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Deposits and Relationship Lending

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Deposits and Relationship Lending [1]

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Abstract: We empirically examine whether access to deposits with inelastic rates (core deposits) permits a bank to make contractual agreements with borrowers that are infeasible if the bank must pay market rates for funds. Such access insulates a bank's costs of funds from exogenous shocks, allowing it to insulate its borrowers against exogenous credit shocks. We find that, controlling for loan market competition, banks funded more heavily with core deposits provide more loan-rate smoothing in response to exogenous changes in aggregate credit risk. Thus, we provide evidence for a novel channel linking bank liabilities to relationship lending.

Keywords: intermediation, banks, relationship lending, disintermediation, securitization

JEL Classifications: G2, G3, G1

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Deposits and Relationship Lending

Empirical explorations of the theory of the banking firm have documented a number of characteristic and distinctive features of bank lending.[1] A durable lending relationship, in which the bank gains information about the borrowing firm, has been shown to be valuable both to small firms (Petersen and Rajan, 1994, and Berger and Udell, 1995) and to large firms (Lummer and McConnell, 1989, and Slovin, Sushka, and Polonchek, 1993). In particular, continuing relationships are associated with lower loan rates, less stringent collateral requirements, and a lower likelihood of credit rationing. There is substantial evidence that banks are specialists in providing contractual flexibility and reducing the costs of financial distress for borrowing firms (e.g., Gilson, John, Lang ,1990; Preece and Mullineaux, 1996; James, 1995, 1996; and Cantillo and Wright, 1997). Bank loan rates also appear to move in a smoother fashion than do market interest rates, which Berger and Udell (1992) have interpreted as evidence of implicit risk-sharing agreements.

However, the empirical literature is nearly silent on one of the central questions in the theory of intermediation: How are these typical lending behaviors related to the structure of the bank's liabilities, if at all?[2] Our paper provides empirical evidence for an explicit link between banks' liability structure and their distinctive lending behavior. We provide evidence on a particular link that relates bank market power in deposit markets to the types of loan contracts (explicit or implicit) that banks and their borrowers can feasibly forge.[3] In our view, *core deposits*, like demand and savings deposits, which are largely rate inelastic, have historically insulated bank funding costs against economic shocks. In turn, core deposits have permitted banks to insulate borrowers against these shocks through implicit multiperiod contracts that insure borrowers against adverse credit shocks. There are multiple ways that a bank might insulate borrowing firms against adversity, but we examine one particular mechanism—loan-rate smoothing. Specifically, we propose that banks with more core deposits smooth firms' borrowing costs in the face of adverse aggregate credit shocks. Although risk-averse firms would clearly value this type of insurance, so would risk-neutral firms seeking to avoid costly asset liquidation or the forgone investment opportunities that might accompany sudden spikes in borrowing costs.

We test this hypothesis using a rich data set, the Survey of Terms of Bank Lending to Business, which provides quarterly information about contract terms of loans made by a large sample of banks, and data from the quarterly Report of Condition and Income (Call Report) on these banks' balance sheets. Our empirical results provide support for the hypotheses that: (i) banks offer borrowers insurance against credit shocks; and (ii) banks with greater access to core deposits provide more insurance to borrowers.

We proceed as follows. In Section 1 we present a model to illustrate our hypotheses and discuss the related literature. In Section 2 we describe the data and present our main empirical results. In this section we also discuss and reject alternative interpretations of our main findings—especially the possibility that the results are driven by unobserved changes in the credit risk of the borrowing populations at low and high core deposit banks. Finally, we conclude in Section 3, where we relate our results to the recent trend toward disintermediation, in which commercial banks have lost market share to other types of intermediaries that hold securities rather than loans.

1. Models and Hypotheses

1.1 An illustrative model

The idea that banks optimally make loans that do not break even period by period is a well-established one in the literature on bank uniqueness. We present a simple illustrative model to clarify our argument regarding the relationship between bank contracting practices and their access to core deposits.[4] Although our claim is that a distinctive feature of bank lending is that banks' access to core deposits facilitates multiperiod agreements with borrowers, our view can be conveyed in a stylized way by examining a model with a single loan transaction.

1.1.1 The basic setup. We focus on the contracting behavior of a single firm and a bank—both of which are risk neutral. There are two time periods. At the beginning of period 0, the firm and the bank share a common prior belief about the state of the economy in period 1, denoted by the random variable $s \in \{d,u\}$; that is, the economy will experience a downturn (d) in period 1 with probability p or an upturn (u) with probability $1 - p$. Both the firm and the bank learn the realization of s at the outset of period 1. The state of the economy is both observable and verifiable.

At the beginning of period 1, the firm needs to invest \$1 to continue production. At the end of period 1 the firm can feasibly produce revenue R_s, $s \in \{u,d\}$, with $R_u > R_d = 0$, without liquidating any assets, but can also generate additional revenue by liquidating assets.[5] Denote the value of the firm's assets—which include future investment opportunities—by A(k), where $k \in [0,K]$ denotes the additional cash generated by liquidating assets.[6] Thus, $A_k(k) < 0$. When we say that the firm liquidates assets, we have in mind any activity that reduces the value of future production activities to generate revenue today, and there is no presumption that the firm is in default when it liquidates assets. Since we are concerned about potentially inefficient liquidation, we assume that liquidating assets to produce revenue reduces the total value of the firm, ex post, i.e.,

$$\frac{d\,(k + A(k))}{dk} = 1 + A_k(k) < 0, \qquad (1)$$

We consider a highly stylized and simplified liability structure. The bank is fully funded by deposits, which the bank acquires after the realization of the state of the economy at the outset of period 1 and which are paid off at the end of period 1. The bank has access to q (< 1) dollars of low cost *core deposits,* with exogenous interest rate factor D, which is independent of the state of the economy. The bank can also acquire *purchased funds*—for which it must pay the market interest rate factor, D_s, with

$$D_d > D_u \quad \text{and} \quad pD_d + (1 - p)D_u > D. \qquad (2)$$

Thus, the cost of purchased funds is state dependent, and their expected cost is higher than that for core deposits.

Our stylized liability structure is intended to capture the following ideas. The cost of equity capital is higher than that of deposits, so the bank holds the regulatory minimal level of capital. Setting the capital ratio at zero is of no special significance. What is important is that the bank cannot profitably write state-contingent contracts with enough investors at the beginning of period 0 to *fully* insulate the borrower against the need to liquidate assets.[7] The higher cost of purchased funds in an economic downturn compared with their cost in an economic upturn reflects an *economywide* risk premium that the bank must pay in competitive funding markets. Such a premium is typical at the beginning of a downturn.

The following parametric restrictions hold:

$$R_u > D_u, \quad D_d > 0, \quad \text{and} \quad K > qD + (1-q)D_d. \tag{3}$$

The first two inequalities say that a bank financed solely with purchased funds need not require the firm to liquidate assets in an upturn, but in a downturn, such a bank must force the firm to liquidate assets so that depositors can be paid off—remembering that $R_d = 0$. The third inequality ensures that a bank financed with at least q dollars of core deposits will be able to pay off depositors, whatever the state of the economy.

1.1.2 Equilibrium loan contracts. At the beginning of period 0, the firm and the bank have a binding state-contingent contract with two loan rate factors, $\{r_u, r_d\}$, which implicitly define two liquidation levels, $\{k_u, k_d\}$. The firm's expected profit under this contract is:

$$\Pi^f = p\left[R_d + k_d + A(k_d) - r_d\right] + (1-p)\left[R_u + k_u + A(k_u) - r_u\right], \tag{4}$$

and the bank's expected profit is:

$$\Pi^b = pr_d + (1-p)r_u - \left[pC_d(q) + (1-p)C_u(q)\right], \tag{5}$$

where $C_s(q) \equiv qD + (1-q)D_s$ denotes the bank's cost of funds in state s, $s \in \{u,d\}$.

The optimal contract will maximize the joint profits of the bank and the firm. Since liquidating assets always reduces firm value (by condition (1)), any optimal contract will reduce liquidation costs to a minimum. Given the parametric restrictions in (3), no assets need to be liquidated in an upturn, but assets will typically need to be liquidated in a downturn (unless q is very high).

Then, the optimal contract will always satisfy,

$$k_u^* = 0 \quad \text{and} \quad r_d^* = k_d^* = C_d(q)\,. \tag{6}$$

Condition (6) says that assets will be liquidated only in a downturn and that the firm will be required to liquidate just enough assets to pay off depositors.

We assume that the bank is a Bertrand competitor in the loan market, taking the structure of its liabilities as given. In this setting, the optimal contract solves:

$$\max_{r_d,\, r_u} \; \Pi^f(r_d, r_u)\,, \tag{7}$$

subject to (6) and,

$$pr_d + (1-p)r_u \geq pD_d + (1-p)D_u \equiv D^e\,. \tag{8}$$

Inequality (8) is a participation constraint, which says that the bank must expect to make as much revenue from lending as it could from investing in securities that pay market interest rates (with expected return D^e). This constraint ensures that the bank captures rents from its core depositors, although Bertrand competition guarantees that it captures no further rents from borrowers. Thus, these Bertrand-competitive banks do earn positive profit, a return on the fixed factor of production (core deposits), to which they have exclusive access. We discuss constraint (8) further below.

Substituting (4), (6), and (8) into (7) we calculate the optimal contract,

$$r_d^* = C_d(q) \quad \text{and} \quad r_u^* = \frac{D^e - pk_d^*}{1-p}\,. \tag{9}$$

The loan rate in a downturn is just high enough to cover the bank's cost of funds. In an upturn, the loan rate is set so that (8) is satisfied with equality. We can now derive our main prediction: the loan rate profile—the difference in the rates paid in downturns and upturns—is flatter for banks that have more core deposits. From (9),

$$\frac{d\,(r_d^* - r_u^*)}{dq} = \left(\frac{1}{1-p}\right)\frac{dk_d^*}{dq} = \left(\frac{1}{1-p}\right)[D - D_d] < 0\ , \tag{10}$$

where the inequality follows, since core deposits are cheaper than purchased funds. Intuitively, a bank with more core deposits receives lower net revenue in the downturn because its lower cost of funds permits the bank to offer the firm a lower loan rate to reduce the inefficient liquidation of assets. Thus, it charges a higher rate in the upturn to satisfy participation constraint (8).

In our Bertrand market, where the bank has an outside investment option—investing in securities—the expected loan rate charged to a borrower is not affected by the bank's access to core deposits. This follows, since the loan contract yields expected revenue just high enough to cover the bank's expected *market* return, which is independent of q. That is, from the bank's participation constraint (8),

$$pr_d^* + (1-p)r_u^* = D^e\ , \tag{11}$$

and D^e is independent of q.

1.1.3 Discussion. In our model, the bank's access to core deposits allows it to insulate the firm against credit shocks as part of an optimal contract. To keep things as simple as possible, we have cast the contracting problem in a static setting, but the essential features of our optimal contract would carry over in a straightforward way to an intertemporal model with aggregate credit shocks. The key is that the bank is free to charge concessionary rates in bad times and compensatory rates in good times. If a bank can offer below-market rates on deposits, it has more freedom to offer loan rates that do not break even period by period—a type of cross-subsidization between depositors and borrowers facilitated by the bank. The more relaxed budget constraint facilitates relationship building and flexibility in the pricing of loans. A bank forced to pay market rates for its funds simply has less freedom to demand of the borrower anything but the single-period profit-maximizing loan rate.

We view two features of our illustrative model as potentially objectionable. The first is our assumption that the loan market is perfectly competitive, an assumption that is clearly unrealistic for many small and medium-size borrowers. The second is that the bank has an outside investment option—investment in market securities—that allows it to capture rents on its captive depositors and prevents competition in loan markets from forcing banks to pass through some of these rents to borrowers in the form of lower average loan rates.[8]

Allowing imperfectly competitive loan markets or permitting banks' cost of funds C(q) to affect the distribution of rents between the bank and the borrower would not affect our main result: that the equilibrium contract will involve loan-rate smoothing and that the degree of smoothing will be positively related to the bank's available core deposits. The joint profit maximizing contract—which requires a flatter loan rate profile—will be the equilibrium contract across a wide range of market structures and distributions of the contractual surplus. Thus, we make the following prediction, which we formalize and test in Section 2:

Hypothesis: An exogenous increase in aggregate credit risk will lead to a smaller increase in loan markups for firms borrowing from banks with higher levels of core deposits than from banks with lower levels of core deposits.

The exact relationship between a bank's core deposits and the *average loan rate*, however, depends upon the fine details of the model of competition, and we do not expect the loan rate to be independent of core deposit levels as in our simple model. In general, higher core deposits can have two opposing effects on average loan rates. Core deposits permit the bank to reduce inefficient liquidation of assets, which increases total contractual surplus. Holding constant the bargaining power between the bank and the borrower, this will tend to raise average loan rates. But the distribution of the contractual surplus may be affected by the bank's core deposit level. In models where the bank's cost of funds affects its threat point in bargaining over the average loan rate, more core deposits can lower the bank's bargaining power, which will tend to reduce the average loan rate.[9] Thus, we do not have any general predictions relating core deposits and average loan rates.

1.2 Related literature

The introduction has already highlighted some of the connections between our model and preceding empirical work in the theory of intermediation. Our work has particularly close links to three recent papers. Allen and Gale (1997) present a general equilibrium model in which a bank-centered financial system permits intertemporal risk sharing that would be impossible in a decentralized market. As in our model—where captive depositors facilitate intertemporal wealth transfers—Allen and Gale's optimal allocation can be supported only in a world where agents have limited market power.[10]

An important contribution is Petersen and Rajan (1995), who present and test a model with a flavor similar to our own. In their paper, banks make low interest rate loans to high-risk customers as part of a long-term implicit contract, a type of intertemporal insurance contract against shocks to a firm's credit risk. These intertemporal insurance contracts are feasible *only* if the bank has ex post monopoly power in loan markets.

They test their model of relationship lending using data on small business firms. Using the age of the firm as a proxy for firm creditworthiness and the Herfindahl index for the local deposit market as a proxy for the degree of competition in loan markets, Petersen and Rajan show that in markets with a higher Herfindahl index, loan rates fall more slowly over a firm's life. In other words, when a bank has monopoly power, it can offer a firm a lower-than-competitive rate early in the firm's life and then make up for this by charging a higher-than-competitive rate later in the firm's life.

There are a number of differences between our work and Petersen and Rajan's. Most important, we focus on market power in the deposit market, rather than the loan market, as the source of loan rate smoothing. Also, we examine shorter-term intertemporal contracts than do Petersen and Rajan. In our empirical results, loan rate smoothing occurs (roughly) over a business cycle, a period significantly shorter than the lifetime of a firm.[11] Despite the differences, we view our approaches—and viewpoints—as complementary.[12] The main point of both papers—that the set of feasible loan contracts depends in an essential way upon the degree of competition—is similar.

As noted above, Berger and Udell (1992) have shown that bank loan rates are less volatile than market interest rates, but they make no attempt to relate smoothing to banks' liability structure. Also, our main concern is with loan-rate smoothing to insulate firms against adverse credit shocks rather than interest rate shocks.[13]

2. Empirical Strategy

2.1 The data

Our two main sources of data are the quarterly Survey of Terms of Bank Lending to Business (STBL) and the Reports of Condition and Income (Call Reports). Since 1977, the STBL has collected detailed microeconomic data on bank loan characteristics from a stratified sample of approximately 340 banks. In the first week of the second month of each quarter, each bank in the sample provides individual data on every business loan it made on a particular day (or number of days). This data set provides a remarkably rich source of information on bank contracting practices, as they vary across banks and over time.

All balance-sheet data for the banks in our sample come from the Call Reports, which banks file quarterly.

From the complete data set we constructed a panel that includes 126 banks that reported in each quarter from the first quarter of 1977 through the fourth quarter of 1989. Our panel excludes all surveyed banks that disappeared through failure or merger during the period. We exclude these banks because we do not want any smoothing results to be driven by banks that engaged in excessively risky investment strategies that ultimately led to failure. For example, a bank that is a poor monitor will tend to have a riskier portfolio—and a higher likelihood of failure—and the lack of monitoring may also lead to pricing that is insensitive to risk. The period following 1989 witnessed major changes in the sample of reporting banks through failures and mergers, so, to retain a relatively large and representative panel, we ended our sample period in 1989.[14]

2.2 Empirical tests

Our regressions take the following general form:

$$\begin{aligned} \text{MARKUP}_{ibt} = {} & a_0 + a_1 \text{CORE DEPOSIT RATIO}_{bt} + a_2 \text{CREDIT RISK}_{bt} \\ & + a_3 \text{CREDIT RISK}_{bt} \times \text{CORE DEPOSIT RATIO}_{bt} + a_4 \text{ CONTROL VARIABLES}_{ibt} . \end{aligned} \tag{12}$$

The subscripts refer to loan i from bank b made in time period t. In all regressions the dependent variable is the ***markup*** over the risk-free rate paid by the borrowing firm. More specifically, this is the difference between the loan rate and the rate on a Treasury security with duration equal to that of the loan. (Table 1 summarizes our definitions of variables.)

In our regressions we test the hypothesis that banks more heavily financed with core deposits provide borrowers with better insurance against adverse shocks to their creditworthiness. According to our hypothesis, the coefficient on the interaction term between credit risk and core deposits, a_3 in equation (12), should be negative, because banks with more core deposits are better able to protect their borrowers against shocks to their borrowing costs.

Our measure of the ***core deposit ratio*** is deposits with denominations less than $100,000 as a fraction of total liabilities.[15] We report the results based on two alternative measures of core deposits. Our preferred measure is the three-year average of the bank's core deposit ratio, where the average is taken over the calendar year prior, the current year, and the calendar year after the loan is made. For example, for any loan made in any quarter of 1977, we use the bank's average core deposit ratio over 1976Q1-1978Q4. The bank's expected longer-term liability structure, rather than transient changes in its liability structure, should be more important for the bank's strategic decisions such as loan pricing policy. The three-year average is meant to capture the bank's expectation regarding its longer-term liability structure. We choose a three-year period, since it allows for some time variation in the core deposit measure and it does not seem to be an unreasonable estimate of the horizon over which a bank concerned about lending relationships would set its loan pricing policy.[16]

As an alternative measure of core deposits, we use the bank's one-year lagged core deposit ratio, i.e., the loan markup at time t is regressed on the bank's core deposit ratio one year prior to t. The bank's liability structure and pricing policy are (at least partly) endogenous strategic decisions, and the lagged core deposit ratio should alleviate any concerns about endogeneity problems. It should be noted that we see no straightforward reason to expect that endogeneity would bias the coefficient on the cross-term between the core deposit ratio and credit risk in one way or the other. Since the lagged core deposit ratio does not capture the bank's expectations about its longer term liability structure, we prefer our three-year average measure of core deposits.[17]

Because there is no one accepted measure of exogenous credit risk, we consider four alternative measures, each of which has certain benefits and drawbacks. Our preferred measure is the ***quality spread***, which is the difference between yields on Baa-rated and Aaa-rated long-term bonds; it averages 1.36 percent over our sample period. This measure has the advantage of being forward looking, but may be a better measure of credit risk for borrowers who have access to national bond markets than for the majority of firms that borrow in local markets. The quarterly growth in GDP and the quarterly growth in employment are also aggregate measures that are inversely related to credit risk; over our sample period, GDP growth averages 2.8 percentage points and employment growth averages 2.4 percentage points. The main drawback of these measures is that they are contemporaneous, rather than forward-looking indicators of risk. To make it easier for the reader to interpret and compare our results, we report them in terms of ***−1×GDP growth*** and ***−1×employment growth***, since both GDP growth and employment growth are positively related to credit risk. Note that all three aggregate measures of credit risk vary over time but not across banks.

In contrast, our final credit-risk measure—the unemployment rate in the state in which the bank is headquartered (***state unemployment***)—exploits the cross-sectional nature of our data. The average unemployment rate over our sample period and states is 6.9 percent, but the rates are quite variable across banks and time—the minimum range in state unemployment rates across the states represented in any quarter in our sample is 5.3 percentage points, while the maximum range is 11.3 percentage points, and the mean range is 8.0 percentage points. One drawback, however, is that the state unemployment rate is not likely to be a good measure of credit risk for firms that operate in national and international markets.[18] Further, we have some concern that it is a lagging measure of economic conditions.

The control variables can be divided into three groups:

The first group includes *bank-specific variables*. The most important function of these variables is to proxy for factors related to the bank-specific component of default risk. In particular, we hope to proxy for changes in the bank's credit screening policy and the riskiness of the bank's portfolio, which are ultimately unobservable. First, we include bank-specific dummy variables in those regressions using measures of credit risk that do not vary by bank, i.e., in regressions using quality spread, !1×GDP growth, or !1×employment growth. Because the state unemployment rate varies across banks and because there are many cases where there was only one bank in a state that responded to the survey, we report results that do not include bank-specific dummy variables when state unemployment is used as our measure of credit risk.[19]

We include a direct proxy for bank-specific default risk, the bank's net chargeoffs in the second year after the loan is granted as a fraction of total loans (***chargeoffs-2***) and net chargeoffs in the third year after the loan is granted as a fraction of total loans (***chargeoffs-3***). Note that we use *future* chargeoffs, as we assume that looser screening should manifest itself with higher chargeoffs in the future, not contemporaneously. We also include the loan-to-deposit ratio (***loans/deposits***) and equity-to-asset ratio (***equity/assets***), either using the one-year lagged value or three-year average value (consistent with the core deposit ratio). Higher loan-to-deposit ratios and lower equity-to-asset ratios may be associated with riskier portfolio strategies. Our measure of bank size is ***ln(total assets)*** in *ln*(millions of 1982 dollars), which proxies for scale-related components of lending costs; we also use either the one-year lagged value or three-year average value. Finally, we include the ***Herfindahl index*** for the bank's deposit market. Although our preferred measure of market power is core deposits, there is evidence that market concentration generates monopoly power for some types of deposits (see Berger and Hannan, 1989). Also, for smaller borrowers in our sample, loan-market concentration may be related to deposit-market concentration. If this is true, the Herfindahl index may also control for the bank's monopoly power in loan markets.[20]

The second group of control variables includes *contract variables*. We recognize that these contract terms are offered as a package along with the loan rate and that, to some extent, the loan rate and other contract terms are jointly determined. However, we believe that the degree of substitutability among contract terms may be small in practice. Accordingly, we view the other contract terms as controls for borrower-specific default risk, as well as controls for other borrower-specific lending costs. The contract variables include the ***ln(face value)*** in *ln*(millions of 1982 dollars) and the ***duration*** of the loan, as well as a set of dummy variables that indicate whether the loan is ***collateralized***, whether it was made under a preexisting ***commitment***, or whether it has a ***fixed base rate***.[21]

One last contractual variable is of special importance: whether the loan was made at a rate above or below the prime rate on the day the loan was made.[22] We view the above-prime and below-prime loan markets as essentially different markets (see Brady, 1985). Below-prime borrowers often have access to national markets, and many have access to money markets. Above-prime borrowers are more bank dependent and are unlikely to have access to money markets. Table 2 shows difference-in-means and difference-in-medians tests for some characteristics of loans made to the two samples; it is immediately clear that above- and below-prime loans are very different, being made to different types of customers and, for the most part, by different types of banks. Below-prime loans are larger, less likely to be collateralized, of shorter duration, and more likely to be made at a fixed rate. They are also more likely to be made by larger banks with somewhat lower core deposit ratios.[23]

Close banking relationships are much less likely to be important—or feasible—for our below-prime borrowers, and our theory concerns relationship lending and insurance against credit-risk shocks. (This is not to say that there are no relationships between large borrowers and their banks, only that routine insulation against credit shocks is not likely to be an important feature of such relationships.) Hence, we look for evidence in the subsample of above-prime loans.[24] Below we discuss some robustness tests that address concerns about whether a potential bias is introduced by selecting a sample based on loan prices, given that the dependent variable in the regression is the loan rate markup.

We include a simple linear time trend (***trend***). This is a crude attempt to control for secular changes in banking markets over the period that may not be captured by our risk measures and market rate measures.[25] Finally, we also include the ***money market rate***, the rate on the Treasury security with the same duration as that of the loan, since markups may vary with interest rate levels. Since both the markup and the money market rate are defined for securities of equal duration, this specification also permits the shape of the yield curve to affect the loan markup. The variable may also serve as an indicator of the stance of monetary policy (especially as the average duration in our sample is under six months and the median duration is under three months).

2.3 Empirical findings

Since our sample size is so large in our main regressions—over 600,000 loans—discussions of statistical significance at conventional levels would convey little information. Most of our variables are significant at levels well below 0.01 percent.[26] Accordingly, we focus on the signs of the coefficients and on their economic significance. We will note, however, when important variables are insignificant at conventional levels. In some of the regressions in Section 2.4, the unit of observation is the bank's portfolio in a particular year, rather than a particular loan. In these regressions, with just over 6,500 observations, discussions of statistical significance at conventional levels are still meaningful.

2.3.1 Estimation results. Our results are consistent with the hypotheses that banks insulate firms against the costs of adverse shocks to their creditworthiness and that access to core deposits increases banks' ability to offer such insurance. Tables 3 and 4 present results using the three-year average core deposit ratio and other control variables and one-year lagged core deposit ratio and other control variables, respectively. (Columns (1) to (4) correspond to our four measures of exogenous credit risk: the quality spread, !1×GDP growth, !1×employment growth, and the state unemployment rate.) First, note that each of our measures of credit risk is significantly positively related to the loan markup. Second, note that the coefficient on the cross-term between our measures of core deposits and credit risk has the predicted negative sign in every case. Thus, banks with greater access to core deposits provide smoother rates in response to credit shocks.

Further, the magnitudes of the credit-risk insurance are economically meaningful: Using our regressions, we compared the change in the loan markup implied by a one-standard-deviation increase in credit risk at banks with low and high core deposit ratios. For example, in the three-year average specification, a one-standard-deviation change in quality spread (0.45 percentage points) would raise the markup 48 basis points more for the bank with the minimum core deposit ratio in our sample than for the bank with the maximum core deposit ratio.[27] Similarly, for the three-year average specifications, the difference in the change in markup between a bank with the minimum core deposit ratio and a bank with the maximum core deposit ratio is 34 basis points when the state unemployment rate is used to measure credit risk, 52 basis points when !1×employment growth is used, and 54 basis points when !1×GDP growth is used. For the one-year lag specifications, these differences are 12 basis points when the state unemployment rate is used to measure credit risk, 13 basis points when the quality spread is used, 36 basis points when !1×employment growth is used, and 54 basis points when !1×GDP growth is used.[28] These numbers are economically meaningful, and they are not unreasonable, since the mean markup charged on above-prime loans in our sample is 413 basis points.[29]

Notice that, in general, the effect of core deposits on smoothing is larger when the three-year average specification is used. We believe our three-year average core deposit measure better reflects a longer term planning horizon, which is relevant to a relationship lender. Hence, we believe the larger estimate is a better measure of the true economic impact of core deposits on smoothing.

The signs on the coefficients of the contractual variables are consistent with prior findings in the literature and economic sense. They are also consistent with our view that the contractual terms are largely exogenous proxies for borrower risk, rather than endogenously determined substitutes with the loan rate markup. For example, collateralized loans, spot loans, and smaller loans are all made at higher rates, indicating that they are proxies for higher borrower risk.

2.3.2 Robustness tests. We have already mentioned some of our robustness tests. To simplify our presentation in discussing these, we will say that results are "qualitatively similar" only when the sign and significance of the coefficient on the cross-term between core deposits and credit risk remain unchanged for all four measures of credit risk. We will note explicitly all cases in which the sign of the coefficient changes or its level of significance declines. (All of the results reported here are available from the authors.)

Our results are robust to the use of alternative specifications of the core deposit ratio and other control variables. Using the average of a bank's core deposit ratio over the entire period (and comparable measures for the other controls), we obtained qualitatively similar results.[30] We also reestimated the regressions using the contemporaneous values of the core deposit ratio and other controls and obtained qualitatively similar results to those obtained when the one-year lagged core deposit ratio and control variables were used. This suggests that endogeneity is not much of a problem. Our results are also not qualitatively affected by dropping the contract-term variables, i.e., the loan's size and duration and whether the loan is collateralized, made under a prior commitment, or made at a fixed rate. Thus, there is no evidence that the endogenous determination of non-price contract variables and the markup is driving our empirical results. Also, reestimating the equations with an alternative measure of core deposits, namely, deposits less than $100,000 minus small time deposits as a fraction of liabilities, again yielded qualitatively similar results.[31]

The results presented above include a simple time trend as a control for secular changes in financial structure and conditions that are not picked up in our variables that vary over time. We reestimated our regressions including dummy variables for each year and found no qualitative change in our results.[32] Finally, because the state unemployment rate varies over banks and time, we reestimated its corresponding regressions for each of the 44 quarters from 1979Q1-1989Q4 separately. Our results are weaker, but still lend some support to those reported above, especially when the three-year average core deposit ratio and controls are used.[33]

We have reported ordinary least squares estimates, but to the extent that the errors across a given bank's loans in a given quarter are correlated, the standard errors on the OLS coefficient estimates will be understated and the significance of the OLS coefficient estimates will be overstated. To address this concern, we reestimated the regressions after averaging each variable across all of a bank's loans in a quarter, so there was one observation per bank per quarter. In all cases, the sign of the coefficient on the cross-term remained negative. For our preferred specification, the three-year averages, there was no lowering of significance levels on the cross-terms except when the state unemployment rate was used (the p-value rose to 0.02 from 0.0001). For the one-year lag specification, the coefficients on the cross-term when quality spread was used and when state unemployment was used became insignificant (the p-values were 0.3048 and 0.6066, respectively).

We investigated any potential bias in the results reported in Tables 3 and 4 that may have been caused by selecting our sample of loans based on the loan rate, i.e., whether the loan was priced above the prime rate, while using markup as our dependent variable. First, we reestimated the regressions for the full sample of loans, including both above- and below-prime loans. This yielded qualitatively similar results to our above-prime sample, which is not surprising, since there are many more above-prime loans than below-prime loans. (F-tests reject this pooling with a p-value of 0.0001 in all cases.) We also estimated the regressions for loans priced two percentage points or more above the prime rate without a qualitative change in results.

Although we feel that the above- and below-prime breakdown best captures the theoretical distinction between bank-dependent firms—to which our theory applies—and firms that routinely borrow in public markets, the size of the borrowing firm is an alternative way of capturing the same idea. We do not have information on borrower size. But we do know the size of the loans and that smaller borrowers tend to receive smaller loans. Thus, if our theory holds, we expect to find credit-risk smoothing for the smaller loans. To test this, we reestimated our regressions for loans in the bottom third of the loan-size distribution (just over 241,000 loans), and we found that banks with higher core deposits engage in more credit-risk smoothing, i.e., the cross-term between credit risk and the core deposit ratio is negative, as it was for the above-prime loan sample. We also estimated the regressions for loans in the top third of the size distribution and found that the signs of the cross-terms were much more mixed, with the cross-term being positive in the one-year lag distributions, and significantly so except when −1×employment growth is used as the credit-risk measure. This is consistent with a portion of the larger loans being made to borrowers who are less in need of the credit-risk smoothing offered by banks.

A final test of robustness is to see whether our regressions support other results that have been fairly well supported in the literature. In particular, many studies have shown that loan rates are sticky in response to shocks to money market rates, i.e., that banks seem to provide interest-rate smoothing to their borrowers (see, e.g., Berger and Udell, 1992). Our results are generally supportive of this finding. As reported in Tables 3 and 4, the coefficient on the money market rate is significantly negative except when −1×GDP growth measures credit risk. This implies stickiness as it indicates that the markup on the loan decreases as market rates increase.[34]

2.4 Other interpretations

We have argued that our empirical results are consistent with the hypothesis that banks with greater access to core deposits can and do offer distinctive services compared to banks heavily dependent on purchased funds. In particular, core deposits have allowed banks to insulate bank-dependent borrowers from credit shocks.

Alternative hypotheses are consistent with some of our results. The first is the Petersen and Rajan (1995) view that the smoothing of loan rates is the effect of monopoly power in *loan markets* rather than in deposit markets. We believe that loan market power is unlikely to explain the relationships we find between loan markups and banks' core deposit ratios. We include Petersen and Rajan's indicator of loan market power—the Herfindahl index for bank deposits—as a control variable in all of our regressions. We also have other controls for variations in the market power of the firm and the bank, specifically bank size and loan size, and by considering only above-prime loans we severely restrict the sample variation in loan market power. After all of these controls, we retain economically and statistically significant effects for the bank's core deposits. Finally, there is little reason to believe that our core deposit variable is acting as a proxy for loan market power. Without a direct measure of loan market power, this hypothesis is impossible to test directly. But using the bank's deposit market Herfindahl as an imperfect proxy for loan market concentration, we find a positive, but not particularly large, correlation coefficient of 0.44 between the core deposit ratio and the Herfindahl index. As a further check, we investigated whether adding a cross-term between the Herfindahl and credit risk in the regressions would affect the coefficient on the cross-term between the core deposit ratio and credit risk. In no case did this happen—across the specifications, the sign, magnitude, and significance level of the cross-term between the core deposit ratio and credit risk were unchanged by the addition of the cross-term between the Herfindahl and credit risk.

A second class of alternative explanations is that our results are being driven by a systematic relationship between changes in the relative riskiness of banks' portfolios and their core deposit ratios. There are two basic variants of this explanation, a demand-side and a supply-side version.

In the demand-side version, there is a relative decline in demand for loans from smaller or higher-risk firms when aggregate risk increases. Since smaller firms borrow disproportionately from smaller banks, which also tend to have high core deposit ratios, the borrowing population might become disproportionately safer at banks with high core deposit ratios. But our regressions control for both bank size and loan size, so it is highly unlikely that our empirical findings are being driven by this kind of change in demand. Nonetheless, these types of demand-side effects are addressed in tests reported below. Note that we are not denying that demand for loans falls disproportionately at small banks, only that our regressions have explicit controls for this effect.

In the supply-side version, the negative correlation between core deposits and the sensitivity of loan rate markups to exogenous changes in credit risk is the result of incomplete controls for the severity of bank credit screens. It should be noted that we have multiple controls for borrower risk in our regressions and that the robustness of our results to dropping contract terms supports our interpretation of these terms as exogenous indices of borrower risk. Further, the highly significant coefficients on subsequent chargeoffs provide strong evidence that our proxy for the severity of the bank's credit screen *does* capture the intended effect. Also, the bank-specific dummy variables act as controls for bank-level differences in credit screening policies. Finally, our restriction to above-prime loans restricts the importance of "flight to quality" effects in our results by limiting any potential change in the share of bank loans made to firms with access to public markets.

Of course, our controls are not perfect. If banks with high core deposit ratios systematically respond to an increase in aggregate credit risk by tightening their credit standards more than banks with lower core deposit ratios, the markups they charge to borrowers would be expected to increase less than the markups charged by banks with lower core deposit ratios. Thus, one would expect to see a negative correlation on the cross-product between credit risk and core deposits, as we found, but it need not be related to banks providing insurance against credit risk.

This scenario is consistent with two views in the literature. Kashyap and Stein (1995) argue that banks that are more heavily funded by deposits, especially small banks, face more daunting external finance constraints. If so, such banks might respond to external shocks to credit risk by increasing the severity of their credit screens as part of a restriction in the supply of credit.[35] Keeley (1990) argues that banks with higher charter values are deterred from taking on risk. Since high core deposit ratios are an indicator of banks' monopoly power in deposit markets, they also indicate higher charter value. This again implies that banks with higher core deposit ratios might react to an increase in credit risk by tightening their credit screens more than banks with lower core deposit ratios. It is important to note that to make an alternative supply-side interpretation of our results, it does not suffice to make the plausible claim that credit screens are more stringent for banks with higher core deposit ratios. One must make the stronger (and less immediately plausible) claim that such banks *increase* the severity of their credit screens *disproportionately* compared with lower core deposit banks when aggregate credit risk increases. Further, one must claim that the core deposit ratio proxies for banks' risk preferences in ways not already taken into account by our existing controls.

To test whether any of these alternative stories explain our results, we estimated the following regressions for our panel of 126 banks:

$$\text{PORTFOLIO RISK}_{bt} = a_0 + a_1\text{CORE DEPOSIT RATIO}_{bt} + a_2\text{CREDIT RISK}_{bt} + a_3\text{CREDIT RISK}_{bt} \times \text{CORE DEPOSIT RATIO}_{bt} + a_4\text{CONTROL VARIABLES}_{bt}. \tag{13}$$

We examined four PORTFOLIO RISK variables: the proportion of a bank's loan volume or number of loans, respectively, that are collateralized (***fraction collateralized-$*** and ***fraction collateralized-#***), since collateralized loans may indicate riskier loans (as shown by Berger and Udell, 1990),[36] and the ratio of chargeoffs in the second and third years, respectively, after loans were made to total loans (***chargeoffs-2*** and ***chargeoffs-3***), since future chargeoffs indicate riskier loans. The CREDIT RISK variables included the quality spread, !1×GDP growth, !1×employment growth, and the state unemployment rate, and the CONTROL VARIABLES included the intercept, the time trend, the Herfindahl index, the equity-to-asset ratio, *ln*(total assets), the one-year T-bill rate, and the loan-to-deposit ratio. Again, we measured the core deposit ratio, equity-to-asset ratio, loan-to-deposit ratio, and *ln*(total assets) as either three-year moving averages or one-year lags, and we included bank-specific dummy variables for all measures of credit risk except the state unemployment rate.[37]

Note that unlike our earlier regressions, the dependent variables reflect features of the bank's portfolio of loans rather than the loans individually, so our sample size drops dramatically, and conventional significance levels have meaning.

For brevity, in Table 5 we present the estimated coefficients only for the variable of interest, the interaction term (credit risk × core deposit ratio). A significantly negative coefficient would indicate that, as credit risk increases, banks with higher core deposit ratios take on less risk, which would support alternative explanations for our results. However, as shown in the top panel of Table 5, this occurred only three times in either the three-year average specification or one-year lag specification: in the chargeoffs-2 regression when either !1×GDP growth or !1×employment growth was used to measure credit risk, and in the chargeoffs-3 regression when !1×GDP growth measured credit risk. Instead, the cross-terms involving quality spread and state unemployment are always significantly *positive* at the 5 percent level or better, indicating that banks with higher core deposit ratios were taking on *more* risk, not less. Thus, these results are generally unsupportive of the alternative interpretation of our previous results. We also used an alternative specification, replacing the trend variable with year-specific dummy variables and found qualitatively similar results.[38]

One might be concerned that the lack of significance in some of the cross-terms shown in Table 5 is due to reduced degrees of freedom (compared with our loan-based regressions reported in Tables 3 and 4), but this does not appear to be the case. Since the variables measuring the share of collateralized loans are the only ones used in equation (13) that are derived from the STBL, and all the others instead come from the Call Reports, we were also able to estimate the chargeoffs-2 and chargeoffs-3 regressions for the full set of all banks that existed over our sample period 1977Q1-1989Q4, whether they were STBL reporters or not.[39] In these regressions, which used 8,788 banks, we again find no support for the view that banks with higher core deposit ratios took on less risk—few, if any, cross-terms show a significant negative sign and those involving quality spread and the state unemployment rate continue to show significant positive signs.

3. Conclusion

In this paper we have investigated empirically a particular channel of bank "uniqueness" linking the structure of bank liabilities to bank lending behavior. To our knowledge this channel has not been explored previously. Specifically, we have examined the hypothesis that access to core deposits permits a bank to make contractual agreements with borrowers that are infeasible if the bank must pay market rates for its funds. Access to core deposits insulates a bank's cost of funds from exogenous shocks. In turn, the bank can insulate its borrowers against exogenous credit shocks as part of a multiperiod implicit relationship.

Using a large sample of loans from the Survey of Terms of Bank Lending to Business, we find convincing evidence for our story. Specifically, we find that banks more heavily funded with core deposits provide borrowers with smoother loan rates in response to exogenous changes in aggregate credit risk. Thus, we provide support for a view that has become prevalent among banking scholars: that part of the distinctive character of bank lending is that firms and banks form multiperiod lending relationships, in which loans need not break even period by period. A unique feature of our results is that they provide evidence that banks' access to core deposits has been one of the foundations of relationship lending.

Our findings may also provide a partial answer to a question that is one of the underlying motivations for the current research: How can we explain the banking sector's shrinking share of intermediated funds (disintermediation) and the shift toward intermediaries that hold securities rather than loans (securitization)?[40] Our answer is that declining demand for deposits has not only raised banks' cost of funds—which directly reduces the supply of bank loans—but it has also reduced the feasibility of relationship lending by banks—reducing the firms' demand for bank loans as they have become less distinctive. Thus, one reason the banking sector has been shrinking is that bank loans have become less special as banks have lost access to core deposits.

Endnotes

1. See Bhattacharya and Thakor (1993) and Thakor (1996) for excellent critical reviews of the theory of intermediation. Nakamura (1993b), Berlin (1996), and Berger and Udell (1998) provide reviews of the recent empirical literature on bank lending.

2. One (indirect) approach to this question is to examine the differences between bank loans and other types of private debt, which *might* then be related to differences in the intermediaries' liabilities. The literature has yet to settle the question of whether bank loan agreements and other private debt agreements have different announcement effects (see Billet, Flannery and Garfinkel, 1995). In a related vein, Carey, Post, and Sharpe (1998) have compared both loan terms and borrower characteristics in a sample that includes both bank loan agreements and finance company loan agreements. Although they find differences, notably that finance company borrowers are riskier, none of the differences have yet been linked directly to the differences in the structure of bank and finance company liabilities.

3. Nakamura (1993a) and Mester, Nakamura, and Renault (1998) present empirical evidence for another view, the "checking account hypothesis," associated with Black (1975) and Fama (1985). According to this hypothesis, checking accounts provide information about borrowing firms' transactions, which in turn provide information about the firms' financial health.

4. Other models of relationship lending include Sharpe (1990), Rajan (1992), Petersen and Rajan (1995) and Boot and Thakor (1996). None of these emphasizes the relationship between competition in the market for bank liabilities and the lending behavior of banks.

5. The assumption that $R_d = 0$ simplifies things without loss of essential insights.

6. For simplicity we assume that the state of the economy can affect the value of the firm's assets only through the liquidation decision, although the liquidation decision may be state dependent.

7. Note that the bank can write fully state-contingent contracts (including equity claims) with its borrowers. The reason inefficient liquidation cannot be avoided is that the bank cannot obtain fully state-contingent

liabilities. The assumption that state-contingent loan contracts are perfectly enforceable is for narrative purposes only. We actually have in mind implicit contracts that may not be perfectly enforceable.

8. Empirically, this second assumption amounts to the belief that banks could profitably offer depositors transactions services while investing in a portfolio of Treasury securities. (Of course, our simple model takes no account of the costs of offering transactions services.) It is unlikely that a bank portfolio composed purely of Treasury securities could be profitable, since even money market funds, which offer less extensive and costly transactions services than banks, hold approximately 40 percent of their portfolios in commercial paper rather than having their entire portfolios in Treasuries.

9. For example, in a symmetric Bertrand duopoly, higher core deposit levels imply lower average loan rates.

10. Although Allen and Gale show that a system of intertemporal transfers may yield a Pareto improvement over the market outcome, we make no such claim about the bank in our model.

11. Given the relatively short-term and repetitive nature of our intertemporal trades, we do not feel that enforceability concerns are as burdensome as in the long-term relationships in Petersen and Rajan.

12. Petersen and Rajan have detailed information about the borrowing firms over time, but only fragmentary information about their lenders. We have information about a changing pool of loans over time—an imperfect proxy for the borrowing firms—but very detailed information about their lenders.

13. Nonetheless, we find that banks with higher core deposit ratios also provide more insurance against interest rate shocks, as we discuss later.

14. For example, in 1996Q3, 73 banks in the panel remained. During the 1980s, small banks were more likely than large banks to have dropped from the sample either because of failure or merger or from lack of reporting in a quarter. Thus, our panel is skewed toward the larger banks in the survey. But this effect should bias our results against finding a relationship between core deposits and loan rate smoothing, since we expect that implicit contracting practices are more likely to be important for small banks and small borrowers.

15. We have also performed all of our regressions using an alternative, narrower measure of core deposits, which includes deposits with denominations under $100,000 less small time deposits. The results are substantially the same in terms of the level of significance and magnitudes of the coefficients, and we report here only the results for the broader measure.

16. For comparison, we also performed regressions using a longer-term measure of the bank's liability structure, average core deposits over the entire sample period. As we discuss in Section 2.3.2, our results remain intact using this measure.

17. In Section 2.3.2, we also discuss results using the contemporaneous core deposit ratio as an alternative to the lagged core deposit ratio. The results are very similar, so endogeneity does not appear to be a concern.

18. The state unemployment rate was available beginning in 1979Q1 for all states except North Carolina, where it was available beginning in 1985Q1. Thus, the regressions using the state unemployment rate were estimated over the 1979Q1-1989Q4 period (and in the 1979Q1-1984Q4 subperiod, these regressions exclude loans made by the two banks in our sample that were headquartered in North Carolina).

19. Indeed, the bank-specific dummy variables explain over 94 percent of the variation in state unemployment over the sample. We did, however, rerun these regressions with bank-specific dummy variables, and only one specification had a qualitative change in either the significance level or sign of the coefficient on the cross-term between the core deposit ratio and the state unemployment rate. The coefficient on the cross-term was positive when we include *both* bank-specific dummy variables and year-specific dummies.

20. Hannan (1991) finds evidence that the deposit market Herfindahl index is positively related to loan rates on small loans. Note that Petersen and Rajan (1995) interpret the deposit-market Herfindahl as a measure of loan-market concentration.

21. Whether the loan was part of a participation was not reported on the STBL until 1982Q3; therefore, it could not be included as a control variable. In preliminary regressions using a hold-out sample of 200 loans

chosen randomly each quarter, we performed estimations over a shorter period (1982Q3-1989Q4) and included this variable. Unlike most of the other contract terms, it was significant in only two of our four regressions (using GDP growth and employment growth). As we discuss below, the contract-term variables can be omitted without qualitative changes to our results. (We excluded the loans in our hold-out sample when performing the regressions reported here to alleviate pretesting concerns.)

22. We use the business day prime rate as reported in the Federal Reserve Board's H.15 statistical release and not the bank-specific prime rates reported on the STBL database. The business day prime rate is the one quoted by a majority of the major banks surveyed by the Federal Reserve.

23. For the subperiod 1982Q3-1989Q4, when banks reported on the STBL whether the loan was part of a participation, below-prime loans were more likely to be participated. The averages for the below-prime loans disguise a surprising degree of variability among the below-prime borrowers that we found in the sample. Most notably, there are several small, below-prime, collateralized loans made by banks with high core deposit ratios.

24. We did estimate our regressions using the below-prime sample of loans and found little support for credit-risk smoothing; the coefficient on the cross term between the core deposit ratio and credit risk was significantly positive for the quality spread and !1×employment growth regressions, insignificantly negative for the !1×GDP growth regression, and significantly positive in the state unemployment rate regression, when either one-year lagged or three-year average control variables were used. Not surprisingly, across all the specifications, an F-test rejects the null hypothesis of pooling the above-prime and below-prime loans, with a p-value of 0.0001.

25. Below we discuss alternative specifications to control for time.

26. In section 2.3.2, we discuss the results when we allow for correlation across the loans of a given bank in a given quarter. If such a correlation exists, our OLS estimates will understate the standard errors of the coefficient estimates and, therefore, overstate their degree of significance.

27. In our sample, the minimum and maximum three-year average core deposit ratios are 0.075 and 0.97, respectively, and the minimum and maximum one-year lagged core deposit ratios are 0.082 and 0.99, respectively.

28. Over our sample period, a one-standard-deviation change in the state unemployment rate is 2.3 percentage points; in the quality spread, 0.45 percentage points; in employment growth, 2.4 percentage points; and in GDP growth, 3.8 percentage points.

29. Consider a similar thought experiment. Over 1977Q1-1989Q4, both the three-year average and one-year lagged core deposit ratios of money-center banks averaged about 0.25. Both of these ratios averaged 0.87 for the quarter of the banks in our sample with the highest ratios. The difference in the change in markup implied by a one-standard-deviation increase in our credit-risk measures between these two groups of banks are as follows: for the three-year average specifications, the difference is 23 basis points when the state unemployment rate is used to measure credit risk, 33 basis points when the quality spread is used, 35 basis points when $-1\times$employment growth is used, and 37 basis points when $-1\times$GDP growth is used. For the one-year lag specifications, these differences are 8 basis points when the state unemployment rate is used to measure credit risk, 9 basis points when the quality spread is used, 24 basis points when $-1\times$employment growth is used, and 37 basis points when $-1\times$GDP growth is used.

30. When we used a bank's average core deposit ratio over the entire period and also included the deviation of the bank's ratio in a period from this average, the cross-terms with credit risk of each of these measures was significant, indicating that each period's core deposit ratio provides information and not just the average. In all cases except when $-1\times$employment growth is used to measure credit risk, the signs on both cross-terms are significantly negative. When $-1\times$employment growth is used, the coefficient on the cross-term involving the average core deposit ratio is significantly negative; the coefficient on the cross-term involving the deviation is significantly positive, but it is smaller in absolute size.

31. It might be argued that this alternative definition of core deposits is less contaminated by changes in

regulation that occurred in October 1982 (e.g., the introduction of MMDA accounts).

32. We also reestimated our regressions including dummy variables for each quarter. Because quality spread, !1×GDP growth, and !1×employment growth vary only by quarter and not by bank or loan, we dropped these variables from the regressions. When credit risk was measured by the state unemployment rate, we included it in the regression. Our results were qualitatively similar in all regressions except those involving quality spread; when credit risk is measured by quality spread, the sign of the coefficient on the cross-term remains the same, but the coefficient is not significantly different from zero.

33. When the three-year average was used, the interaction term between core deposits and unemployment was negative in 25 of the 44 regressions, and in 20 of these significantly so at the 10 percent or better level. In 14 of the remaining 19 regressions, the coefficient was significantly positive at the 10 percent or better level. The specifications using the one-year lagged core deposit ratio and controls are neutral, showing an even split of 22 negative and 22 positive cross-terms, with 17 significant negative and 16 significant positive coefficients.

34. Although the results are not shown here, we also investigated whether banks more heavily financed with core deposits provide borrowers with better insurance against interest rate shocks, by estimating a regression that included an interaction term between core deposits and the money market rate, in place of the interaction term between core deposits and credit risk (we used the quality spread as our measure of credit risk and we included bank-specific dummy variables). In the three-year average specification, the derivative of the markup with respect to the money market rate is negative for all values of the core deposit ratio greater than 20%, and in the one-year lag specification, it is always negative. Since fewer than 5% of the observations in the panel have core deposit ratios less than 20%, this suggests that nearly all banks are smoothing interest rate shocks; moreover, the degree of smoothing is greater for banks with higher core deposits.

35. Although this interpretation is consistent with Kashyap and Stein’s model, their own work is concerned with the effects of monetary tightening rather than the effects of changes in aggregate credit risk.

36. We obtained qualitatively similar results when using the fraction of collateralized *above-prime* loans.

37. Using the bank-specific dummy variables with state unemployment raises the R-squared of the regressions, but the correlation between the dummy variables and state unemployment is high, confounding the interpretation of the cross-term of interest. Note, however, that whether the bank-specific dummies are included or not has no effect on the sign or significance of the cross-term.

38. It may be worth mentioning that we do not view our results as evidence against either Kashyap and Stein's view that smaller banks are more credit constrained than larger banks or Keeley's view that bank risk taking is inversely related to charter value.

39. We did omit some outliers and some observations with missing values, leaving a sample of 8,788 banks. We could estimate the equation using all these banks when we did not include bank-specific dummy variables; unfortunately, computer constraints precluded us from estimating with the full set of banks when we included bank-specific dummy variables, so in these cases we selected a random sample of 1,000 banks. Without year dummy variables we found no significantly negative coefficients on the cross-terms. With year dummies we found only four instances of significantly negative coefficients (at the 10% or better level): for either the three-year average specification or one-year lag specification, in the chargeoffs-2 regression when !1×GDP growth or !1×employment growth is used. Thus, results for the 1,000 bank subsample support our other results.

40. For empirical evidence on these trends see Boyd and Gertler (1994) and Houston and James (1996). Empirical work on the causes of disintermediation is sparse. It includes Becketti and Morris (1992) and Laderman (1993).

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Table 1. Variable Definitions

markup	loan rate minus rate on a Treasury security with the same duration as that of the loan, where duration is calculated as given below
core deposit ratio	bank's deposits with denominations less than $100,000 as a fraction of total liabilities
Credit-Risk Variables:	
quality spread	yield on Baa-rated long-term bonds minus yield on Aaa-rated long-term bonds (Moody's ratings)
state unemployment	unemployment rate in the state in which the bank is headquartered
GDP growth	growth rate of real GDP (1982 dollars) in the quarter (saar)
employment growth	growth rate of payroll employment in the quarter (saar)
Credit Risk × Core Deposit Ratio:	
core deposit ratio × quality spread	
core deposit ratio × state unemployment	
core deposit ratio × GDP growth	
core deposit ratio × employment growth	
Bank-Specific Control Variables	
chargeoffs-2	bank's net chargeoffs in the second year after loan is granted / total loans
chargeoffs-3	bank's net chargeoffs in the third year after loan is granted / total loans
loans/deposits	bank's total loans / total deposits
equity/assets	bank's total equity capital / total assets
total assets	bank's total assets in millions of 1982 dollars
Herfindahl	weighted-average of Herfindahl indexes in all deposit markets in which bank gets deposits, where weights are the fraction of deposits bank gets from the market

Table 1, continued

Contract Terms:

face value	face value of the loan in millions of 1982 dollars
duration	duration of the loan in years. Before 1982, the frequency of interest compounding was not included in the STBL data set, so for these loans, duration = maturity (if a maturity date was stated for the loan) and duration = 1/365 (if no maturity date was stated for the loan). (We also reran regressions calculating duration assuming frequency of interest compounding was monthly, using the maturity indicated if a maturity date was stated for the loan or maturity = 1/12 if no maturity date was stated for the loan. This alternative yielded similar results.)
collateralized	= 1 if the loan was collateralized and 0 otherwise
commitment	= 1 if the loan was made under a preexisting commitment and 0 otherwise
fixed base rate	= 1 if loan has a fixed base rate and 0 otherwise

Other Variables:

trend	linear time trend
money market rate	rate on a Treasury security with the same duration as that of the loan, where duration is calculated as given above
above prime	= 1 if loan rate is above or equal to the prime rate on the day loan was made and 0 otherwise
fraction collateralized-$	percent of a bank's loan volume in a quarter that is collateralized
fraction collateralized-#	percent of a bank's number of loans in a quarter that are collateralized
one-year-T-bill rate	quarterly average rate on one-year Treasury bills

Table 2. Difference in Means and Medians Tests between Above-Prime Loan and Below-Prime Loan Sample

		Above-Prime Loans	Below-Prime Loans
# of loans		627,499	83,982
markup	mean	4.13%*	1.58%*
	median	3.88%*	1.75%*
	standard deviation	1.87%	1.97%
duration	mean	0.4133 yrs.*	0.3969 yrs.*
	median	0.1945 yrs.*	0.0833 yrs.*
	standard deviation	0.7332 yrs.	1.068 yrs.
collateralized	mean	63.16%*	40.68%*
commitment	mean	59.36%*	56.75%*
face value[a]	mean	$259,800*	$3.294 mill.*
	median	$29,640*	$149,300*
	standard deviation	$1.922 mill.	$9.916 mill.
fixed base rate	mean	27.99%*	69.27%*
total assets[a]	mean	$22.74 bill.*	$28.16 bill.*
	median	$ 5.30 bill*	$ 6.35 bill.*
	standard deviation	$40.48 bill.	$41.62 bill.
equity/assets	mean	5.671%*	5.586%*
	median	5.618%*	5.453%*
	standard deviation	1.372%	1.379%
loans/deposits	mean	77.93%*	77.16%*
	median	77.22%*	75.72%*
	standard deviation	14.48%	14.80%
core deposit ratio	mean	56.50%*	49.26%*
	median	59.42%*	51.78%*
	standard deviation	18.58%	20.90%

***** Corresponding values for above-prime sample and below-prime sample are significantly different at the 1% or better level.

[a] In 1982 dollars.

Table 3. Regression Results for Above-Prime Loan Sample: Three-year Averages of Core Deposit Ratio and Controls[a]

Dependent Variable: markup

	(1) **quality spread**	**(2)** **!1×GDP growth**	**(3)** **!1×employment growth**	**(4)** **state unemployment**
No. of loans	627,499	627,499	627,499	531,536
Adjusted R^2	0.3266	0.3020	0.3799	0.1473
Credit-Risk Variables:				
quality spread	2.592*****			
	(177.9)			
!1×GDP growth		0.002580*****		
		(156.7)		
!1×employment growth			0.005464*****	
			(212.1)	
state unemployment				0.001368*****
				(33.97)
Core Deposit Ratio:				
core deposit ratio	0.002857*****	!0.04502*****	!0.02888*****	0.005633*****
	(5.395)	(!100.8)	(!66.26)	(11.22)
Credit Risk × Core Deposit Ratio:				
core deposit ratio × quality spread	!1.186*****			
	(!47.06)			
core deposit ratio × !1×GDP growth		!0.001575*****		
		(!54.30)		
core deposit ratio × !1×employment growth			!0.002426*****	
			(!53.93)	
core deposit ratio × state unemployment				!0.001665*****
				(!25.08)

Table 3, continued

	(1) quality spread	(2) −1×GDP growth	(3) −1×employment growth	(4) state unemployment
Contract Terms:				
duration	−0.006310* (−228.3)	−0.006293* (−223.6)	−0.005998* (−225.9)	−0.006558* (−198.6)
ln(face value)	−0.001555* (−120.9)	−0.001749* (−133.6)	−0.001707* (−138.4)	−0.001546* (−102.8)
collateralized	0.001978* (44.72)	0.001677* (37.27)	0.001901* (44.82)	0.001213* (23.10)
commitment	−0.002711 * (−55.66)	−0.003167* (−63.89)	−0.003001* (−64.22)	−0.001984* (−36.12)
fixed base rate	0.002173* (40.86)	0.001286* (23.78)	0.001600* (31.39)	0.001076* (17.30)
Bank-Specific Control Variables:				
loans/deposits	−0.02307* (−72.06)	−0.01756* (−54.02)	−0.01384* (−45.11)	−0.005970 * (27.11)
equity/assets	0.09884* (23.98)	−0.003076 (−0.733)	0.01720* (4.343)	−0.05521* (−19.61)
chargeoffs-2	0.01231* (4.335)	−0.04476* (−15.53)	−0.01023* (−3.762)	−0.01120* (−3.644)
chargeoffs-3	0.02725* (11.29)	0.07183* (29.26)	0.04669* (20.17)	0.06342* (24.87)
ln(total assets)	0.002666* (22.21)	−0.006126* (−51.61)	−0.002747* (−24.49)	−0.001050* (−40.76)
Herfindahl	1.007×10^{-6}* (9.742)	1.223×10^{-6}* (11.63)	2.808×10^{-9} (0.028)	1.166×10^{-6}* (33.89)
Other Control Variables:				
trend	0.000149* (65.52)	0.000203* (88.62)	0.000061615* (27.80)	−0.000214* (−67.65)
money market rate	−0.04272* (−51.08)	0.01623* (20.23)	−0.061198* (−76.53)	−0.009273* (−8.537)

[a]Bank-specific dummy variables are included in the quality spread, −1×GDP growth, and −1×employment growth regressions; an intercept is included in the state unemployment regression; these coefficients are not reported but are available from the authors. Regressions use the three-year averages of the core deposit ratio, *ln*(total assets), loans/deposits, and equity/assets.

*Significant at the 1% level. **Significant at the 5% level. t-statistics in parentheses.

Table 4. Regression Results for Above-Prime Loan Sample: One-Year Lagged Values of Core Deposit Ratio and Controls[a]

Dependent Variable: markup

	(1) quality spread	(2) !1×GDP growth	(3) !1×employment growth	(4) state unemployment
No. of loans	627,499	627,499	627,499	531,536
Adjusted R^2	0.3242	0.2963	0.3770	0.1444
Credit-Risk Variables:				
quality spread	2.277* (157.4)			
!1×GDP growth		0.002626* (159.7)		
!1×employment growth			0.005172* (201.9)	
state unemployment				0.000742* (19.32)
Core Deposit Ratio:				
core deposit ratio	0.02299* (48.71)	!0.03175* (!86.35)	!0.009817* (!27.15)	0.004367* (8.927)
Credit Risk × Core Deposit Ratio:				
core deposit ratio × quality spread	!0.3292* (!13.08)			
core deposit ratio × !1×GDP growth		!0.001543* (!53.96)		
core deposit ratio × !1×employment growth			!0.001652* (!36.86)	
core deposit ratio × state unemployment				!0.000606* (!9.418)

Table 4, continued

	(1) quality spread	(2) !1×GDP growth	(3) !1×employment growth	(4) state unemployment
Contract Terms:				
duration	!0.006378*	!0.006413*	!0.006060*	!0.006513*
	(!230.6)	(!227.2)	(!227.9)	(!196.7)
ln(face value)	!0.001542*	!0.001735*	!0.001701*	!0.001527*
	(!119.7)	(!132.0)	(!137.6)	(!101.5)
collateralized	0.001835*	0.001660*	0.001860*	0.001234*
	(41.44)	(36.73)	(43.75)	(23.46)
commitment	!0.002726*	!0.003054*	!0.002895*	!0.001938*
	(!55.85)	(!61.34)	(!61.80)	(!35.26)
fixed base rate	0.002068*	0.001207*	0.001595*	0.001046*
	(38.82)	(22.23)	(31.20)	(16.82)
Bank-Specific Control Variables:				
loans/deposits	!0.002532*	!0.008200*	!0.01169*	0.000465**
	(!9.727)	(!30.84)	(!46.68)	(2.231)
equity/assets	0.03435*	0.008579**	!0.02227*	!0.056442*
	(10.38)	(2.544)	(!7.007)	(!21.95)
chargeoffs-2	0.01653*	!0.050028*	!0.005245	!0.002709
	(5.798)	(!17.26)	(!1.921)	(!0.880)
chargeoffs-3	0.01280*	0.07421*	0.05237*	0.06043*
	(5.327)	(30.33)	(22.74)	(23.77)
ln(total assets)	0.006999*	!0.002807*	0.001007*	!0.000712*
	(63.23)	(!25.67)	(9.766)	(!28.85)
Herfindahl	$1.257\times10^{!6}$*	$9.789\times10^{!7}$*	$!2.02\times10^{!7}$**	$7.93\times10^{!7}$*
	(12.25)	(9.333)	(!2.050)	(23.00)
Other Control Variables:				
trend	0.000036733*	0.000119*	0.000009119*	!0.000259*
	(17.20)	(55.37)	(4.438)	(!84.09)
money market rate	!0.02671*	0.027571*	!0.053300*	!0.003319*
	(!32.65)	(34.89)	(!67.29)	(!3.049)

[a]Bank-specific dummy variables are included in the quality spread, !1×GDP growth, and !1×employment growth regressions; an intercept is included in the state unemployment regression; these coefficients are not reported but are available from the authors. Regressions use the one-year lagged values of the core deposit ratio, *ln*(total assets), loans/deposits, and equity/assets.

*****Significant at the 1% level. ******Significant at the 5% level. t-statistics in parentheses.

Table 5. Portfolio-Risk Regression Results for the Panel[a]

	(1) fraction collateralized-#	(2) fraction collateralized-$	(3) chargeoffs-2	(4) chargeoffs-3
3-year moving averages[b]				
core deposit ratio × quality spread	902.3*	518.4**	0.4240*	0.8503*
	(2.952)	(2.448)	(3.772)	(6.471)
Adjusted R^2	0.4813	0.5837	0.3222	0.3250
core deposit ratio × !1×GDP growth	!0.3027	!0.2831	!0.000284**	!0.000401*
	(!0.849)	(!1.145)	(!2.168)	(!2.604)
Adjusted R^2	0.4793	0.5817	0.3216	0.3185
core deposit ratio × !1×employment growth	0.6413	0.3068	!0.000538**	!0.000127
	(1.101)	(0.766)	(!2.536)	(0.508)
Adjusted R^2	0.4798	0.5826	0.3232	0.3174
core deposit ratio × state unemployment	3.920*	2.012*	0.001688*	0.002788*
	(4.744)	(2.988)	(5.509)	(7.675)
Adjusted R^2	0.2693	0.1621	0.1271	0.1065
1-year lagged values[c]				
core deposit ratio × quality spread	996.7*	524.5**	0.2257**	0.6344*
	(3.23)	(2.455)	(2.006)	(4.719)
Adjusted R^2	0.4810	0.5837	0.3324	0.3062
core deposit ratio × !1×GDP growth	!0.1739	!0.2048	!0.000363*	!0.000434*
	(!0.490)	(!0.834)	(!2.808)	(!2.806)
Adjusted R^2	0.4789	0.5823	0.3327	0.3029
core deposit ratio × !1×employment growth	0.8220	0.4301	!0.000871*	!0.000386
	(1.415)	(1.070)	(!4.130)	(!1.522)
Adjusted R^2	0.4794	0.5831	0.3363	0.3018
core deposit ratio × state unemployment	4.005*	1.639*	0.001711*	0.002592*
	(4.953)	(2.489)	(5.723)	(7.273)
Adjusted R^2	0.2658	0.1596	0.1278	0.0978

[a]Regressions also include trend, loans/deposits, equity/assets, *ln*(total assets), Herfindahl index, one-year Treasury bill rate, core deposit ratio; the quality spread, !1×GDP growth, and !1×employment growth regressions also include bank-specific dummy variables; the state unemployment regressions include an intercept; these coefficients are not reported but are available from the authors. Regressions involving quality spread, !1×GDP growth, and !1×employment growth are estimated using 6,414 observations; those involving state unemployment rate use 5,358 observations.

[b]Regressions use the three-year moving averages of the core deposit ratio, *ln*(total assets), loans/deposits, and equity/assets.

[c]Regressions use the one-year lagged values of the core deposit ratio, *ln*(total assets), loans/deposits, and equity/assets.

*Significant at the 1% level. **Significant at the 5% level. ***Significant at the 10% level. t-statistics in parentheses.