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Source: *The Journal of Finance*, Vol. 37, No. 3 (Jun., 1982), pp. 809-825
Published by: Blackwell Publishing for the American Finance Association
Stable URL: http://www.jstor.org/stable/2327710
Accessed: 27/11/2009 08:18

THE JOURNAL OF FINANCE • VOL. XXXVII, NO. 3 • JUNE 1982

An Analysis of Bank Loan Rate Indexation

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ABSTRACT

This paper examines the economic rationale for the use of bank loan commitments and the effect on the allocation of bank credit of indexing the loan rate offered through the commitment to the prime. A simple model of the loan market is constructed and used to examine the effect changes in loan demand and the cost of bank funds have on the allocation of bank credit under indexation. It is shown that indexing implies changes in the relative cost of borrowing for certain groups of bank customers. For nonprime customers, an increase in the cost of bank funds results in a decline in the relative cost of borrowing under commitments. The pattern of commitment use is found to be consistent with the predictions of the model.

RECENT SURVEYS HAVE FOUND that the majority of commercial and industrial loans are made under pre-existing loan commitments.[1] These surveys also find that for most commercial and industrial loans the interest rate is tied or indexed to the prime rate. Although indexing loan rates is widespread, there has been little theoretical or empirical work on the effect of this pricing scheme on the allocation of bank credit. The paucity of research in this area is surprising, considering the frequency with which indexed contracts are used and the current controversy surrounding the use of the prime as an index.[2]

The purpose of this paper is to provide an analysis of the effect of indexed loan rates on the intertemporal allocation of bank credit. A simple model of the loan market is constructed, and used to examine the effect changes in the cost of bank funds and changes in loan demand have on the allocation of credit under indexation. Use of this model demonstrates that indexed contracts do not result in an efficient allocation in the sense that the resulting allocation does not replicate the allocation obtained with complete contingent contracts. Finally, the model is tested empirically using data on commitment use from the *Quarterly Survey of the Terms of Commercial Bank Lending*. It is shown that indexing

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[1] See Campbell and Boltz [4] for summary of the survey results. 54.5 percent and 61.9 percent of commercial and industrial loans were made under commitments by money center and major regional banks respectively in 1977. This probably represents a lower bound on the proportion of bank loans made under explicit agreements. Campbell and Boltz also report that floating rate loans constituted over 50 percent of all commercial and industrial loans originated.

[2] The present study concentrates on indices which tie loan rates to the prime, since this is the most frequently encountered pricing technique in the United States. The analysis is, however, applicable to any indexing technique, including, the practice of tying rates to the LIBOR. For an overview of the controversy surrounding the prime rate convention, see [7].

implies changes in the relative cost of borrowing under agreements for certain groups of bank customers. Therefore, examination of the pattern of borrowing on commitments provides a means of empirically testing the model. The pattern of commitment use is found to be consistent with the predictions of the model.

The paper is divided into four sections. In Section I, the economic rationale for the use of loan commitments and indexed contracts is discussed. In Section II, the effect of indexed loan commitments on the allocation of credit is analyzed. Section III provides an empirical test of the model. A summary and conclusions are provided in the final section.

I. Background: The Economic Rationale for Loan Commitments and Indexed Contracts

A loan commitment is a credit procurement contract under which the bank agrees to supply credit on prearranged terms.[3] The primary explanation given for the use of these contracts has been that they provide insurance. (For example, see Campbell [5] or Fried and Howitt [10]). In particular, it is argued that fixed formula agreements (in which the rate is tied to the prime), provide insurance against fluctuations in the cost of acquiring credit caused by changes in credit risk.[4] Although loan commitments, either implicit or explicit, may provide loan customers with insurance against changes in the cost of borrowing, an explanation for commitments based solely on loan customers' demand for insurance raises serious questions. If the primary incentive for the use of commitments is the demand for insurance, then one must assume that shareholders of the commercial bank and the firm purchasing the contract have systematically different risk preferences[5] or that the market for financial claims is segmented so that the commercial bank is able to diversify the risk associated with the loan commitment, but the nonfinancial firm is not.[6]

Rather than interpreting loan commitments as primarily a risk shifting device, this paper focuses instead on the contracting costs associated with a long-term contract and compares these costs to the costs associated with a series of single spot-market transactions. This approach has been taken recently by Williamson [29] and others to analyze the use of long-term contracts for the acquisition of industrial commodities and labor inputs.[7] Two critical dimensions of the trans-

[3] Loan commitments are by no means homogenous with respect to their characteristics. While most commitments have a fixed formula, in which the borrowing rate is tied to the prime, some commitments offer fixed rates, in which the rate is set at the beginning of the agreement. Clearly, in the case of the latter type of agreement, the customer is protected against changes in the cost of borrowing caused by changes in the *level* of interest rates. This study focuses on fixed formula agreements.

[4] Credit risk means the firm's probability of default.

[5] Indeed, if one assumes that bank regulatory agencies place a binding constraint on the bank's risk exposure, then the bank may behave in a more risk averse manner than the borrower, resulting in a positive demand for insurance by the bank.

[6] The insurance argument raises two additional questions: first, given the ability of firms to form a hedge via a direct market transaction (*e.g.* a futures market transaction) the use of an intermediary is difficult to explain. Second, as discussed in Section III, the pattern of commitment use does not appear consistent with the insurance argument.

[7] See Carlton [6] and Klein, Crawford, and Alchian [19]. The contribution of Williamson is to

action are identified which affect the nature of the procurement contract: the presence of a durable transaction specific asset and the frequency with which transactions recur. Applying this framework to banking markets can provide insights into the role of loan commitments as well as the role of financial intermediaries.

A transaction specific asset is an asset required for the transaction but not marketable or transferable to transactions involving different parties.[8] Transactions can be distinguished, therefore, according to whether the identity of the contracting parties has important cost-bearing consequences. For example, in a discrete transaction (e.g. a spot-market transaction), the identity of the contracting parties is completely irrelevant; the transaction involves the contemporaneous exchange of well-defined objects or claims. However, if transaction specific assets are present, and if transactions are recurring in nature, then the identity of the parties in the transaction has important cost-bearing consequences. Contracting parties can economize on transaction costs by maintaining continuity in their relationship. The recurring nature of the transaction and the existence of a durable transaction specific asset implies that economies of scale can be realized by lengthening the relationship of the specific contracting parties. Long-term contracts emerge as a mechanism to facilitate continuity in the relationship.[9]

The existence of transaction specific costs in loan markets provides an incentive to transact under long-term contracts or commitments.[10] Loan agreements require a substantial investment. The borrower has to supply the bank with financial information. Loan contracts often require special audits and the evaluation of assets used as collateral. In addition, the borrower normally is required to reimburse the bank for legal expenses incurred in setting up the loan agreement. These expenses constitute a transaction specific investment by the borrower.

The bank may also realize cost advantages associated with a continuing relationship with a particular customer.[11] For example, it has been argued that the marginal cost of processing loan applications from established customers is lower than for new customers. In addition, continuing relationships reduce the variability of earnings because the bank can forecast the customer's future loan demand with greater precision. For these reason, the bank has an incentive to establish a long-term relationship or implicit contract with its customer.[12]

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specify important dimensions of transaction costs which affect the nature of the contract. Through this approach, the nature and origins of constraints on the loan rate adjustment process can be specified. This question has not been addressed by the literature on credit rationing. See Baltensperger [2].

[8] Firm specific training costs in labor markets is an often cited example of an investment in a transaction specific asset. See Oi [24].

[9] In this study no distinction is made between explicit and implicit contracts.

[10] The Federal Reserve's Functional Cost Analysis [8] indicates that origination and acquisition costs for commercial loans were about one percent of loan volume in 1978.

[11] The literature on the customer relationship in banking has recognized the cost advantages associated with a continuing relationship between the bank and a particular customer. However, the bank, and not the loan customer, is assumed to enjoy the economies associated with a long term relationship. See Kane and Malkiel [18].

[12] The actual distribution of the gains associated with term contracts does not affect the results. The existence of durable transaction specific assets associated with the loan transaction may also explain the use of loan participation agreements. In such agreements, a lead or agent bank will

Although the existence of durable transaction specific assets provides an incentive for the use of contracts, the presence of these assets has an important effect on the nature of competition. In particular, while there may be a large number of competitors at the initial award stages of the contract, once the agreement is consummated and the necessary transaction specific assets are in place, alternative sources of bank credit are no longer perfect substitutes. The relationship between the banks and its loan customers is transformed into a bilateral monopoly.

The impact of transaction specific assets on the postcontractual nature of competition creates problems in adjusting the terms of the contract. Clearly, if each party had complete and perfect information, and monitoring were costless, the terms of the contract could be specified so as to maintain efficiency.[13] Neither contracting party would enjoy monopoly profits, regardless of the value of transaction specific assets involved in the relationship. Moreover, the allocation of bank credit under long-term, contingent contracts would exactly replicate the allocation resulting from a series of spot-market transactions. However, important obstacles limit the scope of contingent contracts, the most important of which is moral hazard. If the terms of the contract are made contingent upon variables which can be influenced by one of the parties of the contract, incentives to change the variables accordingly will exist. If it is costly to monitor changes in these variables, then one of the contracting parties will have an incentive to misrepresent changes in the variable. In addition, because transaction specific costs are associated with a series of spot-market transactions, market alternatives are poor protection against one party expropriating the transaction cost savings. Market alternatives limit the amount a particular party can expropriate in the contractual relationship to the transaction cost savings associated with the long-term contract.

One means of minimizing the moral hazard problem is to tie or index prices to changes in spot-market prices. The most frequently employed price adjustment technique in banking is indexing loan rates to the prime.[14] Indexing loan rates to

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originate the loan and sell participation to other banks. The agent bank structures the agreement and evaluates the credit risk associated with the borrower, hence economizing on transaction costs. A participation agreement may also reduce the credit risk associated with the agreement. See Walgren [28]. As explained recently:

> Because it is difficult to communicate complete and accurate information about a borrower, the likelihood that a borrower's loan will be properly structured declines as the number of bankers who directly extend credit to the borrower increases. When loans are improperly structured, the risk of loss on the loans increases. Participations allow a single fully informed bank to retain control over a borrower's loans; that bank can design a complete loan package that is properly structured with repayment terms and collateral support consistent with the borrower's repayment ability and asset-liability composition. *Michigan Law Review* (23), 1166.

[13] Efficiency is used here to mean that the loan rate and loan quantity are determined so as to maintain an equality between the bank's marginal opportunity cost of supplying credit to a particular customer and the loan rate.

[14] The above discussion raises an important question; if the use of the prime as an index is explained in terms of providing customers protection against opportunistic behavior, it is not clear why some alternative arrangement (indexing to the federal funds rate, for example) does not dominate. While complete analysis of alternative indexes is beyond the scope of this paper, the lack of bank loan contracts indexed to a particular source of funds may result from the failure of such an index to reflect changes in the bank's liability portfolio associated with changes in the relative prices of

the prime rate (the rate charged the bank's least risky customers and customers with the lowest transaction specific costs), protects nonprime customers from opportunistic behavior. Unless the bank decides to cheat all of its customers simultaneously, changes in the prime may be confidently viewed by its customers as reflecting changes in the cost of bank funds.[15]

Indexing loan rates provides flexibility in response to factors affecting the supply of bank credit. The bank and its loan customer must also establish rules for the determination of the loan size, as well as the price of borrowing. Two different procedures are employed to determine loan size. The first is for the loan contract to specify a floating rate, with the bank setting loan size unilaterally. The second procedure sets limits on the customer's borrowing at the beginning of the loan agreement, but permits the loan customer to choose the loan size within the limits. As discussed below, the method employed has important implications for the allocation of bank credit. As discussed in the next section, no system of indexation exists that will result in an allocation of bank credit identical to that resulting from a set of complete contingent contracts. This result stems from the fact that the opportunity cost of lending is a function of customer specific characteristics, as well as the bank's cost of funds. Indexing, however, implies uniformity in the adjustment of loan terms across customers. The effect of indexation on the allocation of credit is analyzed in the next section.

II. The Intertemporal Allocation of Bank Credit under Loan Rate Indexation

A. The Model

To analyze the effect of indexation, consider the following model of the bank loan market. A bank's loan customers are assumed to consist of two groups: established customers (those who have transaction specific assets in place) and spot-market customers (those who do not have transaction specific assets with the bank). Administration and origination costs associated with a loan, L, for established customers, $C(L)$, are strictly less than the costs associated with a loan of equal size to an identical spot-market customer, $G(L)$. The loan origination and administration costs are assumed to be a convex increasing function of loan size for any customer.[16]

$$C_i'(L) > 0, \qquad C_i''(L) > 0$$

$$G_j'(L) > 0, \qquad G_j''(L) > 0$$

loanable funds. In other words, a direct correspondence between a particular source of funds and the marginal cost of bank funds may not exist. As discussed below, and proved in the appendix, a set of quantity contingent loan pricing rules (of which indexed contracts are a subset) that results in ex-post efficiency does not exist.

[15] Loans granted at below prime rates may appear inconsistent with the above arguments. Rather than representing a departure from the prime rate convention, loans made at below prime appear to differ significantly from loans made at or above prime in several important aspects: (1) below prime loans are primarily fixed rate as opposed to floating rate loans; (2) loans at below prime have a fixed maturity substantially shorter than loans at or above prime; and (3) a substantially smaller proportion of below prime loans are made under pre-existing agreements.

[16] For simplicity, all origination and administration expenses are assumed to be incurred by the

where C_i and G_j refer to the cost functions associated with the ith and jth customers respectively. Moreover, origination and administrative cost functions for all customers are assumed to be identical across all banks in the market. Finally, it is assumed that the marginal cost of acquiring an established customer's loan is strictly less than for acquiring spot-market customer's loan, *i.e.*, $C_i'(L) < G_i'(L)$.

The demand curve for credit from an established customer, i, $(i = i \ldots n)$, is assumed to be inversely related to the loan rate so that

$$D_i = D_i(R_i), \qquad \frac{\delta D_i}{\delta R_i} < 0$$

where

D_i = the quantity of bank credit demanded per period

and

R_i = the loan interest factor, *i.e.*, one plus the interest rate on the loan.

The loan contract is assumed to cover more than one period and D_i represents the quantity of bank credit demanded per period.[17] The negative slope of the demand curve is based on the assumption that the bank loan customer has limited access to alternative means of financing. The implied limit on competition between banks is attributable directly to the existence of transaction specific assets associated with establishing a loan agreement. The demand curve represents the borrower's demand for credit *given* the loan contract. The magnitude of transaction costs involved in establishing the loan agreement (i.e., the difference $G_i(L) - C_i(L)$) will determine, in part, the customer's elasticity of demand. Further, because the transaction costs involved in establishing a loan agreement are directly related to the perceived credit risk of the loan customer, the customer's demand elasticity is assumed to vary inversely with the customer's credit risk.[18]

The bank is assumed to view the realized returns associated with a loan to any customer as a random variable. Let θ represent the revenues generated by the borrower, which can be used to repay any borrowing. The bank is assumed to view θ as a random variable with a density function for the ith borrower, $f_i(\theta)$. For simplicity, we assume that $f_i(\theta)$ is independent of the size of the bank loan.[19]

bank and are reflected in the loan rate. The difference between the acquisition costs of the ith customer in the spot market and the acquisition cost at the bank in which the ith customer has an established relationship, reflect the value of the transaction specific asset. The assumption that $C_i''(L)$ and $G_i''(L)$ are greater than zero are sufficient conditions for a stable equilibrium. See Equation (5).

[17] Loan rate decision is analyzed for a single period covered by the agreement, and therefore time subscripts are omitted.

[18] Transaction costs will be higher for riskier customers because the cost associated with creating and implementing contractual restrictions designed to limit the lender's risk will be higher for high risk loans. See Black, Miller, and Posner [3]. The results of this section are not affected by the relaxation of this assumption.

[19] This assumption is made to simplify the analysis. Our results also hold if $f_i(\theta)$ is a function of loan size. In this case, investment opportunities available must be assumed to be subject to decreasing returns. See Jaffee and Modigliani [16].

The supply function for bank credit can be constructed to determine the maximum loan volume the bank will extend to a customer associated with a given loan rate. For simplicity, assume that the bank determines the loan volume so as to maximize expected profits. Also, assume that the bank can borrow at a constant risk-free interest rate R_f. The expected profits associated with a loan of L_i to an established customer may be written as

$$\prod_i = R_iL_i \int_{R_iL_i}^{M} f_i(\theta)\, d\theta + \int_{0}^{R_iL_i} \theta f_i(\theta)\, d\theta - R_fL_i - C_i(L_i) \tag{1}$$

where

L_i = loan value extended to customer i;
R_f = the risk-free interest factor;
M = the upper bound on the customer's earnings during the period; and
$C_i(L_i)$ = the administrative cost associated with a loan of L_i

The first term in Equation (1) represents the bank's total return in the event default does not occur, while the second term represents the bank's expected receipts if default occurs (i.e., $\theta < R_iL_i$). For any interest factor R_i, the loan volume which maximizes (1), represents a point on the bank's supply curve. The bank's supply curve can be constructed by identifying the set of loan quantities corresponding to alternative interest rate factors which maximize the bank's expected profits as given by Equation (1). Differentiating Equation (1) with respect to L_i and setting the result equal to zero yields

$$R_i(1 - F_i(R_iL_i)) - R_f - C_i'(L_i) = 0 \tag{2}$$

where

$$F_i(R_iL_i) = \int_{0}^{R_iL_i} f_i(\theta)\, d\theta$$

represents the probability of default associated with the loan.

Equation (2) can be solved implicitly for loan volume in terms of R_i. This solution represents the loan supply curve to the customer, and is represented by $L_i(R_i)$.[20]

Assume that an interest factor, $\bar{R}_i$ exists, such that

$$D_i(\bar{R}_i) = L_i(\bar{R}_i)$$

which, given Equation (2), implies that

$$\bar{R}_i(1 - F_i(\bar{R}_iD_i)) - C_i'(D_i) = R_f \tag{3}$$

where $F_i(\bar{R}_iD_i)$ represents the probability of default associated with the amount borrowed by the customer.[21]

[20] Note that the supply of credit to a particular customer is a function of the customer's probability of default, the risk-free rate, and the acquisition cost function. The development of the loan offer curve represents an application of the earlier work of Jaffee and Modigliani [16].

[21] Following a similar procedure, the loan rate associated with a loan of D_i offered by a bank in which the customer i has no established relationship is $\hat{R}_i$ where

$$\hat{R}_i(1 - F_i(\hat{R}_iD_i)) - G_i'(D_i) = R_f$$

At the outset of the loan commitment, the loan rate and quantity is set so that Equation (3) holds. In words, loan terms are set so that the loan rate charged the bank customer just equals the marginal opportunity cost associated with a loan of D_i.[22] As Equation (3) indicates, changes in the cost of bank funds, R_f, and changes in the customer demand for credit will affect the loan rate $\bar{R}_i$.

B. Bank Determined Loan Quantity

The effect of indexing changes in the loan rate to changes in the prime rate when the bank unilaterally determines the loan volume is considered in this section. This procedure is likely to characterize implicit loan contracts, as well as many explicit agreements taking the form of lines of credit.

Consider first the impact of a change in the cost of bank funds R_f. It can be shown that the change in the prime rate associated with a change in R_f is strictly less than the change that would result in the absence of indexation for nonprime customers.

In the absence of indexation, the effect of a change in R_f can be determined by totally differentiating Equation (3) with respect to R_i and R_f. Performing the differentiation

$$dR_i(1 - F_i(R_iD_i)) - R_i\frac{\delta F_i(R_iD_i)}{\delta R_i}dR_i - C_i''D_i'\,dR_i = dR_f \tag{4}$$

where

$$\frac{\delta F_i(R_iD_i)}{\delta R_i} = f_i(R_iD_i)(1 + e_i)D_i$$

$$D_i' = \frac{\delta D_i}{\delta R_i}$$

and

$$e_i = \text{the elasticity of demand for the } i\text{th customer.}$$

The impact of a change in the cost of bank funds on the loan rate, in the absence of indexation is

$$\frac{dR_i}{dR_f} = \frac{1}{(1 - F_i(R_iD_i)) - R_iD_if_i(R_iD_i)\;(1 + e_i) - C_i''D_i'} > 0 \textit{ for } |\,e_i\,| > 1 \tag{5}$$

Equation (5) represents the change in the loan rate resulting from a change in R_f assuming the bank acts as an unconstrained monopolist. As Equation (5) indicates, the magnitude of any change in the loan rate depends upon the customer's credit risk (represented by the probability of default), the customer's elasticity of demand, and the origination and administration cost function. The

[22] Since the customer's demand curve is assumed to be downward sloping, it may appear peculiar that the loan rate in Equation (3) is determined so as to equilibrate supply and demand. Equation (3) implies that the bank is *not* using its monopoly power in setting loan rates ex ante. However, note that $\bar{R}_i$ represents the rate determined at the onset of the agreement, negotiated at the award stages of the contract when the bank possessed *no* market power and prior to any changes in the variables affecting the equilibrium loan terms.

change in the loan rate will be greater the lower the price elasticity of demand and the greater the bank's subjective probability of customer default under the loan agreement.

With indexation, the change in the loan rate associated with a change in R_f will be identical across all bank customers and equal the change in the prime rate, $\frac{dR_p}{dR_f}$. Using Equation (5), it can be shown that loan customers with a less elastic demand for bank credit or customers with a higher default probability than prime customers will be subject to a smaller interest rate adjustment than without indexation.[23] If the cost of funds rises, these customers will be rationed. That is, the customer's demand for credit at an indexed interest rate exceeds the quantity supplied by the bank.[24] Clearly, for customers with demand elasticity or default risk different from prime customers, indexation does not result in a loan contract which is efficient as defined above. By a similar argument, it can be shown that indexation with bank quantity determination does not result in efficiency if the customer's loan demand changes. An increase in the demand for credit will result in rationing at the contracted loan rate.[25]

The loss in transaction cost savings if the customer severs the agreement with the bank once rationing occurs may outweigh the loss associated with rationing.[26] In addition, note that given the assumption of the model, the loan rate offered under the contract dominates the terms obtainable in the spot market. Let L_i^*, R_i^* equal the loan rate and volume combination offered under the contract given an increase in R_f. Since the terms offered under the agreement represent a point on the loan supply curve, the following must hold:

$$R_i^*(1 - F_i(R_i^* L_i^*)) = R_f + C_i'(L_i^*) \tag{6}$$

or

$$R_i^* = \frac{R_f + C_i'(L_i^*)}{(1 - F_i(R_i L_i))}$$

Assuming homogenous expectations associated with the default probability,

[23] The bank in this situation acts as a discriminating monopolist in setting loan quantity. Under indexation, the marginal revenue curve for any customer is horizontal at the contracted rate. Since the marginal opportunity cost of lending to a particular bank customer is an increasing function of the amount borrowed (for $F_i(L_i R_i) > 0$), the quantity may be less than the customer's demand at the contracted interest rate.

[24] Rationing will result in this situation even if one defines the loan rate in the broad sense to include noninterest terms. (For example, including compensating balances or loan maturity). As Baltensperger [2] argues, noninterest loan terms can be thought of as part of the loan price vector. While limitations may exist on the lender's ability to adjust the loan rate, the adjustment of noninterest loan terms reduces the likelihood of rationing. Loan contracts normally specify the loan rate as well as noninterest terms, thus implying the possibility of rationing even in the narrowly defined sense. Failure to specify these items at the initiation of the contract would lead to the opportunity for the bank to expropriate gains associatd with the contract.

[25] Changes in the demand for credit by nonprime customers are assumed to be independent of changes in the demand by prime customers.

[26] Obtaining additional credit in the spot-market is frequently prohibited by bank loan covenants; see [23]. Note that a larger loan, L_i^*, may be obtainable in the spot market at a rate $\hat{R}^*$ where $\hat{R}^* > R_i^*$. Such a combination may be preferred to the terms provided under the contract.

the rate offered to the ith customer in the spot-market, $\hat{R}_i$ is

$$\hat{R}_i = \frac{R_f + G_i'(L_i^*)}{(1 - F(\hat{R}_i L_i^*))}$$

and $\hat{R}_i > R_i^*$ since $G_i'(L_i) > C_i'(L_i)$

C. Customer Loan Quantity Determination

Formal loan commitments frequently specify not only the loan rate, but also the maximum quantity of credit to be supplied under the agreement. Within boundaries set by the commitment, the loan customer can set loan size unilaterally. Available information regarding commitment use suggests that loan limits are set, in many instances, in excess of the customer's current loan demand. For example, the ratio of borrowing on loan commitments to total outstanding agreements averaged about 40 percent during the period 1975 to 1980. In this situation, the loan customer can be thought of as determining loan volume.[27]

In determining loan size, the borrower acts as a monopsonist faced with a perfectly elastic supply of credit at a loan rate consistent with the agreement. Although rationing will not occur under this method of loan quantity determination, the agreement will not necessarily result in a loan quantity consistent with Equation (3). That is, under customer quantity determination, the rate charged a nonprime customer will be less under indexation than under a complete contingent contract. When the prime increases, nonprime loan customers are unambiguously better off under customer quantity contracts. Therefore, one would expect these contracts to sell at a premium. The use of commitment fees for these contracts may serve this purpose.

One cannot determine a priori which system of loan quantity determination results in a more efficient allocation of bank credit. While the allocation of credit will differ depending on the index chosen and the loan quantity determination rule, the allocation of credit under indexation will differ from that obtained under a complete contingent contract. Indexing implies uniformity in the adjustment of loan rates. However, because customers differ in terms of demand elasticity, default probability, and administrative and origination costs, the loan rate adjustment needed to equilibrate supply and demand must differ between customers.

Indeed, indexed loan contracts are a subset of a broader class of contracts in which the loan rate is made contingent upon loan volume. It can be shown that, given a random cost of bank funds (R_f) and customer demand for credit, no ex ante rule exists for loan rate determination which results in efficiency when one of the contracting parties can unilaterally determine quantity.[28] Intuitively, the adjustment mechanism does not contain enough degrees of freedom given the random character of both loan demand and supply. Since the customer's demand

[27] Clearly, the ratio of borrowing to total commitments may be low even if each customer, when borrowing, takes down the entire loan. Available information on individual line use suggests limits are set in excess of the individual customer loan demand. See Higgins [15].

[28] A proof is contained in the appendix. See also Hall and Lilien [12].

is downward sloping and if the bank's offer curve is upward sloping, shifts in demand require the loan rate to be an increasing function of loan quantity to reflect the increasing opportunity cost of lending. However, shifts in the loan offer function caused by changes in the cost of bank funds, R_f, imply that the loan rate is a decreasing function of loan quantity. Clearly, no rule for loan rate determination can meet these two conditions simultaneously.

III. Empirical Implications and Results

In the preceding analysis, it was argued that long-term contracts result from transaction specific costs, and that the effect of loan rate indexation on the allocation of credit will depend upon the quantity determination rule prescribed. In particular, while the model implies no relationship between *aggregate* takedowns and changes in the prime, the analysis does suggest a relationship between changes in the prime and takedowns by specific groups of customers. For formal loan commitments which establish loan quantity limits as well as a formula for rate determination, increases in the prime should result in an increase in the proportion of loans originated under commitments by nonprime customers.[29] In other words, assuming indexation and customer quantity determination are more prevalent under formal loan commitments than for loans not made under commitments, the proportion of loans made under commitments with nonprime customers should rise. This is an important and testable implication of the model. As demonstrated in Section II, this result follows from the fact that changes in the loan rate in the absence of indexation exceeds $\frac{dR_p}{dR_f}$, the adjustment implied by indexation. The relative cost of borrowing on the commitments therefore declines for nonprime customers. For prime borrowers, the relative cost of borrowing under an indexed contract remains unchanged and no change in the proportion of loans originated under commitments is expected.

Ideally, to test the hypothesis concerning cross-sectional differences in the effect of prime rate changes, one would examine the relationship between commitment borrowing by prime and nonprime customers and changes in the prime rate. Unfortunately, data on commitment use by rate charged are not regularly available. However, the percent of short-term commercial loans made under commitments is reported by loan size. Moreover, in a special survey, conducted in 1977, loan size and rate charged were found to be inversely correlated. For loans of $500,000 or more, the correlation coefficient between rate charged and percent of loans originated in each rate class was −.92; for small loans (less than

[29] In Section II, it was assumed that the prime rate was adjusted given a change in R_f, so as to maintain efficiency in the prime market. Therefore, the relative price of borrowing for prime customers under commitments remains unchanged. However, the prime may be established so as to equilibrate the marginal opportunity cost of lending with the aggregate demand for commitment borrowing. In this case, the relative price of borrowing for prime customers would rise resulting in a decline in commitment borrowing. In both cases the analysis implies a differential impact of prime rate changes for prime and nonprime customers. Note also that the results apply under alternative prime plus pricing techniques such as determining loan rates by a multiple of the prime rate.

\$100,000) the correlation was .70.[30] Therefore, loan size may serve as a proxy for prime and nonprime borrowers.

To test this implication of the model the following equation was estimated using quarterly data for the period January 1977 to December 1980.[31]

$$\mathrm{PROP}_{t,j} = \alpha_0 + \alpha_1 D + \overset{(+)}{\alpha_2 RP_t} + \overset{(-)}{\alpha_3 RP_t D} + \overset{(-)}{\alpha_4 \mathrm{DIFF}_t} + e_{t,j} \tag{6}$$

where

$\mathrm{PROP}_{t,j}$ = the proportion of total short term commercial and industrial loans made under commitments; at time t for customer class j;
D = dummy variable with values of 1 for loans in the large size class and zero otherwise;
RP_t = average prime at time t; and
DIFF_t = the difference between the prime and the prime 6-month commercial paper rate.

The dependent variable was constructed by pooling the time series of the loan size classes. The independent variables RP_t and DIFF_t were constructed by "stacking" the time series to produce a vector with $2T$ observations (where T equals the number of time series observations).

The expected sign of each of the variables is indicated in parentheses. The model implies that for nonprime customers, the relative cost of borrowing under commitments varies directly with changes in the prime. Therefore, a positive value of α_2 is expected; i.e. the proportion of short term loans made under commitments varies directly with the prime. A negative and statistically significant value for α_3 is consistent with the prediction of the model that nonprime and prime customers differ in their response to rate changes.[32]

[30] A recent Federal Reserve study found that loan size can be used to approximate borrower size. See [26]. The use of a proxy for prime, nonprime borrowers in Equation (6) implies that the true dependent variable (nonprime, prime) is measured with error. If P equals a binary variable for nonprime prime borrowing, it is assumed that $P = \gamma D$ where D represents the loan size dummy. Therefore, Equation 6 may be rewritten as

$$\mathrm{PROP}_{jt} = \beta_0 + \beta_1 \gamma D + \beta_2 RP_t + \beta_3 \gamma D RP_t + \beta_4 \mathrm{DIFF}_t + e_t$$

α_1 and α_3 in Equation (6) may, therefore, underestimate the true parameters β_1, β_3. The degree to which α_1 and α_3 underestimate the true relationship can be shown to depend upon γ and the variance of P. See Maddala [20].

To minimize any bias induced through the use of a proxy, loan size groups were chosen on the basis of 1977 to maximize γ, i.e., the probability that a loan in the small size class is a nonprime, and the loan in the larger size class is at prime. This procedure is outlined in Aigner and Goldberger [1]. Five rate classes (prime and basis points above prime) were used to calculate the correlation coefficients reported in the text.

While the survey does not provide data on commitment use by loan rate, the average interest rate charged by loan size is provided. The mean difference in average interest rates charged during the period was 84 basis points. Using a simple t test one can reject the hypothesis that the average interest rate charged the two groups is equal. The computed t statistic is 3.45.

[31] Data on commitment use were obtained from the "Quarterly Survey of the Terms of Commercial Bank Lending" conducted by the Federal Reserve System.

[32] The differential effect of prime changes among bank customers may result from differences in the use of fixed and floating rate loan agreements among the groups of bank customers. Clearly, if loans in the smaller size classes are more frequently made under fixed rates, then rises in the prime

The period from 1977 to 1980 provides an excellent oportunity to test the model since the prime varied considerably during this period. It increased in nine quarters, declined during four, and was constant during three quarters.[33]

The regression results are presented below (t statistics are in parentheses).

$$\begin{array}{l}
\text{PROP}_{j,t} = \underset{(4.51)}{14.71} + \underset{(9.57)}{43.84}\,D + \underset{(2.81)}{.81}\,RP_t - \underset{(-2.24)}{.87}\,RP_tD - \underset{(-.24)}{.39}\,\text{DIFF}_t \\
\bar{R}^2 = .96 \qquad N = 32 \qquad D - W = 1.70
\end{array} \tag{6.1}$$

The results presented in Equation (6.1) are consistent with the implication of the model. For nonprime customers, increases in the prime result in an increase in the proportion of loans originated under commitments. The coefficient on RP_t is positive and significant at the 1 percent level. The response of prime customers was significantly different from nonprime customers. The coefficient on RP_tD is negative and significant at 5 percent level. Note that for large loans the response to a change in the prime is small (−0.6) and substantially less than the response observed for small loans. The results contained in (6.1) suggest that the relative cost of borrowing on commitments for prime borrowers rises with changes in the prime (see Footnote 29). The differential effect of prime change is consistent with the hypothesis that uniformity in rate adjustment under indexation results in a decline in the relative costs of borrowing for nonprime customers and, therefore, in an increase in the use of commitments.

Examination of the pattern of borrowing under commitments can also provide insights regarding the services provided by loan commitments. If the primary rationale for loan commitments is to provide insurance against credit rationing as has been argued, one would expect to observe an increase in loans originated under commitments during periods when credit rationing is likely to occur. Because credit rationing is assumed to result from the sluggish adjustment in bank loan rates, one would expect an inverse relationship between the rate of change in the prime and loans originated under pre-existing floating rate commitments.[34]

The following equation was estimated using monthly data over the period 1975 to 1980 to analyze the relationship between aggregate borrowing on lines and changes in the prime:

$$\text{TDR}_t = \beta_0 + \overset{(-)}{\beta_1}\,\text{DIFF}_t + \overset{(+)}{\beta_2}\,\text{C\&I}_t + \overset{(0)}{\beta_3}\,\text{CHP}_t + e_t \tag{7}$$

might result in increased takedowns. However, loans in the smallest loan class had virtually the same percentage of floating rate loans as loans in the largest size class, (35.47 for smallest class vs. 31.1 for the largest loan class). See *Federal Reserve Bulletin*, April 1981.

[33] In addition to running Equation (6), the following model was run separately for each of the loan size classes:

$$\text{PROP}_t = \alpha_1 + \alpha_2 RP_t + \alpha_3 \text{DIFF}_t + e_t$$

For all loan sizes less than \$500,000, α_2 was positive and significant at the .01 level. For loans greater than \$500,000 α_2 was negative, although not significant at the .05 level. These results suggest our findings are not sensitive to the loan classes chosen.

[34] The increase in nonprice terms (nonprice rationing) may be contemporaneously correlated with changes in interest rates. Therefore, a positive relationship between takedowns and changes in the prime would be expected.

where

TDR_t = loans originated under revolving loan commitments;
DIFF_t = the differences between the prime and the 3-month prime commercial paper rate;
$\mathrm{C\&I}_t$ = total commercial and industrial loans originated during the month; and
CHP_t = $RP_t - RP_{t-1}$; the first difference in average prime rate.

The expected sign of each of the variables is indicated in parentheses.[35] Commercial loans originated are included in the model as a proxy for the level of loan demand. The difference between the prime rate and the commercial paper rate measures the effect of changes in the relative cost of bank borrowing. The expected sign of β_3 is negative under the insurance hypothesis; the faster the adjustments in the prime rate, the less nonprice rationing and the lower takedowns.

Equation 7.1 provides the results (t statistics are in parentheses):

$$\underset{(-4.81)}{\mathrm{TDR}_t = -.0046} - \underset{(-3.11)}{.0038\,\mathrm{DIFF}_t} + \underset{(3.26)}{.00762\,\mathrm{C\&I}_t} + \underset{(1.51)}{.00017\mathrm{CHP}_t}$$

$$\bar{R}^2 = .23 \qquad N = 68 \qquad D - W\,1.79 \tag{7.1}$$

As Equation (7.1) indicates, the sign of all coefficients are as predicted by the model. Note that in contrast to the prediction of the insurance hypothesis, the sign of β_3 is positive but not statistically significant at the 10 percent level. The evidence is therefore consistent with the hypothesis that total short term loans originated under commitments are not affected by rate of change of the prime rate.

IV. Conclusion

This paper analyzes the impact of loan rate indexation on the allocation of bank credit. It is shown that indexation does not result in an allocation that is efficient in the sense that the resulting allocation replicates the allocation that results from a complete contingent contract. Moreover, indexing is shown to lead to cross-sectional differences among bank customers in the relative cost of borrowing given changes in the cost of bank funds. The actual pattern of commitment use is found to be consistent with this implication of the model.

The evidence presented contradicts the notion that indexing loan rates to the prime results in an increase in the relative cost of borrowing for nonprime borrowers, as has been recently argued (see Footnote 2). The uniformity in price adjustment under indexed contracts leads to a decrease in the relative cost of borrowing. An increase in the use of commitments by nonprime borrowers is therefore expected.

To conclude, it is important to note that although indexed contracts do not

[35] Data on loan commitments were obtained from the Federal Reserve's Bulletin and Statistical Release G.21 (423); "Loan Commitments at Large Commercial Banks." Takedowns are for formal short-term agreements taking the form of revolving commitments.

result in efficiency, because the resulting allocation of credit does not replicate the allocation attained under complete contingent contracts, such a comparison may lead to serious misconceptions. Specifically, in a world of information and transaction costs, intertemporal efficiency, as defined above, may not be attainable. Contracting and the indexation of loan rates may represent an efficient response of the market to the existence of these costs. It may simply be too costly to construct loan contracts which meet the criteria for efficiency as defined by Equation (3). To argue that indexation results in an inefficient allocation necessitates an assumption that some alternative adjustment mechanism can do better. If such an alternative mechanism exists, then the efficiency of credit allocation must be assessed relative to it. Unless an alternative to indexation is specified, one cannot conclude that indexation of loan rates is inefficient.

APPENDIX*

Assume that the customer's loan demand is a derived demand from the output market. Let $\delta_i(L_i)$ represent the ith customer's revenue function; the total revenue generated from a loan of size L_i. Let $V_i(L_i)$ represent the opportunity cost associated with a loan to the ith customer, so that V_i represents the bank's loan supply curve to the customer (see Equation (2)).

Let e_i, u_i represent random shift parameters in the banks' cost function and the customer's loan demand respectively. Given a complete contingent contract, efficiency implies

$$\delta_i'(L_i, u_i) = V_i'(L_i, e_i) \tag{A.1}$$

Assume that the second derivative of the cost and revenue function with respect to L_i are defined *s.t.*

$$\delta_i'' \leq 0 \quad V_i'' > 0$$

Finally, let $R(L)$ represent a rule for loan rate determination which is contingent upon loan size (indexed contracts with bank or customer quantity determination are a subset of such rules).

Theorem

There exists no loan rate determination rule, $R(L)$, which makes the loan rate contingent upon loan volume which will maintain efficiency as defined in (A.1) for all values of e_i, u_i.

Proof: By contradiction:

Suppose there exists a loan rate determination rule $R(L_i)$ *s.t.*

$$\delta_i'(L_i, u_i) = R(L_i) = V_i'(L_i, e_i) \tag{A.2}$$

the left-hand side of A.2 implies that L_i is a function of u_i *s.t.* $\dfrac{\partial L_i}{\partial u_i} \neq 0$. Similarly, the right-hand side of A.2 implies L_i is a function of e_i *s.t.* $\dfrac{\partial L_i}{\partial e_i} \neq 0$. However, this

* This proof represents an application of earlier work of Hall and Lilian [12] for labor contracts.

in turn implies that

$$\delta_i'' \frac{\partial L}{\partial u_i} = R' \frac{\partial L_i}{\partial u_i} \tag{A.3}$$

and

$$V_i'' \frac{\partial L}{\partial e_i} = R' \frac{\partial L}{\partial e_i} \tag{A.4}$$

But since $\delta_i'' \leq 0$ (A.3) implies $R' \leq 0$, and since $V'' > 0$ (A.4) implies $R' \geq 0$, a contradiction.

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