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The Underinvestment Problem and Patterns in Bank Lending

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Financial theory suggests that leverage causes firms to underinvest and that the extent of underinvestment is related to the degree of financial leverage. This prediction is consistent with both time series and cross-sectional patterns in bank lending. Bank capital typically declines in recessions due to loan losses, and this effectively increases financial leverage. As a result, system-wide underinvestment by banks is a contributing factor in ''credit crunches.'' In the cross section, banks with relatively poor loan quality, capital, and/or liquidity and weak banks with more opportunities subject to underinvestment should and do experience lower loan growth. Cross-sectional differences in the use of subordinated debt and in the extent of securitization provide additional evidence in support of the underinvestment hypothesis. *Journal of Economic Literature* Classification Numbers: E51, G21. © 1998 Academic Press

1. INTRODUCTION

The causes and consequences of credit crunches have long preoccupied economists. Stiglitz and Weiss (1981) propose that credit crunches arise due to credit rationing. Wojnilower (1980) suggests that credit crunches are caused by ceilings on deposit rates and other regulatory impediments.

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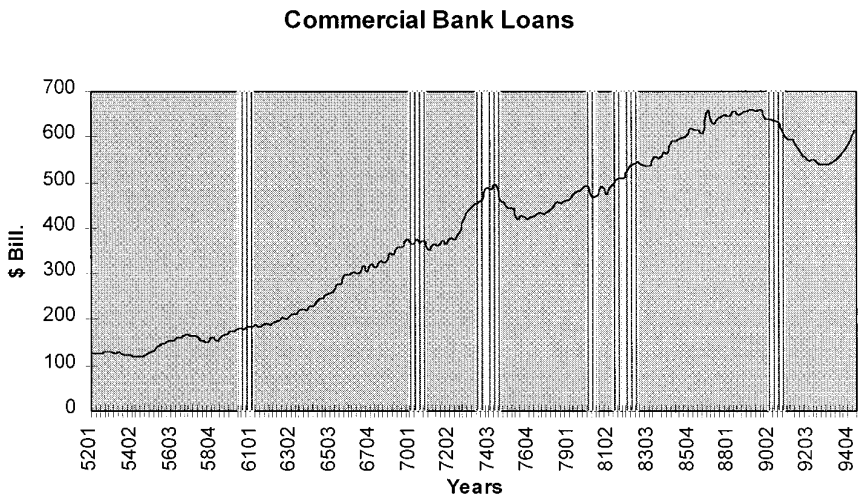

FIG. 1. The highlighted areas are NBER recessions. The bank loan data is from the Federal Reserve Board's flow of funds series. The GNP deflator was obtained from Citibase.

Blum and Hellwig (1995) propose that capital adequacy requirements for banks may contract bank loan supply. In addition, Wagster (1998) reviews a number of hypotheses regarding the most recent credit crunch of 1989–1992 in the United States. The basic insight of this literature is that the credit rationing that causes a credit crunch is a response to unresolved informational frictions and possibly changes in regulatory restrictions. However, credit contractions appear to be a strongly cyclical phenomenon. An important stylized fact of postwar U.S. economic history is the strong procyclical pattern of bank lending. Figures 1–3 indicate that bank loan activity generally declines in recessions and rises rapidly in expansions.[1] In fact, we only talk about contractions in the supply of bank loans or "credit crunches" during economic contractions. This procyclicality aspect of credit crunches deserves a better explanation than available in the existing literature.

Credit rationing by banks that arises from unresolved informational problems is particularly problematic because the core economic function of banks is now viewed as facilitating real investment by resolving problems

[1] Kashyap *et al.* (1993) use the ratio of bank loans to short-term external finance to examine the lending channel of monetary policy transmission and I use it to note a relationship between economic contractions and credit crunches. If the decrease in bank lending during recessions was demand induced then we would expect to see a decline in the demand for non-bank sources of credit (i.e., commercial paper) as well.

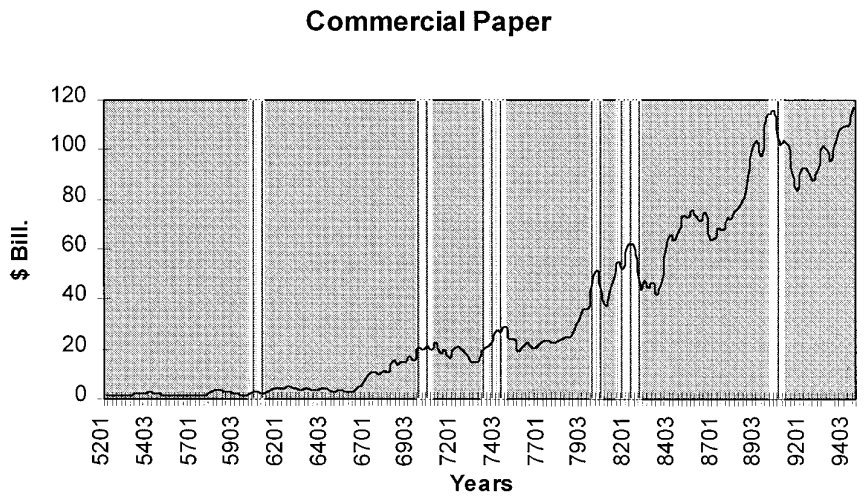

FIG. 2. The highlighted areas are NBER recessions. The commercial paper data is from the Federal Reserve Board's flow of funds series. The GNP deflator was obtained from Citibase.

arising from information asymmetry (Leland and Pyle, 1977; Campbell, 1979; Diamond, 1984; Fama, 1985; Seward, 1990; Allen, 1990; Bhattacharya and Thakor, 1993). If loans to borrowers with positive net present value projects are rejected by banks, it is unlikely that those less equipped to resolve informational frictions will make these loans; valuable productive

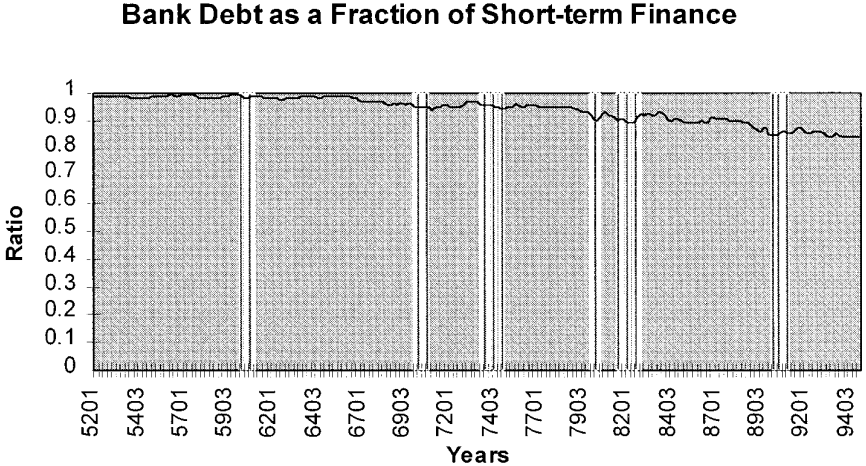

FIG. 3. The highlighted areas are NBER recessions. Short-term finance is the sum of bank loans and non-bank commercial paper.

investment may thus be forgone. Even if a borrower finds other financing, significant deadweight costs are likely to be associated with the denial of bank credit. In fact, several studies suggest that bank financing may reduce the cost and increase the availability of other types of financing (James, 1987; Lummer and McConnell, 1989; Hoshi *et al.*, 1990; Best and Zhang, 1993; Petersen and Rajan, 1994). It is important for academics and policymakers to understand the link between bank lending incentives and economic conditions because of the likely connection between contractions in bank lending and macroeconomic performance. Observers have argued that contraction in bank lending played an important role in the 1990–1991 recession in the United States and the 1991–1996 recession in Japan. Moreover, there is increasing concern that weak banking systems in both industrialized and emerging economies will hinder future economic growth.[2]

My goal in this paper is to address the following policy-relevant questions that are raised by the preceding discussion:

- Why is bank lending behavior—including credit rationing—procyclical and could it arise from factors other than the usual informational frictions, such as the distorted lending incentives of banks caused by their highly leveraged capital structures?
- Are there mechanisms that can diminish distortions in bank lending behavior and hence reduce rationing? In particular, what is the role of asset securitization?
- What is the impact of capital requirements on bank lending incentives?

I address the first question by developing a model in which one does not need regulatory rigidities, asymmetric credit information, or borrower-related moral hazard to explain procyclical lending. The basic idea I put forth is that the highly leveraged capital structures of banks create distorted investment incentives—as they would for any highly leveraged firm—and cause credit availability to be positively related to economic conditions, leading to credit crunches during economic contractions.

In my model, each loan opportunity is evaluated incrementally by the bank. The bank manager decides whether or not to invest based on bank shareholders' expected gross return from the loan. Suboptimal investment decisions result from potential wealth transfers between bank shareholders

[2] For an example of industry concerns see *The Economist* 10/26/1991. Also, in 1991 and 1993 Presidents Bush and then Clinton signed banking legislation designed to encourage bank lending and relieve the "credit crunch." Also, there appears to be some belief that weak banks in both Mexico and Japan are responsible for recent credit crunches in their respective countries. A January 25, 1996 *Wall Street Journal* article reported, "Credit Crunch: The Banking Disaster in Mexico Whipsaws an Ailing Economy." On April 22, 1996 Barron's reported that "a credit crunch in Japan is putting a damper on growth in major industrialized countries."

and existing depositors and are consistent with Merton (1977) and John *et al.* (1991), who find that deposit overhang provides incentives for suboptimal risk-taking by banks. The bank manager, acting on behalf of shareholders, will tend to accept some negative net present value loans and reject some positive net present value loans.[3] If the bank manager rejects a loan opportunity with positive total NPV to the bank, I call it underinvestment (Benveniste and Berger, 1987; James, 1988, 1989). Bank underinvestment is important because, while bank regulators may exert some control of overinvestment (acceptance of loans with negative net present value) by monitoring bank portfolios *ex post* and placing restrictions on ''risky'' lending activities, they cannot force banks to make good loans because they do not observe loan opportunities.

In this framework, credit crunches occur because the incidence of underinvestment [see Myers (1977)] by banks increases during contractions and decreases during expansions. I find that underinvestment may occur at critical times and in critical ways—ways that are consistent with the stylized facts. Specifically, during periods or in regions where bank lending opportunities have been less profitable and/or riskier than the norm, underinvestment incentives will be higher because many banks will have a greater probability of failure due to an increase in expected losses on existing loans. That is, the debt overhang problem is more severe. I find empirical support for many of the model's predictions.

The model's implications are also consistent with Keeley (1990) in that banks with high charter values will have less perverse investment incentives. Bank lending will be more procyclical (i.e., the underinvestment problem is more severe) when banks have low charter value. For example, lending should be more procyclical today than it was in the 1960s and 1970s because bank charter values have deteriorated as a result of deregulation and competition. The decrease in charter values could explain why the contraction in bank lending during the last recession was more prolonged than in prior recessions. Cross-sectionally, banks with high charter value will underinvest less. I provide empirical evidence consistent with this hypothesis.

To address the second question, I focus on asset securitization, or the linkage of cash flows for new loans with new financing. This is the only financial arrangement that effectively alleviates both the underinvestment and overinvestment problems (Stulz and Johnson, 1985; James, 1989; Berkovitch and Kim, 1990). Securitization is most effective in restoring the

[3] Ferguson and Peters (1996) find equilibrium credit rationing in a model with symmetric information and no exogenous constraint on the supply of loanable funds. Credit rationing may appear to be underinvestment and it will occur if the loan is marginally profitable but has portfolio costs (i.e., it increases the variability of earnings or increases the amount of capital the bank must hold). In my model, with debt overhang a profitable loan that actually reduces the variability of earnings might be rejected.

correct lending incentives because it minimizes potential wealth transfers between shareholders and existing depositors [see Berger and Udell (1993) for a review of the empirical evidence]. Therefore, procyclicality and cross-sectional differences in lending activity should become less severe as markets for securitized loans develop. For example, my empirical results suggest that residential mortgage lending is less procyclical than commercial mortgage lending. I also find that banks securitized relatively more of their assets between 1985 and 1992 if they had weak capital or liquidity or poor loan quality (proxies for the severity of the debt overhang problem).

As for the third question, capital requirements and subordinated debt both reduce incentives to overinvest in my model but increase incentives to underinvest and thus may reduce credit availability. This occurs as bank shareholders receive relatively less value from low risk, positive net present value loans when these loans must be partially financed with capital. This result is consistent with existing evidence.[4,5] However, my model suggests that a reduction in bank loan supply may occur during recessions *even in the absence of binding capital requirements* because the average quality of existing loans deteriorates during recessions and this makes underinvestment by banks more common. Berger and Udell (1994) indeed find that bank credit reallocation during the credit crunch of 1990–1992 was related to problem loans and only weakly related to bank capital. They also find that bank lending was related to bank health between 1979 and 1992 and not just during the credit crunch of 1990–1992.[6] Consistent with the underinvestment hypothesis, their evidence suggests that system-wide changes in bank health during the recession contributed to the credit crunch and that weak banks had lower loan growth. Further, consistent with the idea that subordinated debt exacerbates bank underinvestment, I find that weak banks with higher costs of underinvestment (as measured by market-to-book) use less subordinated debt.

[4] Several authors assert that part of the decline in lending during the recession of 1990–1991 may have resulted from a credit crunch caused by higher capital standards imposed under the Basle Accord of 1988 (Bernanke and Lown, 1991; Baer and McElravey, 1992; Hancock and Wilcox, 1994; Shrieves and Dahl, 1995; and Thakor, 1996). Berger and Udell (1994) fail to find a link between risk-based capital and only weak evidence linking leverage requirements to reductions in bank lending during this period.

[5] The Basle Accord imposed risk-based capital requirements on banks in 12 industrialized countries. Commercial loans were assigned the highest risk rating and banks were forced to assign 8% capital to this activity while risk ratings and thus capital requirements were lower for residential lending and government securities holdings. For an outline of these requirements, see Avery and Berger (1991).

[6] This cross-sectional prediction differs from the asymmetric information hypothesis regarding credit crunches unless information asymmetry problems are more severe for weak banks during contractions than they are for healthy banks.

The existing theories of bank lending cycles are also consistent with the broad stylized facts. However, the underinvestment hypothesis provides distinct cross-sectional implications. In the cross-section, banks with less profitable loan portfolios are more likely to underinvest in new low-risk profitable opportunities that arise. Banks that underinvest have a higher probability of failure and therefore expect existing depositors to capture more of the gains from any new valuable loans that are made. Further, underinvestment may significantly impact credit availability in markets dominated by ''risky'' banks. To the extent that bank profitability and risk are a function of loan opportunities in the market in which the bank competes, we may observe cross-sectional differences in lending across regions or communities.[7]

In the next section I review competing theories of credit crunches. In Section 3, I develop a model of bank lending incentives. Section 4 contains an extension of the model to analyze the effect of capital requirements and subordinated debt on bank lending incentives. Section 5 provides evidence in support of the model. Section 6 contains policy implications. Section 7 concludes.

2. THEORIES OF CREDIT CRUNCHES

Here I describe existing theories regarding credit crunches. In each of these a credit crunch is defined as a reduction in the available supply of credit.[8] While the outcome is the same under each interpretation—the supply of loans declines—the cause differs. Stiglitz and Weiss (1981) propose that excess demand for loans may persist due to asymmetric information between borrowers and lenders that leads to equilibrium credit rationing. This asymmetry may become more costly during economic downturns and makes it very difficult (costly) for lenders to distinguish borrower quality. Due to adverse selection and moral hazard problems, lenders reduce the supply of loans rather than raise the interest rate to clear the market. If the rate were raised, only borrowers with poor prospects or those who did not intend to repay would be willing to borrow and the expected return to lending would decrease.

[7] Total lending will be relatively low to the extent that regulators are more effective in controlling a bank's tendency to overinvest or make negative NPV, high risk loans. At any rate, lending and risk-taking will be suboptimal and some good loans will be rejected.

[8] For example, Peek and Rosengren (1995b) refer to a credit crunch as a situation where ''loan supply has fallen faster than loan demand.'' Bernanke and Lown (1991) describe it as ''a significant leftward shift in the supply curve for bank loans, holding constant the safe real interest rate and borrower quality.'' Wojnilower (1980) defines it as a significant interruption in the supply of credit.

Another rationale for credit crunches is disintermediation. Wojnilower (1980) suggests that credit crunches between 1950 and 1979 were caused by ceilings on deposit rates or other regulatory impediments that prevented banks from meeting loan demand. For example, until the early 1980s banks were subject to ceilings on deposit rates. If a period of monetary restraint leads to a sharp increase in interest rates and market rates rose above these ceilings, depositors would withdraw their funds from the banking system and place them in assets that were paying market interest rates (e.g., treasuries and, later, money market mutual funds). This loss of deposits would then cause banks to cut back new loan volume.

Additional rationales for credit crunches were advanced after the recession of 1990–1991 when a severe credit crunch seemed to occur. Economists developed hypotheses that could explain the events of that time. These hypotheses are outlined in Wagster (1998). They are classified as the capital crunch hypothesis, the risk-based capital hypothesis, the voluntary risk-retrenchment hypothesis, and the loan examination hypothesis. Blum and Hellwig (1995) proposed that capital adequacy requirements for banks lead to contractions in loan supply. In their model, an economic shock increases borrower defaults and this causes a decrease in bank capital. If the level of capital begins to fall below the required minimum, banks cut back lending activity. Syron (1991) and Peek and Rosengren (1995b) describe a ''capital crunch'' where a decline in capital and binding capital requirements cause banks to shrink. A credit crunch is a possible result of a capital crunch. The risk-based capital hypothesis maintains that the recession of 1990–1991 coincided with the implementation of risk-based capital standards. These standards raised capital requirements for commercial loans and may have encouraged banks to reallocate their assets from loans to government securities that were subject to much lower requirements. The voluntary risk reduction hypothesis suggests that bank managers may have voluntarily reallocated bank assets during this period in order to reduce overall risk. The higher regulatory scrutiny hypothesis proposes that commercial lending declined due to increased scrutiny of bank loan portfolios and lending standards by regulators who were concerned about bank risk.[9] Finally, Thakor (1996) suggests that risk-based capital requirements that are solely linked to credit risk can exacerbate credit rationing and reduce aggregate lending. He shows that with risk-based capital requirements, an increase in the money supply will reduce aggregate lending if short-term interest rates decrease more than long-term rates.

[9] Although the empirical evidence is mixed, Bernanke and Lown (1991), Peek and Rosengren (1995b), and Brinkmann and Horvitz (1995) find evidence consistent with a capital crunch in that banks with lower capital experienced lower loan growth. Berger and Udell (1994) find some evidence consistent with voluntary risk-retrenchment, no link between risk-based capital and bank lending, and only a weak leak between bank leverage and lending.

With the exception of the voluntary risk-reduction hypothesis, existing theories of credit crunches rely on asymmetric information, capital adequacy requirements or regulatory rigidities to explain periods of contraction in bank loan supply. In my model, the highly leveraged capital structure of banks and the susceptibility of the value of that capital to changes in economic conditions cause credit availability to be positively related to economic conditions. A contraction in credit does not necessarily imply a reduction in bank risk-taking. Credit crunches occur during contractions because the debt overhang problem becomes more severe and banks underinvest more. My model suggests that the severity of the 1990–1991 recession was due to the very weak financial condition of the industry compared to that in previous downturns. This weakness may have resulted from increased competition, deterioration in the value of bank charters and the high leverage in the non-financial corporate sector during the 1980s. Thus, although my explanation is not inconsistent with earlier research, it sheds different light on the events.

3. MODEL OF BANK INVESTMENT INCENTIVES

In this model, entrepreneurs have value-increasing projects that require outside financing. Banks evaluate these lending opportunities incrementally. Lending decisions are based not on total return but on the portion of the return that is captured by bank shareholders. These quantities are not equivalent because there is a positive probability that the bank will share the returns or losses from the new loan with fixed claimants (depositors). The bank manager will forgo some value-increasing loans and accept some value-decreasing loans. The participants in the model are: (1) an entrepreneur/borrower who has a new project that requires outside financing; (2) a banker who decides whether or not to incur contracting costs and provide financing for the entrepreneur's project; and (3) bank lenders who observe the bank's lending decisions and existing assets.

Consider a model with two periods and two possible states, L and H. Assume that the participants are risk neutral and the riskless rate of return is zero. At $t = 0$, the bank invests in an asset, A. Asset A generates gross return A_i in state i, with $A_L < A_H$. The gross returns include all income associated with the investment such as return of principal, interest, fees and other contracted payments. States L and H occur with probability π and $1 - \pi$, respectively. I assume that π depends on economic conditions. Banks operating in markets or during times where lending opportunities have been of above-average quality realize the state H cash flows more often (i.e., A_H) than do banks operating in markets or during times where loan opportunities have been below average in quality. In other words, π

TABLE I
Entrepreneur's State Contingent Outcomes

Probability	Gross returns, new investment
π	$Y(j)$
$1 - \pi$	$Y(j) + s(j)$
NPV of new project = $\pi Y(j) + (1 - \pi)[Y(j) + s(j)] - I(j)$	

is lower (higher) in markets where loan opportunities have been above (below) average.

At $t = 1$, everyone knows the parameters of A. In addition, the entrepreneur receives an investment opportunity, j. Project j requires an investment of $I(j)$. It generates gross returns $Y(j)$ in state L and $Y(j) + s(j)$ in state H. For exposition, I assume that $Y(j) \geq 0$, $s(j)$ may be positive or negative, and $Y(j) + s(j) \geq 0$.[10] The entrepreneur has no existing assets or outstanding debt.[11] The entrepreneur decides whether to invest and apply for bank financing based on the project's net present value. The net present value is equal to $Y(j) + (1 - \pi)s(j) - I(j)$ and the entrepreneur bears a cost, $c_i(j)$, of contracting with bank i. If the project is valuable (i.e., NPV $> c$), the entrepreneur will apply for bank financing.

At $t = 2$, the state is realized and the bank's existing asset, A, and the entrepreneur's project, j, pay off. See Tables I and II for the entrepreneur and bank payoffs, respectively.[12] The realizations are publicly observable.

TABLE II
Bank's State-Contingent Outcomes

Probability	Gross returns, existing assets	Gross returns, new loan
π	A_L	$\min\{R(j), Y(j)\}$
$1 - \pi$	A_H	$\min\{R(j), Y(j) + s(j)\}$

Note. $R(j)$ is the face value of the loan based on $Y(j)$ and $s(j)$.

[10] My results hold under less restrictive assumptions regarding the payoffs (e.g., $Y(j) < 0$). In addition, though I have chosen not to consider the possibility of asymmetric information my results are robust to such considerations. The bank over- and underinvests in loans based on the distribution of expected returns in the two states.

[11] This assumption is made because the primary concerns of this paper are banks' investment incentives, who bears the cost of these incentives and how financing affects these incentives. If the borrower has debt outstanding, investment is distorted more severely because of the additional perverse incentives.

[12] The model is similar to Berkovitch and Kim's (1990) framework for examining leverage induced over- and underinvestment incentives for nonfinancial corporations.

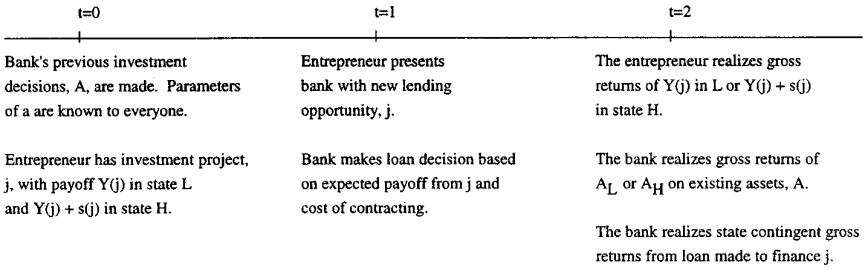

FIG. 4. Time line of events.

The entrepreneur may default on the loan in one state. Later I show that both the expected level of the default payment and the state in which loan default occurs are important factors in the bank's loan decision. The information structure and sequence of events described above are outlined in Fig. 4.

The bank decides whether to finance project j based on the project's expected payoffs and the bank's contracting cost. The bank's total investment in the project, $I'(j)$, consists of the loan, $I(j)$, and the contracting cost, $c(j)$. The loan should be made if there is a feasible loan face value, $R(j)$, such that the net present value of the loan, $\delta(j)$, is non-negative. In perfectly competitive loan markets, the bank will set the face value of the loan, R, such that the following equation is satisfied:

$$\delta_i = \pi[\min(R(j), Y(j))] + (1 - \pi)[\min(R(j), Y(j) + s(j))] - I' = 0. \quad (1)$$

Equation (1) is the net present value of a new loan. In (1) the payment received by the bank in either state L or H is the lower of the face value of the loan, R, or the gross return from the entrepreneur's project. The net present value is then the expected payment on the loan less the bank's total investment. The face value that solves (1), R_o, will depend on which of the following default scenarios holds for this loan:

(d1) $Y(j) < I'(j) < R_o(j) \leq Y(j) + s(j)$;
(d2) $Y(j) + s(j) < I'(j) < R_o(j) \leq Y(j)$.

There are additional default scenarios. I focus on the most interesting cases, where default is possible but not certain. For a project to satisfy condition (d1) ((d2)), $s(j)$ must be positive (negative). Therefore, projects that satisfy condition (d1) are positively correlated with the bank's existing assets and those that satisfy (d2) are negatively correlated with existing assets. I will identify their types as Y_p and Y_n for positive and negative correlation, respectively.

I use Eq. (1) to find $R(j)$, the face value of a loan for project j that yields net present value $\delta_i(j)$. $R_p(j)$ and $R_n(j)$ are the solutions for loans with positive and negative correlation with existing assets, respectively:

$$R_p(j) = [\delta(j) - \pi Y_p(j) + I'(j)]/(1 - \pi) \tag{2.1}$$

$$R_n(j) = [\delta(j) - (1 - \pi)(Y_n(j) + s(j)) + I'(j)]/\pi. \tag{2.2}$$

Setting $\delta(j)$ equal to zero, I find $R_o(j)$, the face value of a loan that provides zero net present value to the bank for each loan type:

$$R_{op}(j) = [I'(j) - \pi Y_p(j)]/(1 - \pi) \tag{3.1}$$

$$R_{on}(j) = [I'(j) - (1 - \pi)(Y_n(j) + s_n(j))]/\pi. \tag{3.2}$$

Using the solution for $R_{op}(j)$ in Eq. (3.1) and the inequalities from default condition (d1), I find that under the net present value rule all loans with positive correlation where $0 < Y_p(j) + (1 - \pi)s_p(j) - [I(j) + c_i(j)]$ should be accepted. In other words, the bank should make only those loans where the project's present value, $Y_p(j) + (1 - \pi)s_p(j)$, exceeds the bank's required investment, $I'(j)$. However, these loans will be risky since $Y_p(j) < I'(j)$. A similar analysis holds for projects with negative correlation. Using the solution for $R_{on}(j)$ in Eq. (3.2) and the inequalities from default condition (d2), all loans where the project's present value exceeds the required investment, $I'(j)$, should be granted. These loans are also risky because $Y_n(j) + s_n(j) < I'(j)$.

To examine the bank's actual investment decision, I assume that the market observes the bank's contracting cost, the amount of its investment, and the future gross returns from that investment. The bank's existing assets are financed with deposits with a face value, F_0, that mature after $t = 1$ and some amount of equity. Other costs associated with raising deposits are ignored. I also assume that there is a positive probability that the bank will be insolvent at $t = 2$ and there is a positive probability that shareholders will receive some return at $t = 2$. These two assumptions, which are described by the following inequalities, imply that the depositors' expected loss and the value of equity are positive:

$$0 < A_L < F_0 < A_H. \tag{A1}$$

If the investment is rejected, the market value of equity is

$$E_x = (1 - \pi)(A_H - F_0). \tag{4}$$

The payoff to equityholders includes the value of the put option provided by existing depositors. Specifically, if the bank is insolvent at $t = 2$, the depositors receive the assets, A_L.

Next I calculate the value of each claim if the new investment is undertaken. The initial assumption is that the bank's required investment, $I'(j)$, is financed entirely with insured deposits with a face value of F_1. Since the deposits are insured, the face value will equal the market value, D_1:

$$I'(j) = D_1 = F_1. \tag{5}$$

Finally, I assume that if a loan of type (d1) is made, there is still a positive probability the bank will be insolvent at $t = 2$. In this case, insolvency occurs in state L and the market value of the bank's existing equity is positive. If a loan of type (d2) is made, I assume that the bank is solvent at $t = 2$. These assumptions are captured by the following inequalities:

$$A_L + Y(j) < F_0 + F_1 < A_H + Y(j) + s(j) \tag{A2.a}$$

$$F_0 + F_1 < A_L + Y(j) < A_H + Y(j) + s(j). \tag{A2.b}$$

The value of the bank's equity for type (d1) and (d2) loans, respectively, is

$$E_{1p} = E_x + \delta_i(j) + \pi\{I'(j) - Y_p(j)\} \tag{6.1}$$

$$E_{1n} = E_x + \delta_i(j) + \pi\{A_L - F_0\}. \tag{6.2}$$

In Eqs. (6.1) and (6.2), $\delta_i(j)$ is the net present value of the new investment for bank i. If bank managers maximize net present value they invest when $\delta_i(j) \geq 0$. However, managers maximize shareholder value. Therefore, they compare the value of equity if the new investment is made with that if the investment is rejected. The net present value and shareholder maximization rules do not lead to equivalent investment decisions. As in John *et al.* (1991), this occurs due to the limited liability of equity. With shareholder maximization, if the project is positively correlated with the bank's existing assets, (6.1) applies and managers will invest whenever $\delta_i(j) + \pi\{I'(j) - Y_p(j)\} \geq 0$. If the project is negatively correlated with the bank's existing assets, (6.2) applies and managers will invest only when $\delta_i(j) + \pi\{A_L - F_0\} \geq 0$. The third terms in Eqs. (6.1) and (6.2) represent wealth transfers to or from existing depositors.[13] The wealth transfer in (6.1) is positive and loans with negative value will be made when the wealth transfer from existing depositors to equity exceeds the loss from the loan. The wealth

[13] If all deposits could be fairly priced, the premium for type (d1) loans ρ_1 would equal $\pi[F_1 + F_0 - A_L - Y(j)]/(F_1 + F_0)$ and E_1 would equal $E_x + \delta_i(j)$.

transfer in Eq. (6.2) is negative and some loans with non-negative value are rejected because the wealth transfer to existing depositors exceeds the loan's value. Thus, banks overinvest (underinvest) in loans that are positively (negatively) correlated with existing assets.

The degrees of the investment distortion will differ across banks depending on lending opportunities, as well as the probability, π, that state L is realized. Recall that π is assumed to depend on economic conditions and is larger in markets or during times when the economy is relatively weak. The higher the probability of failure the larger the wealth transfer to or from existing depositors and therefore, the larger the investment distortion. In addition, the severity of the underinvestment problem will depend on the profitability of loan opportunities. Banks that operate in markets with relatively profitable opportunities are less likely to underinvest.

PROPOSITION 1A. *The degree of investment distortion depends on the probability of insolvency. The higher the probability of insolvency, the greater the distortion.*

PROPOSITION 1B. *The degree of investment distortion decreases with the profitability of loan opportunities.*

Proof. See the Appendix.

These perverse incentives could be reduced if banks could offer a debt contract where new debtholders were not entitled to cash flows from existing assets but were entitled to all cash flows from the new loan. This could be achieved by establishing separately funded subsidiaries, issuance of secured debt, or asset securitization. There is no overinvestment or underinvestment (a formal derivation of the decision rule is in the Appendix). Risky banks are more likely to use asset securitization or secured debt because it allows them to obtain financing that is based on the cash flows of a value increasing, diversifying new loan rather than their existing assets.

This result is consistent with the avoidance of underinvestment rationale for securitization with recourse outlined in Benveniste and Berger (1987) and loan sales and off-balance sheet activities provided in James (1988, 1989). More generally, it is consistent with Stulz and Johnson (1985) where profitable projects that are not undertaken when only equity and unsecured financing is available may be undertaken when the firm can issue secured debt. I also find this type of financing reduces the overinvestment problem. The use of secured debt or securitization should vary across time and cross-sectionally. Banks operating in markets or times where loan quality has been below average (i.e., π is relatively high) should securitize relatively more loans. Because bank underinvestment is directly related to the proba-

bility of insolvency (π) for loans financed with insured deposits, the benefit of securitizing loans to avoid underinvestment also increases with π.

PROPOSITION 2A. *Investment distortions are more severe when bank loans are financed with deposits than when they are financed with secured debt. The reduction in investment distortion arising from the use of secured debt increases as the probability of insolvency increases (or as economic conditions worsen).*

PROPOSITION 2B. *For loans that are easily securitized, loan volume will be less sensitive to changes in the probability of insolvency (or economic conditions).*

Proof. See the Appendix.

4. ALTERNATIVE FINANCING CONTRACTS AND DIFFERENTIAL INVESTMENT

In this section, I examine how subordinated debt and capital requirements affect banks' lending incentives.

A. *Subordinated Debt*

White (1991) and Kaufman and Benston (1993) suggest that subordinated debt can curb excessive risk-taking by insured banks because these debtholders will discipline bank managers. Empirically, Avery *et al.* (1988) and Gorton and Santomero (1990) found no relationship between risk premia on subordinated bank debt and measures of default risk. However, Flannery and Sorescu (1996) do find evidence of a link in the post-"too big to fail" era. In this model I find subordinated debt reduces overinvestment. However, it may increase underinvestment and therefore may not alleviate differential investment arising from cross-sectional and time series differences in current loan quality. These incentives will be most distorted for banks with high probabilities of insolvency (i.e., banks in weak markets). Intuitively, subordinated debtholders demand a premium for bearing default risk while insured depositors do not. Thus, managers of banks operating in weak markets or times will face high premia and will invest less. The major implications regarding subordinated debt are: (1) banks in general prefer insured deposits over subordinated debt because subordinated debt is more expensive and reduces incentives to invest; (2) banks operating in weak markets or times are less likely to choose subordinated debt over deposits; (3) subordinated debt increases the incidence of underinvestment; and (4) a bank's willingness to use subordinated debt will depend on the value of its loan opportunities.

PROPOSITION 3. *The willingness of a bank to use subordinated debt depends on the profitability of its loan opportunities. The willingness to use subordinated debt first decreases and then increases with the profitability of loan opportunities.*

Proof. See the Appendix.

B. *Capital Requirements*

Requiring minimum capital ratios is seen as another means of alleviating overinvestment incentives. Bank capital requirements protect the deposit insurer in two ways. First, the higher the capital requirement, the larger the expected losses that must be absorbed by the equityholders and the lower the insurer's expected losses. Second, because shareholders must absorb more losses, they will have greater incentives to prevent losses. When banks are required to finance a portion of new investment with equity, overinvestment is lower versus the case where new loans are financed entirely with insured deposits. However, underinvestment may increase. Therefore, raising capital requirements may not be an effective tool for reducing investment differentials between high and low quality banks across time or across banks.

PROPOSITION 4A. *Overinvestment (underinvestment) is indirectly (directly) related to the required equity ratio.*

PROPOSITION 4B. *Raising capital requirements leads to greater reductions (increases) in overinvestment (underinvestment) the higher the probability of insolvency or the weaker economic conditions.*

Proof. See the Appendix.

5. NEW AND EXISTING EMPIRICAL EVIDENCE

In this section I discuss evidence that is consistent with the empirical implications of Propositions 1–3 of my model. I provide new evidence if the existing evidence is ambiguous or the prediction has not been tested. Proposition 1 says that differences in the probability of insolvency (bank health) and the profitability of loan opportunities cause differences in the degree of investment distortion. Propositions 2 and 3 assert that the use of asset securitization and subordinated debt, respectively, will depend, in part, on the probability of insolvency and the relative profitability of loan opportunities. In empirical tests, balance sheet proxies for the probability of insolvency and the profitability of loan opportunities are considered. I use loan quality, liquidity, and capital ratios as measures of insolvency

probability and the market-to-book ratio to capture differences in the profitability of loan opportunities.[14]

A. *Bank Loan Growth, Bank Health, and Growth Opportunities: Evidence on Proposition 1*

Deteriorating economic conditions are associated with decreases in the value of the bank's existing assets as well as new opportunities and therefore cause a decline in bank health (or increase insolvency risk). Proposition 1a suggests that both over- and underinvestment increase as bank health deteriorates but I propose that overinvestment is more easily monitored by regulators because they can observe portfolio quality but not loan opportunities. As a result, bank lending declines when economic conditions worsen. A number of studies support this proposition. Lown and Peristiani (1996) find that large, undercapitalized banks and banks with poor asset quality contributed to the 1990 credit slowdown by charging higher than average rates on automobile and personal loans. Peek and Rosengren (1997) find that shocks to the capital of Japanese banks led to a decline in credit growth of their bank subsidiaries in the U.S. It is difficult to argue that this decline in loan growth was demand induced since the shock resulted from the stock market crash in Japan. This is consistent with an increase in the probability of failure leading to increased underinvestment. Similarly, Houston *et al.* (1997) find that loan growth at subsidiary banks is sensitive to the holding company's cash flow and capital position and Peek and Rosengren (1995b) find that bank capital affected bank lending during the recession of 1990–1991.

Berger and Udell (1994) examine the relationship between bank health and bank portfolio behavior between 1979 and 1992. Using quarterly data for all U.S. commercial banks, they find that weak banks (as measured by several risk variables) tended to have lower commercial loan growth between 1979 and 1992. This is consistent with my model since it predicts that weak banks will have lower commercial loan growth because their debt overhang problem is more severe and they underinvest more. The authors conclude that their evidence does not support credit crunch hypotheses because there was no difference in bank reaction to risk variables in the ''crunch'' vs ''noncrunch'' periods. However, in my model a credit crunch can occur during a recession even without a difference in bank reaction to risk variables because during recessions the weakened condition of banks alone will cause an increase in underinvestment and reduction in

[14] The model assumes that the probability of insolvency is determined by exogenous changes in economic conditions. This probability (and balance sheet proxies for it) can also be influenced by bank decisions. At any rate, the implications for cross-sectional variation in lending incentives are the same.

lending. Consistent with this interpretation, I find banks were weaker on average during the so-called crunch period (1989–1992). For a sample of 380 large banks the mean ratio of bad loans-to-assets was 1.44% during the crunch period (1989–1992), which is economically and statistically higher than the mean of 0.01% during a noncrunch period (1985–1988).

According to Proposition 1b, banks with good growth opportunities will have less perverse investment incentives. Therefore, these banks should underinvest less and have higher than average loan growth. I examine a sample of publicly traded bank holding companies between 1985 and 1995 with $1 billion or more in assets. The balance sheet data comes from bank holding company Y-9s and the market value data is from CRSP. Following Smith and Watts (1992), Gaver and Gaver (1993), and Barclay and Smith (1995), I use the market-to-book ratio as a proxy for growth options in a firm's investment opportunity set because the balance sheet does not include the value of these growth opportunities. The higher the growth opportunities, the higher the market-to-book ratio and the greater the possible losses from underinvestment. Table III contains results consistent with the hypothesis that banks with good growth opportunities underinvest less.

Since bank holding companies may have nonbank assets, I use growth in commercial loans rather than the ratio of commercial loans to assets in these regressions.[15] Panel A shows that growth in commercial loans is positively related to liquidity and market-to-book and negatively related to the bad loan ratio. The relationship between the proxy for growth opportunities and the growth in commercial loans is economically and statistically significant. Holding everything other than the market-to-book ratio constant, a bank with a market-to-book ratio one standard deviation above the mean would have an additional $641.6 million in commercial loan growth. Since my model predicts that banks with the highest probability of insolvency will have the most severe investment distortions, I examine the behavior of very weak banks in panel B of Table III. I include dummies for banks that are weak based on capital ratios (a capital ratio below 4%) and bad loan ratios (bad loan ratio in the highest quartile).[16] I interact the dummy variables with the proxy for growth opportunities. I report only the results for the low capital interaction terms because when the loan quality dummy is interacted with market-to-book, the adjusted R^2 is lower

[15] For the commercial loan ratio the sign and significance of some coefficients change and the explanatory power is much lower. However, they are mainly consistent with the underinvestment hypothesis—especially with respect to asset quality and loan growth.

[16] Under the leverage requirements imposed by U.S. regulators in 1991, banks were to have a minimum ratio of tier 1 capital-to-assets of 3%. The actual requirement depended on the bank's operational risk, interest rate, and credit risk and could be 100 to 200 basis points higher than 3% [Hancock and Wilcox (1994)]. While I report results for a 4% threshold, the results are similar if 3% is used.

TABLE III
Growth in Commercial and Industrial Loans, Bank Health, and Growth Opportunities

Intercept	Bad loans		Liquidity ratio	Capital ratio	M/B	Log of assets			Adj. R^2	No. of obs.
Panel A. Dependent variable is growth in commercial loans										
−70242393***	−23469977*		19999855***	−94904	15855697***	3408414***			30.6%	1502
(4802614)	(12699453)		(1998877)	(10908673)	(4067606)	(139444)				
Panel B. Dependent variable is growth in commercial loans										
−64176556***	20718279	17904216***	19911201*	9167461**	−1890221307**	3634797870**	−1739728480**	−3126625***	3408050***	33.0% 1502
(4797195)	(16615190)	(1990248)	(12098670)	(4116099)	(821236293)	(1613132524)	(791246046)	(541649)	(137052)	

Note. Regressions of growth in commercial loans on lagged values of selected bank holding company characteristics (including regional and time dummies) for 1985–1995. Bad loans is the ratio of past due loans to total assets. Liquidity ratio is the ratio of securities to assets. Capital ratio is the ratio of equity capital to assets. Market-to-book (M/B) is the market equity plus book debt divided by the holding company's book value. Low capital is a dummy variable that equals one if the holding company's ratio of equity to assets is less than 4%. Poor quality is a dummy variable that equals one if the holding company's ratio of bad loans to assets is greater than 1.7%. *p*-values are reported in parentheses.

* Statistically different from zero at the 10% significance level.

** Statistically different from zero at the 5% significance level.

*** Statistically different from zero at the 1% significance level.

and the coefficients of the variables are insignificant. In this regression, growth in commercial loans is positively related to holding company liquidity and capital ratios (marginal significance). Loan growth is also lower for banks with poor loan quality. This evidence is consistent with Propositions 1a and 1b. Weak banks, as measured by capital, liquidity, and loan quality, have lower loan growth. In addition, there is generally a positive relationship between loan growth and growth opportunities, even for banks with low capital. For holding companies with low capital, loan growth is lower but increases with the market-to-book ratio. However, this relationship is nonlinear. For very high (low) values of market-to-book, commercial lending decreases (increases).[17]

While these results generally support my model's predictions, they are also consistent with the voluntary-risk-retrenchment hypothesis. It is possible that whenever banks experience deterioration in asset quality, liquidity, and/or capital, they voluntarily reduce commercial loan growth in order to reduce risk. This behavior could occur in any time period and in the absence of changes in regulation. In addition, weak banks with very good growth opportunities may have more incentive to voluntarily reduce risk so they do not lose these valuable growth opportunities. In other words, these banks have a higher charter value and want to preserve that value [see Keeley (1990)]. They reduce risk in order to decrease the probability of losing their charter value. Since the evidence is consistent with both the underinvestment and voluntary risk retrenchment hypotheses, in the following sections I provide evidence on the relationships between bank health and securitization and subordinated debt that supports the underinvestment model.

B. *Asset Securitization Activity and Bank Health: Evidence on Proposition 2*

Proposition 2a states that the reduction in underinvestment from securitizing loans increases with bank insolvency risk. This implies that weak banks will engage in more securitization activities. A number of papers have examined the relationship between securitization and bank risk [see Berger and Udell (1993) for a review]. Most of these studies document a positive association between various measures of securitization activity and bank risk. This is consistent with Proposition 2a since risky banks are more subject to underinvestment problems and therefore have a greater incentive to securitize assets to alleviate this problem. James (1988) suggests that loan sales and standby letters of credit have payoff characteristics that

[17] This result does not appear to be driven by outliers and holds under various specifications of the model.

TABLE IV
Securitization Activity and Bank Health

Dependent variable	Intercept	REC	Bad loans	Liquidity ratio	Low capital	Log (assets)	Adj. R^2	No. of obs.
SLC ratio	−0.265***		0.104***	−0.043***	0.011***	0.021***	41.1%	1738
	(0.012)		(0.029)	(0.007)	(0.002)	(0.001)		
Sales-to-loans	−0.218***	−0.007*	0.334***	−0.064***	0.023***	0.017***	14.3%	2091
	(0.024)	(0.004)	(0.053)	(0.016)	(0.004)	(0.001)		
Sales-to-assets	−0.208***	−0.008	−0.012	−0.091***	0.040***	0.016***	7.1%	2091
	(0.037)	(0.006)	(0.079)	(0.024)	(0.067)	(0.002)		
Log (loan sales)	−9.120***	0.016	3.109**	−4.399***	0.595***	1.313***	41.3%	2091
	(0.690)	(0.110)	(1.484)	(0.460)	(0.126)	(0.045)		

Note. Regressions of proxy variables for asset securitization on selected bank characteristics between 1985 and 1992. Because variable definitions on Call Reports changed in 1990, the standby letter of credit regression is done for 1985–1989 only. The SLC ratio is the ratio of standby letters of credit to total loans. Sales to loans is the ratio of loan sales to total loans (the sum of loan sales plus loans outstanding). Sales to assets is the ratio of loan sales to total assets. REC is a dummy variable that equals one during a NBER recession. Bad loans is the ratio of past due loans to total loans. Liquidity ratio is the ratio of securities to assets. Low capital is a dummy variable that equals one if the bank's ratio of equity to assets is less than 5%. *p*-values are reported in parentheses.

* Statistically different from zero at the 10% significance level.

** Statistically different from zero at the 5% significance level.

*** Statistically different from zero at the 1% significance level.

are similar to secured debt and demonstrates that secured debt and asset securitization are means of alleviating the underinvestment problem in banking. He uses quarterly data to analyze the relationship between standby letters of credit outstanding and several measures of risk for 58 bank holding companies between 1984 and 1986. The author finds that ''securitization'' is positively related to financial leverage, maturity mismatching, the proportion of bad loans to total loans and variation in monthly stock returns (a market measure of risk). Berger and Udell (1993) analyze the relationship between loan sales and several measures of risk for over 12,000 banks between 1983 : Q2 and 1991 : Q2. They conclude that their evidence does not support the underinvestment hypothesis. Since James (1988) and Berger and Udell (1993) arrive at different conclusions, I conduct a test of the relationship between bank health and both standby letters of credit and loan sales. Table IV presents evidence that supports Proposition 2a and is consistent with James (1988).

The data are from individual bank Call Reports from 1985 to 1992. Standby letters of credit (SLCs) are analyzed only between 1985 and 1989 because of changes in variable definitions in the 1990 Call Report. My sample size is larger than James (1988)—I use a slightly longer time period and include all banks with assets over $1 billion. However, since I have bank level and not holding company data, I use only balance sheet measures of risk and leverage. I find banks with weaker liquidity, lower capital ratios and weaker asset quality issue more SLCs and sell a higher fraction of their

loans.[18] This suggests the relationship between risk and securitization is not restricted to very large, publicly traded bank holding companies.

My results on loan sales differ from B&U who find that several measures of risk and leverage are not related to loan sales. There are a number of explanations for the different results. I find leverage is not related to loan sales when I look at capital ratios. However, there is a significantly positive relationship between loan sales and a dummy variable for banks that have weak capital. This suggests that the relationship between loan sales and capital may be nonlinear—beyond a certain threshold capital is no longer an important determinant of loan sale activity. B&U use the ratio of loan sales-to-total assets to measure securitization activity while I use loan sales-to-loans outstanding plus loan sales. Like B&U, I find that loan sales-to-assets is not significantly related to asset quality in a multiple regression that includes liquidity and a dummy variable for weak capital. Therefore, the choice of the loan sales measure apparently matters. Finally, our models are specified differently. B&U perform single regressions for each risk variable where the risk variable is on the left-hand side and lagged loan sales-to-assets is the right hand side variable. However, using their specification I still find a positive relationship between lagged loan sales-to-assets and my dummy for weak capital and the bad loan ratio. This suggests that there may be differences in loan sales behavior across our samples.

Finally, Proposition 2b suggests that for loans that have active securitization or secondary markets, volume will be less sensitive to changes in bank health caused by changes in economic conditions. I test this prediction by examining the behavior of two types of mortgage loans—residential and commercial. Ginnie Mae was established in 1968 to sponsor mortgage-backed securities programs and provide guarantees to investors in mortgage-backed securities. Fannie Mae was reorganized and Freddie Mac was established in 1968 to help create pass-through securities by buying and holding mortgages, providing guarantees to investors in mortgage-backed securities, and issuing bonds to finance them. As a result, secondary markets for residential mortgages developed in the 1970s and became very active in the 1980s. On the other hand, the secondary market for commercial mortgages is still early in its development. Between 1990 and 1994 this market grew from $10 billion to $65 billion in new issues while the residential market was relatively stable at $200 billion per year. Therefore, commercial real estate mortgage volume should be more sensitive to economic

[18] The results are similar for various measures of securitization activity. For example, even the amount of SLCs outstanding is significantly related to capital, liquidity and asset quality. Further, I ran a Tobit (censored) model since the dependent variables in some of the regressions take on the value of zero or one and over 25% of the observations take on the value zero. The results were qualitatively similar.

TABLE V
Securitization and Mortgage Volume during Recessions

Intercept	REC	REC*80s	RBC	70s	80s	90s	Adj. R^2	No. of obs.
0.802***	0.002	0.0025***	0.050***	−0.035***	−0.041***	−0.055***	76.7%	149
(0.002)	(0.003)	(0.005)	(0.005)	(0.003)	(0.003)	(0.007)		

Note. Regression of the ratio of residential mortgage debt outstanding to the sum of residential plus commercial mortgage debt outstanding from 1959 to 1996. REC is a dummy variable that equals one during a NBER recession. RBC is a dummy variable that equals one after the 4th quarter of 1992 when risk-based capital requirements were fully implemented. REC*80s is a dummy variable that equals one during recessions occurring in either the 1980s or 90s. 70s, 80s and 90s are time dummies for those decades. *p*-values are reported in parentheses.

* Statistically different from zero at the 10% significance level.
** Statistically different from zero at the 5% significance level.
*** Statistically different from zero at the 1% significance level.

conditions than residential mortgage volume especially in the 1980s and 1990s.[19]

I analyze the behavior of residential and commercial real estate mortgage volume between 1959 and 1996 using two quarterly series from Citibase. They are commercial mortgage debt outstanding and nonfarm one- to four-family mortgage debt outstanding. Since my interest is in the relative changes in the two markets, I examine the ratio of residential mortgage debt to the sum of residential plus commercial mortgage debt (Ratio).[20] I run the regression

$$\text{Ratio}_t = \alpha_0 + \alpha_1 \text{REC}_t + \alpha_2 \text{RBC}_t + \alpha_3 \text{REC*80s}_t + (\alpha_4 \ldots \alpha_6)\text{decade}_t + \varepsilon_t$$

where REC is a dummy variable that equals one during a NBER recession and 0 otherwise, RBC is a dummy variable that equals one after 1992 when risk-based capital requirements were phased in, REC*80s is a dummy variable that equals one during a NBER recession that occurs in the 1980s or 1990s, and decade is three dummy time variables to control for changes in these markets over the period.[21] The risk-based capital dummy seemed appropriate because under risk-based capital, banks are required to hold more capital for commercial mortgages than for residential. This may have lowered the incentive for banks to make commercial mortgages. The results are reported in Table V.

[19] These markets may behave differently over business cycles due to differences in changing demand or supply for residential mortgage loans versus commercial real estate loans. For example, Stevenson (1995) notes that commercial real estate suffers from boom and bust cycles due to excessive capital flow into these markets.

[20] I also performed the same regression using simply the ratio of residential mortgages to commercial mortgages and the results were substantively similar.

[21] There were 6 NBER recessions during this period. They were 1960:2–1961:1, 1970:1–1970:4, 1973:4–1975:1, 1980:1–1980:3, 1981:3–1982:4, and 1990:2–1991:1.

It appears that the commercial mortgage market grew faster than the residential market from the seventies through the nineties but risk-based capital may have led to a shift in relative growth toward residential loans. In general, there is no significant change in the ratio during recessions. However, during the three recessions in the 1980s and 1990s, the ratio was significantly higher. This means that residential mortgage volume either grew more or fell less than commercial mortgage volume during these recessions—i.e., it was less sensitive to the economic contraction. These results hold even if I proxy for the severity of the recession by including the percentage change in real GNP during the recession. This evidence suggests that perhaps securitization provided some insulation from economic cycles for the residential mortgage market.

C. *Subordinated Debt and Growth Opportunities: Evidence on Proposition 3*

Proposition 3 states that a bank's willingness to use subordinated debt depends on the profitability of its investment opportunities. As loan opportunities become more profitable, banks are first less likely to use subordinated debt financing. However, beyond some critical value their willingness to use subordinated debt increases with the profitability of loan opportunities. Here I provide evidence consistent with this prediction. I use the market-to-book ratio as a measure of the profitability of a bank's loan opportunities. The more profitable their loan opportunities, the higher the market-to-book ratio and the greater the possible losses from underinvestment. I analyze a sample of bank holding companies between 1985 and 1995 with $1 billion or more in assets. The balance sheet data comes from Y-9s while the market value data is from CRSP. The results are reported in Table VI.

Like Barclay and Smith (1995), I perform censored (Tobit) regressions since the range of values for the dependent variables is zero to one. While many of these large banks use subordinated debt, a significant number of the observations (30%) take the value zero. I use two measures of bank reliance on subordinated debt—the ratio of subordinated debt to total financial claims and the ratio of subordinated debt to total debt. The results for each measure are qualitatively similar. The mean subordinated debt to asset ratio and the total debt ratio are 0.80% and 0.82%, respectively. The use of subordinated debt is significantly negatively related to tier 1 capital, liquidity, and market-to-book. This result is consistent with Barclay and Smith (1995), who find a similar relationship between subordinated debt and market-to-book for a sample of industrial firms from 1981 to 1992. Like them, I interpret the evidence as support for the incentive contracting hypotheses—senior (junior) claims are more (less) likely to be used when

TABLE VI
Subordinated Debt and Investment Opportunities

Dependent variable	Intercept	REC	Bad loans	Liquidity ratio	Capital ratio	Market-to-book	(Market-to-book)^2	Log (assets)	Adj. R^2	No. of obs.
Subtot	0.562***	−0.003***	−0.014	−0.026***	−0.091***	−1.154***	0.548***	0.004***	11.3%	1524
	(0.133)	(0.001)	(0.021)	(0.006)	(0.032)	(0.248)	(0.121)	(0.000)		
Subrat	0.518***	−0.003***	−0.020	−0.023***	−0.159***	−1.063***	0.505***	0.003***	11.4%	1524
	(0.118)	(0.001)	(0.019)	(0.005)	(0.029)	(0.230)	(0.112)	(0.000)		

Note. Regressions of subordinated debt-to-total debt (Subtot) and subordinated debt-to-assets (Subrat) on selected bank characteristics between 1985 and 1995. REC is a dummy variable that equals one during a NBER recession. Bad loans is the ratio of past due loans to total loans. Liquidity ratio is the ratio of securities to assets. Capital ratio is the ratio of equity to assets. Market-to-book is the market equity plus book debt divided by the bank's book value. *p*-values are reported in parentheses.

* Statistically different from zero at the 10% significance level.

** Statistically different from zero at the 5% significance level.

*** Statistically different from zero at the 1% significance level.

a firm faces severe incentive problems like underinvestment. As my model predicts, the relationship between subordinated debt and market-to-book is nonlinear. The use of subordinated debt actually increases for banks with very large values of market-to-book.

6. UNDERINVESTMENT AND PUBLIC POLICY AND THE IMPLICATIONS OF PROPOSITION 4

The model provides several implications for public policy. Propositions 1a and 1b suggest that loan supply will decrease during economic contractions. Anecdotal and empirical evidence suggests that the borrowers most likely to suffer consequences from shortages of bank credit are small to medium sized firms that cannot easily access public markets and therefore are more reliant on bank loans. For example, Gertler and Gilchrist (1994) show that small firms have more significant declines in both sales and inventory during monetary tightening than larger firms.[22] These bank-dependent borrowers are a significant part of the economy. Lown (1990) reports that manufacturing firms with assets of $250 million or less obtain approximately 85% of their short-term financing from banks. These small firms generate 25% of the income earned by manufacturing firms. Dennis *et al.* (1988) report that small firms produce 38% of GNP and Brown *et al.* (1990) find they employ 50% of the work force. Hancock and Wilcox (1998) find that between 1989 and 1992 gross state product declined more when small banks (who tend to lend to smaller firms) lost capital than when large banks lost capital.

If banks underinvest in loans during economic contractions and small firms are reliant on banks for capital and are important to the economy, then perhaps regulatory initiatives should focus on improving the availability of small firm financing during contractions. Thakor (1996) suggests that increasing the money supply may not accomplish this. Propositions 2a and 2b suggest that there may be a role for securitization. Policy initiatives that attempt to improve secondary markets for small business loans may help improve credit availability during contractions and reduce the severity of economic contractions. These initiatives may include government guarantees and sponsorship of debt issues backed by small firm loans.

Proposition 1a suggests that the underinvestment problem increases as banks' balance sheets weaken. Therefore, in order to encourage these banks to make profitable low-risk loans, their balance sheets must be enhanced. This might be accomplished through immediate injections of new equity

[22] Brewer *et al.* (1996) find that smaller firms in their sample are more dependent on bank loans than are larger firms. Petersen and Rajan (1994) find that bank financing affects the availability and price of alternative financing for small firms.

(not phased-in capital requirements) and by facilitating removal of bad loans from bank portfolios. The latter may take the form of assisting in the establishment of secondary markets for non-performing loans (e.g., by packaging or insuring these loans) or at least removing barriers to sales of these loans. Though the removal of bad loans will reduce the book value of capital, market capital will be unchanged. However, if management of bad loans ties up nonfinancial capital, the bank may have more resources available for new loan production after their removal.

In addition, when there are market-specific underinvestment problems, regulators may encourage banks from unaffected or stronger economic markets to enter those markets. The outside banks will have less perverse investment incentives and will make profitable loans. In this respect, Mexico may be dealing with its banking crisis more effectively than Japan. Mexico has encouraged foreign banks to buy unhealthy banks while Japan has protected its banks from competition. In fact, removal of interstate (international) banking restrictions should reduce the occurrence and severity of regional (national) economic contractions because healthy banks will be free to enter the depressed markets and alleviate the underinvestment problem when it does exist.[23] In addition, if removing these barriers improves diversification and lowers failure probabilities then debt overhang and lending procyclicality should be less severe. However, this may be attenuated to the extent that competition reduces bank charter values.

Finally, Proposition 4 implies that raising capital requirements during an economic contraction will increase the severity of the contraction and accentuate cross-sectional differences in lending, at least in the short-run. This occurs because raising capital requirements initially leads to increased underinvestment by risky banks. Therefore, a recession may be the wrong time to increase capital requirements or regulatory burdens.

7. SUMMARY AND CONCLUSIONS

Banks that have a significant probability of failure underinvest in some positive NPV loans. Bank lending is procyclical in any environment where changes in economic conditions cause changes in the probability of insolvency. If a negative economic shock (or poor loan choices) increases the probability of borrower default and hence the probability of bank failure, banks will underinvest more than the norm. The change in lending incentives will further accentuate differences in the quantity and quality of loans

[23] This may not occur if larger banks make fewer loans and/or fewer relationship-based loans to small businesses as suggested by Peek and Rosengren (1995a) and Berger and Udell (1996), respectively.

made across banks or across time and may increase the severity of national and regional business cycles. The underinvestment incentive is relatively higher when loan quality, liquidity, and/or capital is weak and when growth opportunities are low.

I analyze commercial loan growth between 1985 and 1995 and find empirical support for each of the above predictions. Securitization alleviates underinvestment and therefore procyclical lending. I analyze cross-sectional differences in loan sales and standby letter of credit activity across banks and time series trends in residential vs. commercial real estate markets and find empirical support for this prediction. Weak banks securitize relatively more of their assets and commercial real estate activity (where securitization markets are not well developed) is more sensitive to economic conditions than residential activity. Finally, subordinated debt and capital requirements alleviate overinvestment but tend to exacerbate underinvestment incentives. Therefore, banks with relatively high underinvestment costs will be less reliant on subordinated debt. Consistent with this hypothesis, bank holding companies with high market-to-book ratios, a proxy for underinvestment costs, are generally less reliant on subordinated debt.

There are a number of areas for further research. The effect of financing choice on lending decisions may change if information asymmetry is incorporated in the model. Secured debt may not be as useful in mitigating underinvestment problems if there is asymmetric information regarding the value of these loans. There is also a need for further investigation of some of the empirical implications. One of the empirical results is puzzling. Among weakly capitalized banks, loan growth first increases and then decreases with the value of growth opportunities. The model does not predict this curvilinear relationship. However, this result is consistent with the idea that banks with very valuable growth opportunities (i.e., high charter value) are more reluctant to take risk because they have more to lose if they become insolvent. If banks with high charter value are limiting risk to protect this value, then risk measures should decrease for these banks. Future research may determine if this is the case. In addition, it may be useful to extend the empirical analysis to cover several recessions. This may allow us to determine whether the ''abnormal'' contraction in loan supply during the last recession in the U.S. was due to the relatively weak condition (i.e., asset quality and capital) of the banking industry and/or weak charter values (i.e., the value of growth opportunities). Finally, the model implies that banks with distorted incentives will underinvest in loans that are negatively correlated with existing assets. Because these loans would reduce portfolio risk, underinvestment implies that loan portfolio risk is higher than it should be. Tests of the implication regarding risk-taking are left for future research.

APPENDIX: PROOFS

Proof of Proposition 1a. Consider loans of type (d1). According to (6.1), banks overinvest when $\delta < 0$ and $\pi[I' - Y] > |\delta|$. If the loan were rejected, shareholder value would be E_x. With the investment, shareholder value increases. The amount of the increase in shareholder value arising from overinvestment is $\delta + \pi[I' - Y]$. I call this the benefit of overinvestment. To prove that overinvestment increases with the probability of insolvency, I must show that this benefit increases with the probability of insolvency, π. The derivative of the benefit is $I' - Y$. This derivative is greater than zero by assumption (d1). Therefore, as π increases the amount of overinvestment increases.

Now consider loans of type (d2). By (A1), $[A_L - F_0] < 0$ and (6.2) implies that these banks underinvest when $\delta > 0$ and $|\pi[A_L - F_0]| > \delta$. If the loan were accepted, shareholder value would be $E_x + \delta + \pi[I' - R]$. If the loan is rejected, shareholder value is just E_x and is higher than shareholder value if the loan is accepted. The difference in shareholder value from rejecting these loans is $-\{\pi[A_L - F_0] + \delta\}$. I call this the benefit of underinvestment. To prove that underinvestment increases with the probability of insolvency, I must show that this benefit increases with the probability of insolvency. The derivative of the benefit with respect to π is $-[A_L - F_0]$ and by (A1), this is greater than zero. Q.E.D.

Proof of Proposition 1b. Consider type (d1) loans. For profitable loan opportunities, $\delta_i > 0$, and there is no overinvestment problem. Since the wealth transfer for (d1) loans is positive, these loans are also not subject to underinvestment. Next consider type (d2) loans. Banks underinvest if $\delta > 0$ and $|\pi[A_L - F_0]| > \delta$. As loan opportunities become more profitable, this inequality is less likely to hold. Q.E.D.

Proof of Propositions 2a and 2b. First, I show that secured debt financing provides less distorted investment incentives. With secured financing the expected payoffs to new debtholders in the default state for type (d1) and type (d2) loans, respectively, are described by the following equations:

$$Z_p = Y(j) \tag{A.1}$$

$$Z_n = Y(j) + s(j). \tag{A.2}$$

In order to raise the amount needed for the investment, the face value of the secured debt, F_1, must satisfy the following equations for each default scenario:

$$I'(j) = \pi Y(j) + (1 - \pi)R(j) \tag{A.3}$$

$$I'(j) = \pi R(j) + (1 - \pi)\{Y(j) + s(j)\}. \tag{A.4}$$

The indifference equations must be modified in order to be consistent with cash flows to equity under secured debt financing. The face value, F_1, is given by (A.3) and (A.4). Solving for F_1 in (A.3) and (A.4), and rewriting in terms of the value of equity, E_x, from (6.1) and (6.2), respectively, the new value of equity for (d1) and (d2) loans will be

$$E_1 = E_x \tag{A.5}$$

For loans of type (d1) the wealth transfer term disappears and all negative NPV loans are rejected. Under unsecured deposits I showed that the wealth transfer is positive and overinvestment increases with π. Since investment does not depend on π when secured debt is issued, the higher the probability of insolvency the greater the reduction in overinvestment. The wealth transfer term also disappears for type (d2) loans. For all values of π, all positive NPV loans will be acceptable if the loans can be financed with secured debt. However, for loans financed with unsecured deposits I show in Proposition 1a that the higher the probability of insolvency, the more banks underinvest (i.e., they reject more positive NPV loans). Therefore, the higher the probability of insolvency, the larger the reduction in underinvestment. Q.E.D.

Proof of Proposition 3. Consider that banks might finance new loan opportunities with subordinated debt with a market value of M_1, rather than with insured deposits. Expected payoffs to subordinated debtholders in state L are described by the following equation:

$$Z = \max\{A_L + Y(j) - F_0, 0\}. \tag{A.6}$$

In order to raise the amount needed for the investment, the face value of the subordinated debt, F_1, must satisfy the following equation:

$$M_1 = I'(j) = \pi Z + (1 - \pi)F_1. \tag{A.7}$$

Solving for F_1 in (A.7) and substituting that value into (6.1) and (6.2), the new value of equity will be:

$$E_1^s = E_x + \delta_i(j) + \pi\{Z - Y_p(j)\} \tag{A.8a}$$

$$E_1^s = E_x + \delta_i(j) + \pi\{A_L - F_0\}. \tag{A.8b}$$

For type (d1) loans, the wealth transfer term is $-\pi Y_p(j)$ when $Z = 0$

and is $\pi(A_L - F_0)$ when $Z > 0$. The wealth transfer to equityholders under subordinated debt financing is smaller than that when new loans are funded with insured deposits. Consider banks with loan opportunities where $\delta < 0$. Shareholders gain less when the bank overinvests if the negative NPV opportunity is financed with subordinated debt versus insured deposits. Therefore, banks with these types of opportunities will prefer not to issue subordinated debt. Now consider banks with many profitable opportunities (i.e., $\delta > 0$). Under subordinated debt financing, banks may underinvest in these loans when $Z > 0$. Therefore, these banks will prefer not to issue subordinated debt. Finally, type (d2) loans are profitable, negatively correlated with existing assets and make the existing deposits riskless. For these loans, the wealth transfer term under subordinated debt is equivalent to that under insured deposit financing. Therefore, banks with these types of opportunities will be most willing to issue subordinated debt. Q.E.D.

Proof of Proposition 4. Assume that the regulator requires the bank to finance a portion of new investment with equity, say $\alpha I'(j)$. The remaining investment is financed with insured deposits of $(1 - \alpha)I'(j)$. This condition means that the face value of new deposits is

$$F_1 = (1 - \alpha)I'(j). \tag{A.9}$$

The new equity is raised from existing shareholders. The value of the equityholders' claim if the project is taken is now given by

$$E_1 = E_x + \delta_i(j) + \pi\{I'(j)(1 - \alpha) - Y_p(j)\} \tag{A.10a}$$

$$E_1 = E_x + \delta_i(j) + \pi\{A_L - F_0\}. \tag{A.10b}$$

Taking the derivative of (A.10a) with respect to α, $\partial E_1/\partial\alpha = -\pi I'(j) < 0$. For these loans, the higher is α, the lower is the likelihood that the loan is accepted (i.e., less overinvestment and more underinvestment). The derivative also indicates that the change in the degree of over- and underinvestment caused by higher capital requirements is directly related to the probability of insolvency. Taking the derivative of (A.10b) with respect to α, $\partial E_1/\partial\alpha = 0$. Q.E.D.

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