such arrangements specify preestablished limits on the amount of credit that borrowers are able to draw down at a set spread over some reference rate. On the other hand, even many large loans are made under informal credit line agreements, where "banks retain full flexibility with respect to pricing."

[10] The reason for implicit contracts invoked here is much different from that in Fried and Howitt (1980). In their model, "implicit contracts" arise from the desire to shift interest rate risk away from the borrower, analogous to the motivation invoked in the early microfoundations theories on labor contracts. Just as in the wage-smoothing literature, the stability of implicit contracts in a strategic intertemporal setting is assumed. In our theory, implicit contracts arise because of intertemporal strategic interaction.

reputation. In the context of our loan market, if a bank exploits its "captured" customers, it is likely to lose market share as potential new customers learn of such practices. Broken agreements in the past would be punished by the loss of future credibility.

As suggested by Klein and Leffler (1981) in the somewhat different context of unobservable quality and moral hazard, reputation can only be sustained in competitive markets if economic rents are earned over time. Here, only when the bank has a potential long-run stream of economic profit at risk is there any incentive to forego the current potential profit from violating "contracts" and using ex post monopoly power on captive borrowers.

In order to address this set of issues, we extend the model above by assuming that, in each period, there are two cohorts of firms in the market, one new and one old. Each cohort is otherwise identical to the single cohort in the original model and remains in the market for two periods, while banks exist for an infinite number of periods.

In general, banks can lend to firms in both cohorts during any given period. As before, in each period, banks first make offers to their old customers, but now they can make offers to firms in the new cohort at the same time that they make offers to the old customers of other banks. It is assumed that a bank may also send a signal as part of the offer to any new customer, called a "promise," which specifies the rate the bank will charge the firm in the following period, contingent upon the firm's first-period performance. Promises are nonbinding, but the number of promises each bank has reneged on is assumed to become common knowledge in the market. We call the first-period offer, augmented by the promise, an "implicit contract."

For sake of simplicity, it is further assumed that, if a bank has reneged on any previous promises, firms believe that the bank will break all current and future promises. Thus, a bad reputation is an absorbing state. Finally, we shall assume that banks are restricted to choosing from among stationary "contracting" policies; that is, a bank must offer an identical implicit contract to each cohort if it offers any implicit contract at all. Letting $\delta = 1/(1 + d)$, where d is the bank's discount rate, we now define a "credible" implicit contract:[11]

Definition: A Credible Implicit Contract (CIC) is a triplet (r^1, r^{2S}, r^{2F}), where r^1 is the rate offered to a new firm and $r^{2\gamma}$ is the second-period contingent rate "promised" to that firm, satisfying the inequality:

$$\frac{1}{1-\delta}\left[[(1 + r^1)p - (1 + \bar{r})]I(r^1) + \sum_{\gamma} \text{prob}(\gamma)[(1 + r^{2\gamma})p(\gamma) - (1 + \bar{r})]I(r^{2\gamma})\right] \geq \tilde{\pi}(\phi),$$

where prob(γ) is, again, the fraction of old firms that signaled γ.

The left-hand side of the inequality is the present discounted value of profit earned by lending to new firms and one's old customers, each of mass one, at the

[11] For expositional simplicity, we continue to assume the firm's discount rate to be zero. The qualitative results derived below continue to hold if, for example, the firm's discount rate is equal to the bank's.

"contracted" rates from the current period until infinity. The right-hand side, $\tilde{\pi}(\phi)$, is the profit from charging the subgame perfect rates to old customers in the current period. If the bank reneged in any period and charged subgame perfect rates to old customers, its promises would subsequently carry no credibility; it would thus be relegated to competing with subgame perfect contracts, which always earn zero profit. Such a CIC is "credible" in the sense that the present value of keeping one's promise to current customers and executing identical implicit contracts with future cohorts is not exceeded by the profits from reneging on current promises.[12]

Definition: The Competitive CIC (CCIC) is that CIC which maximizes the firm's two-period expected profits, subject to the constraint that the firm voluntarily participates under each contingency.

Definition: Let $v(r) = [g(I^*(r)) - (1 + r)]I^*(r)$; thus, $v(r)$ is the maximum net profit a firm can earn if its project is successful, given that it is charged a loan rate r.

PROPOSITION 3: *The CCIC is characterized by the triplet* $(\hat{r}^1, \hat{r}^{2S}, r_F)$, *where the first two elements are the solution to the following problem*:

$$\max_{r^1, r^{2S}} p[v(r^1) + p(S)v(r^{2S})],$$

subject to

$$\frac{1}{1 - \delta}\left[[(1 + r^1)p - (1 + \bar{r})]I(r^1) + p[(1 + r^{2S})p(S) - (1 + \bar{r})]I(r^{2S})\right] \geq \tilde{\pi}(\phi).$$

According to Proposition 3, in the CCIC, banks charge unsuccessful old customers the break-even rate; that is, banks expect to make zero profit on old unsuccessful customers. The reason for this is quite straightforward. The break-even rates are the prices that induce efficiency—the prices that would be charged if explicit contingent contracts were signed. In the CCIC, the loan rates only depart from the efficient prices (contingent contract prices) in order to help satisfy the credibility constraint. Only by raising loan rates above break-even rates, thereby yielding positive bank profits, can one move toward satisfying the credibility constraint. However, since firms are not bound by the contracts, and since any firm can get a loan at r_F, the break-even rate on unsuccessful firms, from an outside bank, contracts must specify a price less than or equal to that rate. Thus, the CCIC rate charged to old unsuccessful firms is their break-even rate.

Since banks act competitively, if the only type of loan contracts offered were CICs, only the Competitive CIC would be offered and accepted in equilibrium.

[12] The subgame perfect strategies of the more general closed-loop game, in which banks can offer a different implicit contract in each period, would be considerably more complicated and much less intuitive. The incentive to keep a price commitment would be a function of an endogenous and potentially badly nonstationary proportion of new versus old customers looking for loans at a given bank. Promises would thus have to be contingent not only on the customer's performance but also on the proportion of good reputation banks that actually "contract" with, and lend to, other firms in that customer's cohort.

Let λ be the Lagrange multiplier on the credibility constraint. Manipulating the two first-order conditions, we compute the CCIC rates as a function of λ:

$$\hat{r}^1 = r_p - [(1-\delta)/\lambda + 1]I(\hat{r}^1)/I'(\hat{r}^1), \tag{16}$$

$$\hat{r}^{2S} = r_S - [(1-\delta)/\lambda + 1]I(\hat{r}^{2S})/I'(\hat{r}^{2S}). \tag{17}$$

Note that λ must be negative; an increase in $\tilde{\pi}(\phi)$, the profit the bank earns by breaking its promise (and charging the second-period subgame perfect rates), lowers the value of the Lagrangian.

By substituting the "contract" rates—(16) and (17)—into the credibility constraint, one can solve for λ in terms of the firm's optimal investment levels, the derivatives of the optimal investment function, the profits a bank can earn by breaking its promise (charging subgame perfect rates), and the bank's discount rate:

$$\lambda = -(1-\delta)/[1-(1-\delta)\tilde{\pi}(\phi)/B], \tag{18}$$

where $B = -[pI(\hat{r}^1)/I'(\hat{r}^1) + p(S)I(\hat{r}^{2S})/I'(\hat{r}^{2s})] > 0$.

Since $\lambda \leq -(1-\delta)$, equations (16) and (17) specify the *positive* markup the bank charges in the CCIC over the standard competitive rates (charged in the contingent contract). Furthermore, as the firm's signal of past success becomes more accurate, this markup converges to zero: as $\phi \rightarrow 1$, $\tilde{\pi}(\phi) \rightarrow 0$ and, from (18), $\lambda \rightarrow -(1-\delta)$.

PROPOSITION 4: *If the bank's discount factor, δ, is high enough, the CCIC will be offered and accepted in equilibrium; that is, equilibrium in the bank loan market is characterized by implicit contracts.*

Proof: From (18) we can see that

$$\lim_{\delta\rightarrow 1} \frac{1-\delta}{\lambda(\delta)} = \lim_{\delta\rightarrow 1} -[1-(1-\delta)\tilde{\pi}(\phi)/B] = -1. \tag{19}$$

Applying this result to (16) and (17), it is clearly the case that, as $\delta \rightarrow 1$, the CCIC rates approach the standard competitive rates. Since these functions are continuous, by choosing δ close enough to one, we can generate a CCIC with rates arbitrarily close to the standard competitive rates. However, as shown previously, each firm strictly prefers ex ante to sign contracts at the standard competitive rates, rather than pay the subgame perfect rates. Therefore, if the banks' discount factor is close enough to one, a firm will also strictly prefer the CCIC to the subgame perfect rates.[13]

According to Proposition 4, if banks place a high enough relative value on future as opposed to current profit, competitive equilibrium in the bank loan market will be characterized by implicit contracts. Under some subsets of the

[13] This is true even though the firm's discount rate is zero in the formal analysis, in part because banks operate in this market forever, while a given firm participates only for a finite period of time. Note that some version of this proposition is likely to hold even if firms were infinitely lived, since the loss from signing an infinite sequence of subgame perfect contracts would rise without bound as the firm's discount rate approached zero.

feasible parameter space, only banks offering the CCIC will attract new firms. The CCIC interest rates can be ranked, relative to the subgame perfect ($r_{\tilde{p}}$, $r_{\tilde{S}}$, r_F) and the standard competitive (r_p, r_S, r_F) interest rates as follows: for new firms, $r_{\tilde{p}} < \hat{r}^1 < r_p$, and, for successful firms, $r_{\tilde{S}} > \hat{r}^{2S} > r_S$.

When it exists, an equilibrium with implicit contracts is clearly more efficient than lending under subgame perfect single-period contracts. More capital is allocated to high quality firms, less to new firms. A new firm's lifetime expected profit is higher; competitive banks also earn a profit in each period. The banks' per-period profits are high enough to provide the incentive to keep their promises and maintain their reputations.

The credibility constraint requires that banks earn a stream of profits over the long run. Because of the assumption of constant marginal cost throughout, this constraint holds or fails to hold independent of scale, that is, independent of the number of customers the bank services in steady state. Without regulatory barriers to entry, these quasi-rents must be dissipated either by a sunk cost of entry, such as a charter or setup cost, or by per-period fixed costs of operations. In either case, long-run equilibrium is characterized by banks entering the market (in period zero) up to the point where each can expect to lend to just enough firms per period to generate a discounted profit stream which offsets such costs.

While the rationale behind bank commitments in our theory is substantially different from that in Boot, Thakor, and Udell (1989), it is instructive to compare the penalty structures for reneging.[14] In their model, the bank would like to renege on some of its commitments, but the maximum feasible penalty is assumed to be proportional to the size of the bank's end-of-period equity. Thus, as in our theory, it is the potential loss of earnings on other loans that raises the credibility of commitments. In their model, that threat arises from the ability of an outside agency to verify cheating and then confiscate current assets; in ours, it arises from the effect of reputation on the flow of future profits.

The impact of relaxing some of the reputational assumptions is intuitive; as in other models of reputation (Shapiro (1983) and Allen (1984)), these assumptions are only made for the sake of simplicity. If it takes more time for a bank's reputation to change, or if the market's memory is imperfect, or if borrowers do not believe "once a cheater, always a cheater," then the cost of breaking a promise falls. The result is a tighter credibility constraint and, thus, higher loan rates and rents earned by banks in the CCIC. This, of course, lowers the likelihood that an implicit contract equilibrium will exist.

Finally, the results depend in part on the restrictions placed on the form of single-period contracts. If banks were able to price nonlinearly, rents of captured customers could be extracted in the subgame perfect equilibrium without distorting investment decisions. This could be accomplished, for example, by a two-part tariff: banks charging successful firms the efficient marginal interest rate $1 + r_S$

[14] In their paper, the intertemporal commitment, which compels the bank to make some second-period loans on which it will earn expected net present value losses, is used to reduce rationing that arises because of information asymmetries between bank and firm. In our model, the rationale behind the commitment is quite different; the contract is needed to keep the bank from using its monopoly information, which arises due to the information asymmetries between banks.

per dollar borrowed in the second period, plus a lump sum fee equal to the rents the bank could earn by charging the subgame perfect linear price $1 + r_{\tilde{S}}$.

However, in a more realistic setting rich with firm heterogeneity, the qualitative results are robust to the removal of the linear pricing restriction. In general, a monopolist only prices efficiently if it can perfectly price discriminate. The more difficult it is to discriminate, the greater is the inefficiency—underconsumption—induced by monopolistic behavior. In the case at hand, if firms have private information about their own project, an attempt by their old bank to extract rents due to *its* information advantage (over other banks) is likely to conflict with that bank's ability and desire to induce efficient behavior under subgame perfect contracting. Our results are robust to nonlinear pricing, for example, if firms have private information about the demand curve, $g_k(I)$, that they face.[15]

IV. Concluding Remarks

In summary, we have demonstrated that the asymmetric evolution of borrower information in the bank loan market yields ex post monopoly power even though banks are ex ante competitive. The degree to which banks and their customers use information gathered over time to efficiently adjust investment decisions depends in part upon the ability of banks to precommit against using their informational advantage to extract rents. Since complete contingent contracting is expensive and difficult in a complex environment, implicit commitments may dominate. The credibility of implicit agreements depends upon the bank's valuation of future transactions and the existence of informal mechanisms for transmitting information about a bank's behavior. Implicit contracts are sustained only when banks earn positive rents from loans to current and future customers.[16]

One potentially important set of implications of our theory, still to be fleshed out, are the macroeconomic or business cycle implications. As suggested by Bernanke (1983), one of the factors that may have contributed to the depth and length of the Great Depression was the rise in the cost of credit intermediation that probably accompanied the collapse of financial institutions. Our model suggests a plausible microeconomic explanation.

Suppose that, for example, due to some factors external to our credit market (default on third-world loans), several of these banks failed and, thus, were no longer available to extend credit to their old customers. If implicit contracts were operative, customers with relatively good records at the bankrupt banks are likely to face higher interest rates on loans they subsequently arrange with "outside" banks. The credit market remains just as competitive, but, since other banks are not able to distinguish as well between the good risks and the bad, they have to

[15] See the working paper version (April 1989, same title) for an example of such a generalization.

[16] That firm-specific information generated over time may be best exploited through the use of implicit contracts in bank-borrower relationships is consistent with the James (1987) finding that firms announcing new bank credit agreements experience larger positive stock price responses than firms announcing public straight debt offerings. Risk-averse managers who would rather lock in a fixed supply of capital at a fixed interest rate through a straight debt offering will not be forced to respond to new information concerning the profitability of their firm.

charge the good risks higher rates, compared to what their old banks would have charged them.

The destruction of information via bankruptcy of financial institutions acts, according to this story, as a propagation mechanism. The risk premia on loans to those firms whose opportunities have not worsened are driven up, causing them to lower working capital investment. Ultimately, the result may be lower production and employment and possibly additional bankruptcies throughout those regions of the economy once serviced by the now-bankrupt institutions. The importance of this story depends, of course, on the specific mechanisms employed to replace or repair failed banks.

Finally, while we have focused on credit markets, the general form of the microeconomic relationships developed in this paper may apply to other markets as well. Labor-firm relationships generate a great deal of "inside" information on the rents that can be produced through the continuation of such relationships. This information might be exploited by the firm through its power in setting wages; alternatively, firms may set wages so as to maintain their reputation for "fairness."

Of course, the model abstracts from an alternative justification for relationships: the existence of relationship-specific capital investment. This is the motivation for implicit contracts invoked by Wachter and Williamson (1978). While relationship-specific investment is particularly important in labor markets, it also arises in the bank loan market; there are nontrivial costs associated with the initial pre-loan evaluation of firm risk. The relative empirical importance of our theory versus specific-capital theories for explaining lending relationships depends on the relative importance of information gathered in the pre-loan evaluation period versus that obtained in the post-loan monitoring period.

Appendix

LEMMA 1: *Suppose that $r_k(F) \geq r_F$. If $r_k(S) > r_{\tilde{F}}$, then the competitive counteroffer by outside banks is $r_{jk}(\tilde{F}) = r_{\tilde{F}}$, $r_{jk}(\tilde{S}) = r_{\tilde{S}}$. All firms are drawn away from their old bank.*

Proof: Each of the components of this counteroffer attracts both successful and unsuccessful firms from bank k since the rates are lower on all accounts. Furthermore, these are the break-even rates for lending to randomly drawn firms with the respective signals.

LEMMA 2: *Suppose that $r_k(F) \geq r_F$. If $r_{\tilde{F}} \geq r_k(S) > r_{\tilde{S}}$, then the competitive counteroffer by outside banks is $r_{jk}(\tilde{F}) = r_F$, $r_{jk}(\tilde{S}) = r_{\tilde{S}}$. Firms that (noisily) signal success are drawn away from their old bank.*

Proof: Offers less than or equal to $r_{\tilde{F}}$ to firms that signal failure will only draw away those who actually failed, while higher offers are always unprofitable. The offer to firms that signal success draws away all such firms and earns an expected profit of zero on each of them, as in Lemma 1.

LEMMA 3: *Suppose that $r_k(F) \geq r_F$. If $r_{\tilde{S}} \geq r_k(S)$, then the competitive counteroffer by outside banks is $r_{jk}(\tilde{F}) = r_F$, $r_{jk}(\tilde{S}) = r_F$. All firms stay with their old banks.*

Proof: Higher offers to firms with either signal will only draw those firms that were actually unsuccessful, unless the offers are so high that expected losses are made even when the successful firms are also attracted.

Proof of Proposition 1: Clearly, for bank k, $r_{\tilde{F}}$ dominates the set of offers $r_k(S)$ considered in Lemma 2. All the other choices earn less profit since price is lower and the number of loans k makes does not change. Similarly, $r_{\tilde{S}}$ dominates all offers $r_k(S)$ considered in Lemma 3. Each of these offers yields positive second-period profit for k. The set of offers considered in Lemma 1 yields zero profit. Thus, we have established that, if bank k offers $r_k(F) \geq r_F$, its optimal offer to successful firms is either $r_{\tilde{F}}$ or $r_{\tilde{S}}$.

However, bank k can only do worse by offering $r_k(F) < r_F$ in conjunction with any offer to successful firms. Profits from lending to unsuccessful firms, if they stay, are lower (negative). Furthermore, the lower the loan rate offered to unsuccessful customers, the more relaxed is the adverse selection constraint facing outside banks trying to bid away j's successful customers. Finally, k is indifferent among offers $r_k(F) \geq r_F$ since k earns zero profit on unsuccessful firms if $r_k(F) = r_F$ but does not lend to them otherwise.

Therefore, the offers made by bank k in cases (i) and (ii) of Proposition 1 dominate all other offers k could make. Furthermore, Lemmas 2 and 3 show that the offers made by bank j in (i) and (ii) are the competitive counteroffers. Thus, the equilibrium must be the sets of offers described in either (i) or (ii).

The proof of Proposition 2 is quite similar to that of Proposition 1 and, thus, for brevity, is not included in full formal detail. Clearly, it should be easy to see that, given the inside bank offers $(r_j(\cdot))$ proposed, outside banks are unable to draw away a profitable pool of the bank's old customers. In order to formally demonstrate that this is also the inside bank's best set of offers, the set of lemmas must be expanded, in the obvious way, to include (and compare among) the richer set of offers the inside bank can make when it also observes the noisy signal.

REFERENCES

Allen, Franklin, 1984, Reputation and product quality, *Rand Journal of Economics* 15, 311–327.

Bernanke, Ben S., 1983, Nonmonetary effects of the financial crisis in the propagation of the Great Depression, *American Economic Review* 73, 257–276.

Besanko, David and Anjan V. Thakor, 1987, Competitive equilibrium in the credit market under asymmetric information, *Journal of Economic Theory* 42, 167–182.

Boot, Arnoud and Anjan V. Thakor, 1989, Dynamic equilibrium in a competitive credit market: Intertemporal contracting as insurance against rationing, Working Paper, Indiana University.

———, Anjan V. Thakor, and Gregory F. Udell, 1988, Credible commitments, contract enforcement problem and banks: Intermediation as credibility assurance, Working Paper, Indiana University.

Brady, Thomas F., 1985, Changes in loan pricing and business lending at commercial banks, *Federal Reserve Bulletin* 71, 1–13.

Chan, Yuk-Shee, Stuart I. Greenbaum, and Anjan V. Thakor, 1986, Information reusability, competition, and bank asset quality, *Journal of Banking and Finance* 10, 243–254.

——— and Anjan V. Thakor, 1987, Collateral and competitive equilibrium with moral hazard and private information, *Journal of Finance* 42, 345–363.

Fama, Eugene F., 1985, What's different about banks?, *Journal of Monetary Economics* 15, 29–39.

Fried, Joel and Peter Howitt, 1980, Credit rationing and contract theory, *Journal of Money, Credit, and Banking* 12, 472–487.

Gale, Douglas and Martin Hellwig, 1985 Incentive-compatible debt contracts I: The one-period problem, *Review of Economic Studies* 52, 646–664.

Hodgman, Donald R., 1961, The deposit relationship and commercial bank investment behavior, *Review of Economics and Statistics* 63, 257–268.

James, Christopher, 1987, Some evidence on the uniqueness of bank loans, *Journal of Financial Economics* 19, 217–235.

Kane, Edward and Burton Malkiel, 1965, Bank portfolio allocation, deposit variability, and the availability doctrine, *Quarterly Journal of Economics* 79, 113–134.

Klein, B. and K. Leffler, 1981, The role of market forces in assuring contractual performance, *Journal of Political Economy* 89, 1326–1346.

Parsons, Donald O., 1986, The employment relationship: job attachment, work effort, and the nature of contracts, in Orley Ashenfelter and Richard Layard, eds.: *Handbook of Labor Economics* (North Holland, Amsterdam).

Shapiro, Carl, 1983, Premiums for high quality products as returns to reputations, *Quarterly Journal of Economics* 98, 559–579.

Stiglitz, Joseph and Andrew Weiss, 1983, Incentive effects of terminations: Applications to the credit and labor markets, *American Economic Review* 73, 912–927.

——— and Andrew Weiss, 1983, Credit rationing in markets with incomplete information, *American Economic Review* 71, 393–410.

Such, Carol L., 1985, Interaction between signaling and repeated play with borrower default, IMSSS Technical Report No. 480, Stanford University.

Wachter, Michael L. and Oliver Williamson, 1978, Obligational markets and the mechanics of inflation, *Bell Journal of Economics* 9, 549–571.

Wood, John Arnold, 1975, *Commercial Bank Loan and Investment Behavior* (John Wiley & Sons, London).