Bank Leverage and Monetary Policy's Risk-Taking Channel: Evidence from the United States

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Abstract: We present evidence of a risk-taking channel of monetary policy for the U.S. banking system. We use confidential data on the internal ratings of U.S. banks on loans to businesses over the period 1997 to 2011 from the Federal Reserve's survey of terms of business lending. We find that ex-ante risk taking by banks (as measured by the risk rating of the bank's new loans) is negatively associated with increases in short-term policy interest rates. This relationship is more pronounced in regions that are less in sync with the nationwide business cycle, and less pronounced for banks with relatively low capital or during periods when banks' capital erodes, such as episodes of financial and economic distress. These results contribute to the ongoing debate on the role of monetary policy in financial stability and suggest that monetary policy has a bearing on the riskiness of banks and financial stability more generally.

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1. Introduction

The global financial crisis has reignited the debate on the link between short-term interest rates and bank risk taking, also known as monetary policy's "risk-taking" channel: the notion that interest rate policy affects the quality and not just the quantity of bank credit. Specifically, many hold the view that interest rates were held too low for too long in the run up to the crisis (Taylor, 2009), and that this helped fuel an asset price boom, spurring financial intermediaries to increase leverage and take on excessive risks (Borio and Zhu, 2008; Adrian and Shin, 2009).

More recently, a related debate has ensued on whether continued exceptionally low interest rates (including because of unconventional monetary policy measures) are setting the stage for the next financial crisis (e.g., Rajan, 2010; Krishnamurthy and Vissing-Jorgenson, 2011; Farhi and Tirole, 2012; Acharya et al., 2013; and Chodorow-Reich, 2014). More generally, there is a lively debate about the extent to which monetary policy frameworks should include financial stability considerations (Woodford, 2012; Stein, 2014). Despite the obvious policy interest, the empirical evidence on this topic is scant, especially for the United States.

A growing theoretical literature analyzes the role of monetary policy in altering bank fragility in the presence of asymmetric information and funding liquidity risk. These models predict that banks may engage in riskier activities when real interest rates are low (e.g., Adrian and Shin, 2010; Freixas et al., 2011; Diamond and Rajan, 2012; Acharya and Naqvi, 2012; Dell'Ariccia, Laeven, and Marquez, 2014; Brunnermeier and Sannikov, 2014; and Drechsler et al., 2014). In addition, a few empirical papers have provided evidence of this relationship (see for instance, Jimenez et al. 2014, Ioannidou et al., 2009, Altunbas et al., 2010; more references in the next section). But these have mostly focused on Europe.

In this paper, we study the link between short-term interest rates and bank risk taking using confidential data on individual U.S. banks' loan ratings from the Federal Reserve's Survey of Terms of Business Lending (STBL). The paper makes three important contributions to the literature. First, to our knowledge, the paper is the first to present evidence of an inverse relationship between interest rates and bank risk taking using commercial bank loan-level data (for the U.S.), which is critical to assess the impact on general credit conditions.[1]

Second, the paper constructs an ex-ante measure of bank risk taking (unlike much of the existing literature[2]) using confidential loan-level data on the riskiness of new loans of U.S. banks. This allows us to focus on the risk attitude of banks at the time a loan is issued, rather than on ex-post loan performance which could be affected by subsequent events. Notably, this restricts our attention to a specific form of risk taking: the extension of new loans. This has two advantages. It greatly reduces concerns about endogeneity of the monetary policy stance. And it focuses on a margin that is fully under the control of a bank (in contrast to the overall riskiness of its portfolio which will largely reflect cyclical changes in the risk profile of existing loans).

Third, the paper links the strength of the relationship between policy rates and bank risk taking to the banks' capital structure. This provides a link with an important segment of the theoretical literature on banking that predicts that risk taking is a function of a bank's capital.

Different theoretical approaches deliver different predictions on the relationship between the monetary policy rate (or more precisely the interest rate on safe assets) and bank risk taking

[1] STBL data have been used before to study the determinants of risk taking in bank loans, including how it varies over the cycle, but not to test its relationship with monetary policy conditions (see, for instance, Asea and Blomberg, 1998, Carpenter, Whitesell, and Zakrajšek, 2001, and Black and Hazelwood, 2013).

[2] An exception is Jimenez et al. (2014) who use credit history information on past doubtful loans as an ex ante measure of firm credit risk. Our measure of ex ante risk taking differs from their in the sense that ours is based on the bank's assessment of risk at the time the loan was made. Additionally, our measure of risk is at the loan level while theirs is at the firm level.

(see Altunbas et al., 2010, Chodorow-Reich, 2014, and Dell'Ariccia and Marquez, 2013, for a discussion). On the one hand, most portfolio allocation models will predict that an exogenous decrease in the yield on safe assets will lead to greater risk taking (see, for instance, Fishburn and Porter, 1976). On the other, corporate finance models focusing on the effects of limited liability predict that a decrease in the interest rate banks have to pay on deposits will reduce risk taking: the classical risk shifting effect. Further, the strength of this risk shifting effect depends on the leverage/capital of banks. It is the strongest for the least capitalized banks. These banks are more exposed to agency problems, which become more severe when interest rates are higher and their intermediation margins are compressed (Stiglitz and Weiss, 1981; Hellman et al., 2000; and Acharya and Viswanathan, 2011).[3] So, in risk-shifting models, the least capitalized banks will be the most sensitive to interest rate changes. However, since the relationship between the interest rate and this source of risk taking is opposite to that of the portfolio allocation effect, in models that take both into account, they partly offset each other (see Dell'Ariccia et al., 2014).

As a way of background, we present a simple model that puts together these two opposing effects. In our model, the net result is that bank risk taking is negatively associated with interest rates. Its strength, however, depends on the leverage/capital of banks. For less capitalized banks, the classical risk-shifting effect is stronger and thus the overall relationship between interest rates and risk-taking is weaker. Note that our model serves solely as background to help motivate the empirical work. More elaborate existing models give similar predictions. The model by no means should be seen as the contribution of this paper. This is an empirical paper.

[3] For financial intermediaries with long-term liabilities and shorter-term assets, such as life insurance companies and pension funds, search for yield models predict the opposite relationship between policy rates and risk shifting (Rajan, 2005, and Dell'Ariccia and Marquez, 2013).

Consistent with the discussion above, we find that bank risk taking—as measured by the risk ratings of the bank's loan portfolio—is negatively associated with short-term interest rates—as proxied by the federal funds rate[4]—and that this negative relationship is more pronounced for highly capitalized banks. Our empirical analysis shows that, for the typical new loan, a one-standard deviation decrease in interest rates is associated with an increase in loan risk ratings of 0.06 (compared to its standard deviation of 0.8). Moreover, consistent with theoretical models of bank leverage and risk taking that embed risk shifting behavior, we find that the effect depends on the degree of bank capitalization: the effect of interest rates on bank risk taking is less pronounced for poorly capitalized banks. The economic effect of this result is meaningful: reducing interest rates from its 75th percentile to its 25th percentile would increase loan risk ratings for a strongly capitalized bank (with Tier 1 capital ratio at its 75th percentile) by 0.04 more than for a weakly capitalized bank (with Tier 1 capital ratio at its 25th percentile).

Importantly, both the theoretical model and our empirical results should not be interpreted as implying that the additional risk taking associated with lower rates is "excessive." As it is the case with many other theoretical models and empirical results in this literature, our model and statistical results are not well suited to answer whether or not the additional risk taking of banks facing more accommodative monetary policy is excessive (for an exception, see Stein, 2012).[5]

The results survive several robustness tests, including those designed to address the concern that monetary policy is endogenous to bank risk taking. Our focus on new loans in itself

[4] Our focus is on short-term interest rates. While current monetary policy, by setting the policy rate, has a direct influence only on short-term real interest rates, its effect on long-term interest rates depends on the degree to which the conduct of monetary policy affects inflationary expectations, and more generally about markets' expectations of monetary policy in the future.

[5] Although our results can inform the design of optimal monetary policy, by themselves, they cannot determine whether past or present monetary policy is actually optimal.

reduces concerns about endogeneity, since this subset of loans is less likely to inform FOMC decisions than a bank's entire portfolio. However, to further address these concerns, we take the following steps. First, we limit the sample in the main analysis to loans not under previous commitment (i.e., we exclude pre-committed loan agreements and withdrawals from credit lines), thereby focusing on what constitute truly new business loans. Second, we focus on states whose economic cycle exhibits a low correlation with the U.S. cycle. Economic conditions in these states are less likely to affect monetary policy (the same idea behind the papers focusing on Spain versus the Eurozone). Third, throughout the analysis we control for macroeconomic conditions and in robustness checks we replace the policy rate variable with a Taylor residual, so that financial stability considerations are accounted for as long as they affect monetary conditions only through their effect on macroeconomic conditions. Finally, we perform a number of sample splits to assess whether results are robust to excluding from the sample those periods during which financial stability considerations are more likely to have influenced monetary policy, such as during periods of financial crisis when banks' capital erodes and the number of bank failures increases. Taken together, these results alleviate endogeneity concerns and provide evidence in support of a causal interpretation of the link between interest rates, bank capital, and bank risk taking.

The paper proceeds as follows: Section II highlights our contribution to the existing empirical literature. Section III presents a simple model of bank risk taking that incorporates real interest rates and bank leverage. Section IV presents the methodology used to assess the link between interest rates and bank risk taking. Section V presents the data and descriptive statistics of the main variables used in the empirical analysis of this paper. Section VI presents and

interprets the empirical results, including a number of robustness tests and extensions. Section VII concludes.

2. Relation with Existing Literature

There is a growing empirical literature on the link between interest rates and bank risk taking. This paper adds to our understanding of this relationship along several dimensions: the way we measure risk taking, geographic and sectoral coverage, and attention to the relationship between bank capital structure and risk taking.

Existing papers mostly measure bank risk using information on changes in lending standards observed in lending surveys (see Lown and Morgan, 2006, for the U.S., and Maddaloni and Peydro, 2011 for the euro area) or rating agency estimates (Altunbas, Gambacorta, and Marquez-Ibañez, 2010). Papers based on credit registries generally use borrower-level measures of risk based on pre-existing default history or ex-post loan default rates (Jimenez et al., 2014, Ioannidou et al., 2009).

In the former case, a loosening of lending standards is interpreted as indicative of improved access to credit for low-quality borrowers. However, lending surveys, such as the ECB's Bank Lending Survey (BLS) or the Federal Reserve's Senior Loan Officer Opinion Survey (SLOOS), generally indicate only whether lending standards have changed relative to the recent past, not their absolute level. Further, a decline in lending standards may reflect an improvement in the quality of the borrower pool, in which case the implications for risk taking are ambiguous. This is in contrast to the STBL survey we use, which captures the absolute level of risk of new business loans as perceived by loan officers.

Relative to the papers based on credit register data, STBL data has the advantage of providing a loan-specific (rather than borrower-specific) measure of risk. However, since in our data the borrower identity is not disclosed, we cannot combine loan information with firm characteristics from other datasets or analyze within-borrower variation by including borrower fixed effects. That said, the STBL data allow controlling for an array of loan characteristics such as collateral, maturity, and size.

Another novelty of the present paper is that it employs U.S. loan-level data. Most recent studies focus on Europe. The few papers focusing on the U.S. use syndicated loans or aggregate measures of risk (Paligorova and Santos, 2012, Delis et al., 2013, and Buch et al., 2011). But syndicated loans are restricted to relatively large corporations which may not be entirely representative of broader credit markets. The advantage of using U.S. data as we do (aside from the U.S. being of immediate interest, as the largest economy in the world and the epicenter of the recent global financial crisis) is twofold. The combination of STBL and Call Report data on balance sheets of individual banks offers relatively long time series (contrary to, say, euro area surveys) and information on a relatively large sample of banks with ample heterogeneity in leverage and other relevant bank characteristics. In addition, we can use state level heterogeneity to test the robustness of our results and eliminate concerns about the endogeneity of monetary policy (akin to the papers focusing on the euro zone).

Our paper is most closely related to Jimenez et al. (2014) and Ioannidou et al. (2009), who use detailed information on borrower quality from credit registry databases for Spain and Bolivia. Consistent with our results, they find a positive association between low interest rates at loan origination and the probability of extending loans to borrowers with bad credit history or no history at all (i.e., risky borrowers). They also find that low rates decrease the riskiness of banks'

overall loan portfolios. Therefore, holding interest rates low for a short period of time may improve the overall quality of banks' loan portfolios, but holding interest rates low for a prolonged period of time could increase loan default risk substantially over the medium term.

Jimenez et al. (2014) is also the only other paper (to our knowledge) that explores how the relationship between the policy rate and risk taking changes with bank capitalization. Here we find evidence consistent with the presence of risk-shifting by less capitalized banks (as predicted by most models in which moral hazard stems from limited liability; e.g., Matutes and Vives, 1996, Hellman et al., 2000, and Repullo, 2004). In contrast, they find that the least capitalized banks react the most to changes in the policy rate, taking less risk when monetary policy is tightened and more when it is eased. These particular results in the two papers are not easily compared. First, they obtain their result with borrower fixed effects; hence, from changes in the riskiness of individual firms, rather than the absolute level of riskiness of a loan. Second, the two papers use very different measures of risk (loan ratings here, firms with a history of non-performing loans there); different unit of analysis (loans here, firms there); and different samples (U.S. here, Spain there).

3. A Simple Model of Interest Rates, Leverage, and Bank Risk Taking

In this section, we present a highly simplified version of the model in Dell'Ariccia, Laeven, and Marquez (2014). For a model in the same spirit but where banks choose among portfolios with different risk/return characteristics, see Cordella and Levy-Yeyati (2003). Consider a perfectly competitive banking system. Loans are risky and a bank's portfolio needs to be monitored to increase the probability of repayment. The bank is endowed with a monitoring technology. It can exert monitoring effort q which guarantees an identical probability of loan repayment. This monitoring effort entails a cost equal to $(1/2)cq^2$ per dollar lent.

Bank owners/managers raise deposits (or more generally issue debt liabilities) and invest their own money to fund the bank's loan portfolio. Let k represent the portion of bank assets financed with the bank owner's money (consistent with other models, this can be interpreted as the bank's equity or capital), and $1 - k$ the fraction of the bank's portfolio financed by deposits. In this simplified version of the model, we treat k as exogenous. Dell'Ariccia et al. (2014) show that similar results are obtained when k is endogenized.

Banks are protected by limited liability and repay depositors only in case of success. Let r^* be the economy's reference rate in real terms, which for simplicity and without loss of generality can be normalized to be the real risk-free interest rate (we will use "reference" and "risk free" interchangeably). Deposits are fully insured and thus insensitive to risk taking. It follows that the deposit rate is equal to the reference rate, so that $r_D = r^*$.

Equity, however, is more costly, with a yield $r_E = (r^* + \xi)/q$, with $\xi \geq 0$. The cost r_E can be interpreted as the opportunity cost for the bank owner/manager of investing in the bank, adjusted to reflect the bank's risk through the probability of success q.[6] The term ξ represents an equity premium in line with existing literature (see, for instance, Hellmann et al., 2000, Repullo, 2004, Dell'Ariccia and Marquez, 2006, and Allen et al., 2011).

We structure the model in two stages. For a fixed reference interest rate r^*, in stage 1, the lending rate is set competitively so that banks make zero expected profits in equilibrium. In stage 2, banks then choose how much to monitor their portfolio, q. We solve the model by backward induction starting from the last stage. The bank's expected profit can be written as:

$$\Pi = \left(q\big(r_L - r_D(1-k)\big) - r_E k - \left(\frac{1}{2}\right) cq^2\right) L(r_L), \qquad (1)$$

[6] Here we assume that the premium on equity, ξ, is independent of the real interest rate r^*. Since k is exogenous, this assumption does not affect the results (for a discussion of this assumption in a more complex model, see Dell'Ariccia, Laeven, and Marquez, 2014).

which reflects the fact that the bank's portfolio repays with probability q. When the bank's projects succeed, the owner (shareholders) receives a per-loan payment of r_L and earns a return $(r_L - r_D(1-k))$ after repaying depositors. When the bank fails, the owner receives no revenue but, because of limited liability, does not repay depositors. We can rewrite equation (1) as:

$$\Pi = (q(r_L - r^*(1-k)) - (r^* + \xi)k - (1/2)cq^2)L(r_L). \quad (2)$$

Maximizing (2) with respect to q yields:

$$\hat{q} = \min\left\{\frac{r_L - r^*(1-k)}{c}, 1\right\}. \quad (3)$$

Substituting $\hat{q}$ back into the profit function (2), we get:

$$\Pi(\hat{q}) = \frac{(r_L - r^*(1-k))^2}{2c} - (r^* + \xi)k\,, \quad (4)$$

from which we can obtain the lending rate consistent with a free-entry competitive equilibrium by imposing zero profits:

$$r_L = r^*(1-k) + \sqrt{2ck(r^* + \xi)}. \quad (5)$$

Substituting r_L back into equation (3), we get:

$$q^* = \frac{\sqrt{2ck(r^*+\xi)}}{c}. \quad (6)$$

from which it is immediate that $\frac{\partial q^*}{\partial r} > 0$ and $\frac{\partial (q^*)^2}{\partial r\,\partial k} > 0$.

An examination of (3) immediately reveals that changes in the reference rate affect bank monitoring through two distinct channels. First, because of limited liability, there is the classical risk-shifting channel. The rate the bank has to pay on its deposits goes up, which (other things equal) reduces bank profits in case of success and, hence, its incentive to monitor its portfolio. Second, there is a pass-through channel: The bank lending rate also responds to changes in the reference rate. This will increase bank profits in case of success, improving the bank's incentives. The relative strength of these two channels depends on the degree of bank

capitalization. The risk-shifting effect is maximal for a fully levered bank and goes to zero for a bank fully funded with capital (for which limited liability is irrelevant).

This stylized model has the following testable implication: Bank risk taking is negatively associated with the policy interest rate. Further, this negative relationship depends on the capitalization of the bank: it is less pronounced for poorly capitalized banks.

4. Empirical Methodology

We employ panel regression analysis to investigate the relationship between the policy rate and the riskiness of new loans issued by U.S. commercial banks. Our basic regression model is as follows:

$$\sigma_{kit} = \alpha_i + \lambda_j + \beta r_t + \gamma K_{it} + \theta X_{kit} + \mu Y_{it} + \rho Z_{jt} + \varepsilon_{kit}, \quad (7)$$

where σ_{kit} is the risk rating of loan k extended by bank i during quarter t (which we use as a measure of ex-ante risk of each bank loan), r_t is the federal funds rate at the beginning of quarter t, K_{it} is the capital-asset ratio (inverse of bank leverage) of bank i at the beginning of quarter t, X_{kit} is a set of loan-specific control variables (loan size, an indicator for collateral backing, and loan maturity), Y_{it} is a set of bank-specific control variables (other than bank leverage), Z_{jt} is a set of time-varying regional (either U.S. state or Census region) control variables, α_i are bank-specific fixed effects, λ_j are state-specific fixed effects, and ε_{kit} is the error term. To control for dependence of observations within quarters, standard errors are clustered by quarter. Our coefficient of interest is β, which we expect to be negative.

To test whether the effect of interest rates on bank risk taking depends on bank capital, we enrich regression model (7) by including an interaction term as follows:

$$\sigma_{kit} = \alpha_i + \lambda_j + \beta r_t + \gamma K_{it} + \delta K_{it} r_t + \theta X_{kit} + \mu Y_{it} + \rho Z_{jt} + \varepsilon_{kit}. \quad (8)$$

The focus of this specification is on the interaction term between interest rates and bank capital. Based on the model and related literature, we expect to find a negative coefficient δ on the interaction between measures of bank capital and interest rates. This would support the notion that (since the risk shifting effect operates in the opposite direction and is stronger for less capitalized banks) reductions in interest rates increase bank risk taking especially for banks with relatively high capital (low leverage).

As an alternative specification, we replace the interest rate variable with time fixed effects as follows:

$$\sigma_{kit} = \alpha_i + \lambda_j + \tau_t + \gamma K_{it} + \delta K_{it} r_t + \theta X_{kit} + \mu Y_{it} + \rho Z_{jt} + \varepsilon_{kit}, \quad (8a)$$

where τ_t are quarter-specific fixed effects.

Note that, strictly speaking, the model in equation (8) and most of the related theoretical literature are cast in terms of real, not nominal, interest rates. This is, however, not a problem for our empirical approach as long as current monetary policy, by setting the policy rate, has a direct influence on short-term real interest rates, which is the case as long as rigidities prevent prices from adjusting immediately. Indeed, over our sample period (1997-2011), the correlation between nominal and real effective federal funds rates is high at 0.9. And we obtain results similar to our main specification when we adjust the federal funds rate with CPI inflation.

5. Data and Descriptive Statistics

A. Survey of Terms of Business Lending

This paper uses confidential loan-level data over the period 1997-2011 from the Federal Reserve's Survey of Terms of Business Lending (STBL) to construct a measure of ex-ante bank risk taking. The STBL is a quarterly survey on the terms of business lending of a stratified

sample of about 400 banks conducted by the U.S. Federal Reserve. It typically covers a very large share of the U.S. banking sector's assets. For example, the combined assets of the banks responding to the survey for the fourth quarter of 2011 represented about 60 percent of all assets of U.S. commercial banks.[7] The survey asks participating banks about the terms of all commercial and industrial loans issued during the first full business week of the middle month in every quarter (i.e., February, May, August, and November). Banks report the risk rating of each loan by mapping their internal loan risk ratings to a scale defined by the Federal Reserve. Loan risk ratings vary from 1 to 5, with 5 representing the highest risk. Ratings are verified by the Federal Reserve which should alleviate concerns of self-reported biases.[8] The publicly available version of this survey encompasses an aggregate version of the terms of business lending, disaggregated by type of banks. In this paper, we use the confidential data on individual loans with additional bank and regional level controls.

In addition to the loan ratings, the STBL collects loan information on the face amount, the rate of interest (including the base pricing rate), the frequency of compounding, the date on which the loan rate can be recalculated (if any), the maturity date (if any), the commitment status, and whether the loan is secured by collateral.

The legal basis for the survey is the Federal Reserve Act and the survey is conducted on a voluntary basis. Individual responses are regarded as confidential under the Freedom of Information Act, and the STBL micro-level data are therefore not available to researchers outside the Federal Reserve System. However, aggregate estimates for business loan terms are published in the quarterly release of the STBL.

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[7] According to the Federal Reserve's H.8 statistical release, total assets of all commercial banks in the United States were $12.6 trillion as of December 2011.

[8] To further alleviate concerns that the self-reported risk ratings are biased across banks we show that the ratings are highly correlated with ex post loan performance as measured by nonperforming loans at the bank level.

Since its inception in February 1977, the STBL has been revised periodically to accommodate changes in lending practices. Critical for us, the loan risk ratings were added to the STBL in 1997. Because of the importance of the risk ratings, Federal Reserve Banks periodically verify that respondent banks are correctly mapping their most current risk rating systems to the risk categories defined in the STBL.

Also in 1997, the STBL respondent panel was expanded to include U.S. branches and agencies of foreign banks. At the same time, interest rate adjustments and maturity items were added and redefined, and a risk-rating item was added. In 2003, a field for the date on which the terms for loans made under formal commitment became effective was added, the number of base pricing rate options was reduced from five to two, and the data item indicating whether loans are callable was deleted. In 2006, the minimum size of loans reported was increased from $1,000, a level at which it had been held since the inception of the survey in 1977, to $3,000. The adjustment reflected price inflation over the intervening period and the increased use of business credit cards, developments that had likely added significantly to the burden of reporting small loan amounts.

The STBL is the Federal Reserve's main source of data on marginal returns on business loans for a representative set of banking institutions nationwide and a wide range of loan sizes. As a result, the STBL provides valuable insights into shifts in the composition of banks' business loan portfolios and the implications of those shifts for bank profitability. Moreover, the STBL is an important source of individual loan data used by those concerned with lending to small businesses, for which banks are the primary source of credit.

Beyond their use for current analysis by the Federal Reserve Board, the STBL survey data have been used in a number of research papers, all of which are co-authored by Federal

Reserve economists given the confidential nature of the dataset. For example, Friedman and Kuttner (1993) used STBL data to study credit conditions during the 1990-1991 economic recession and Asea and Blomberg (1998) focused on the behavior of lending standards over the cycle. Black and Rosen (2007) used STBL data to study the functioning of the monetary transmission mechanism in general. STBL data has also been used to study the likely effects of industry consolidation on the availability and pricing of small business loans (see Berger, Kashyap, and Scalise, 1995). Carpenter et al. (2001) used STBL data to show that more closely linking capital requirements to the riskiness of individual business loans might allow banks to set aside noticeably less capital for those loans and might not substantially change the cyclical behavior of required capital levels. Morgan and Ashcraft (2003) used the STBL to find that risk ratings on a bank's newly extended business loans help predict changes in the rating assigned to the bank by federal regulators. In the context of the recent financial crisis, Black and Hazelwood (2013) use STBL data to study the effect on bank risk taking of the capital injected through the Troubled Asset Relief Program (TARP) to stabilize U.S. banks.

B. Datasets and Variable Definitions

Our main analysis is at the loan level, combining loan level data from the STBL with bank-specific data from the Consolidated Reports of Condition and Income for commercial banks as well as regional macroeconomic indicators.

Loan variables: Risk rating is the ex-ante internal risk rating assigned by the bank to a given new loan, as reported in the STBL. The internal risk rating is a discrete index that increases with higher perceived risk. In the STBL scale, 1=Minimal Risk, 2=Low Risk, 3=Moderate Risk, 4=Acceptable Risk, and 5=Special Mention or Classified Asset. In addition,

for each loan, the STBL reports the name of the bank extending the loan, the size (in dollars) and maturity (in years) of the loan, whether or not the loan is secured by collateral, the pricing of the loan (interest rate), and whether or not the loan was made under previous commitment. We exploit all these loan-specific variables in our empirical strategy.

Bank variables: We complement data from the STBL with banks' balance sheet information from the quarterly Consolidated Reports of Condition and Income (FFIEC 031 and 041) (Call Reports) for commercial banks. We construct the following bank-specific variables: *Bank size* is the log of bank total assets; *Net income / assets* is the ratio of net income to total assets; *Liquid assets / assets* is the ratio of liquid assets to total assets; *Deposits / assets* is the ratio of total deposits to total assets; *Short-term deposits / deposits* is the ratio of short-term (i.e., up to one year) deposits to total deposits; *Non-retail deposits / deposits* is the ratio of non-retail deposits to total deposits; *Loans / assets* is the ratio of total loans to total assets; *C&I loans / loans* is the ratio of commercial and industrial loans to total loans; and *Tier 1 capital ratio* is the ratio of Tier 1 regulatory capital to total risk weighted assets.

In some specifications, we use alternative capitalization measures. *Total capital ratio* is the ratio of Tier 1 plus Tier 2 regulatory capital to total risk weighted assets; *Common stock / assets* is the ratio of common stock to total assets; and *Market capitalization / assets* is the ratio of stock market capitalization to total assets, where market capitalization is measured as the end-of-quarter stock market capitalization of the entire bank holding company (BHC) as reported in CRSP for the largest bank in the BHC.

We also use Call Report data to compute a nonperforming loan ratio for C&I loans, defined as the fraction of nonaccrual C&I loans in total C&I loans at the commercial bank level.

We use this measure of nonperforming loans to assess whether our ex-ante measure of risk taking based on loan ratings forecasts loan defaults.

Bank location is based on its headquarters as reported in the National Information Center (NIC) database. We use information on bank location to match bank-specific data with regional (state-specific) data.

Regional variables: Our regressions control for state- or region-level factors (where state-level factors are unavailable) to allow for the possibility that local conditions such as employment, inflation, house prices, and economic activity affect bank risk taking. At the state level, we consider: the growth rate in personal income taken from the Bureau of Economic Analysis (BEA); the unemployment rate, taken from the Bureau of Labor Statistics (BLS); and the annual rate of change in housing prices (quarter over quarter, annualized rate) based on the index published by the Office of Federal Housing Enterprise Oversight/Federal Housing Finance Agency (OFHEO/FHFA). At the regional level (as defined by the U.S. Census Bureau), we consider the annual rate of change in the consumer price index (CPI) (quarter over quarter, annualized rate) taken from BLS.

Nationwide variables: The short-term interest rate is measured using the three-month average target federal funds rate in nominal terms. By adjusting reserves, the Federal Reserve closely controls the market-determined effective federal funds rate, a process which allows it to implement monetary policy. The effective federal funds rate is a volume-weighted average of rates on trades arranged by major brokers and calculated daily by the Federal Reserve Bank of New York using data provided by the brokers.

As alternative short-term interest rate we use the one-year yield on U.S. Treasuries. In some specifications we also include the term spread defined as the difference between the ten-

year Treasury yield and the one-year Treasury yield. Data on Treasury yields are from the Federal Reserve Economic Data database of the Federal Reserve Bank of St. Louis.

In some specifications we use Taylor rule residuals as a measure of the exogenous component of monetary policy (when we use the federal funds rate, we control for economic conditions directly by including unemployment, income growth, GDP growth, and inflation in the regression). Taylor rule residuals are obtained from a regression of the target federal funds rate on the deviation of CPI inflation from 2% and the difference between actual and potential GDP growth from the second quarter of 1997 to the last quarter of 2011.

Other nationwide variables include Real GDP growth (quarter over quarter, annual rate), taken from the BEA. The dating of recessions (quarters) is taken from the National Bureau of Economic Research (NBER).The fraction of U.S. bank failures is taken from the U.S. Federal Deposit Insurance Corporation (FDIC) and is computed relative to the number of insured banks.

C. Descriptive Statistics of Main Variables

Table 1 reports summary statistics on our main regression variables. Descriptive statistics are reported separately for the complete sample of loans (panel A) and the subsample of loans that were not extended under previous commitment (panel B). The latter represents a sample of truly new loans. Because we are interested in the marginal impact on the riskiness of new loans, the main part of our regression analysis is based on this subsample of new loans. Descriptive statistics across the two samples are not markedly different and all the regression results we report are robust to using either sample. In what follows, we summarize descriptive statistics for the sample of loans that were not extended under previous commitment.

The average loan risk rating in the sample is 3.42, with a standard deviation of 0.84, indicating that the average loan over the sample period as reported by banks is somewhere between moderate risk (rating 3) and acceptable risk (rating 4). The average loan amount is US$ 552,945 but the variation is large, reflecting the fact that the STBL covers business loans to firms of all sizes. The average loan maturity is quite short, about 1.3 years, indicating that a substantial fraction of loans are for the financing of working capital and other short-term financing needs. The banks in the sample have a Tier 1 capital ratio of 12.3 percent on average, but the dispersion is significant, with a standard deviation of 4.9 percent. Banks also vary significantly in size, averaging US$24 billion in total assets but with a standard deviation of over US$115 billion, indicating that the sample includes both small and large banks. The bank at the 25th percentile of total assets has US$ 359 million in assets. Banks on average are profitable (with average net income of 0.6 percent of total assets) but again the variation is substantial. And loans constitute the largest component of banks' balance sheets, averaging 64 percent of total assets, with business (C&I) loans forming an important component of total loans, at 21 percent of total loans on average. This suggests that our focus on the riskiness of business loans offers a reasonable representation of the riskiness of the overall asset portfolio of the average bank.

The federal funds rate also displays substantial variation over the sample period, averaging 3.0 percent in nominal terms but with a standard deviation of 2.2 percent. Finally, about one-fifth of quarters in the sample are recession periods.

Table 2 shows the distribution of loan risk ratings for the full sample of loans. The majority of loans obtain risk ratings of 3 or 4, and the average quality of loans varies over time, reaching a high of 3.5 in 2003. A not insignificant fraction of all loans obtain the worst rating of 5 (i.e., special mention or classified loan). One concern is that these loans have been restructured

or reclassified and are not truly new loans. In robustness checks we therefore exclude these loans from the sample.

A negative relationship between bank risk and the short-term interest rate, as measured using the nominal federal funds rate, is evident in the STBL data (see Figure 1). Here ex-ante bank risk taking is measured using the average loan risk rating for the full sample of loans. The data show a negative relationship between average bank risk rating and the nominal federal funds rate that is statistically significant at the 1% level, consistent with a negative relationship between interest rates and bank risk taking.[9]

6. Empirical Results

In this section we present our main results concerning the effect of monetary policy conditions on bank risk taking (as measured by the loan ratings reported to the STBL) and the role played by bank capitalization in this relationship. We also present several robustness checks that suggest that our baseline results are not driven by a response of monetary policy to bank risk taking.

A. Main Results

Table 3 reports the results from OLS regressions of bank loan risk ratings on the federal funds rate and control variables from the second quarter of 1997 to the fourth quarter of 2011. Regressions are estimated at the loan level with standard errors clustered at the quarter level. Obviously, loan risk ratings depend on loan characteristics such as maturity, collateral, and loan

[9] We obtain a very similar picture when using the real federal funds rate (nominal rate adjusted for CPI inflation) instead. After all, the correlation between the real and nominal federal funds rate is 0.9 over the sample period. We also obtain similar results when detrending variables using either a linear time trend or a Hodrick-Prescott filter.

size, and not controlling for these factors could confound the analysis on the relationship between interest rates and loan risk ratings. Similarly, bank characteristics (such as capitalization, profitability, and liquidity) and socio-economic characteristics (such as GDP growth, inflation, and unemployment) may impact the riskiness of loans issued by a bank at any given time. We therefore include a large set of loan-specific, bank-specific, and region-specific control variables.

In particular, we control for loan size, collateral, and maturity of the loan by including the following variables: Loan size (measured in logs), a dummy for secured loan (equal to 1 for loans secured by collateral), and loan maturity (in years). We supplement this with data on bank characteristics and socio-economic conditions obtained from commercial bank Call Reports and a variety of data sources (see Section 4 for details). Results are reported separately for the full sample (columns (1) to (3)) and the subsample of loans that were not extended under commitment prior to the quarter of the survey (columns (4) to (6)). The latter subset of loans represents about 60% of observations.

The reason for excluding loans made under commitment is twofold. First, these loans are likely to be less responsive (as opposed to "discretionary loans") to current macro conditions, including the interest rate environment. Including loans made under commitment into the sample could therefore underestimate the effect we focus on. We do not find this to be the case, however. Second, loans not made under commitment represent a sample of "discretionary" new loans and therefore better capture the marginal impact on the riskiness of new loans.

Results point to a significantly, negative relationship between short-term interest rates and ex-ante bank risk taking (columns (1) and (4)). The economic effect of this result is significant. Based on the regression estimates in column (4) of Table 3, where we exclude loans

extended under previous commitment from the sample, a one-standard deviation decrease in interest rates of 2.2 would suggest an increase in loan risk ratings of 0.06. (The same effect in the sample of all loans is 0.08). This is a significant though relatively small effect compared to the standard deviation of loan risk ratings of 0.8, suggesting that the overall impact of interest rate changes on bank risk taking are relatively modest. However, as we will see, this effect varies across different types of banks and across different periods.

Next, we consider the differential effect of bank capital on the link between interest rates and loan risk ratings, as predicted by our model. In columns (2) and (5), we estimate model (8) when including an interaction term between the federal funds rate variable and the Tier 1 capital ratio as measure of bank capital (or leverage). The Tier 1 capital ratio is computed as the ratio of Tier 1 capital to risk-weighted assets. Results in column (2) are based on the complete sample of loans and results in column (4) on the subset of loans that were not extended under previous commitment.

Consistent with our model predictions, we obtain a statistically significant, negative coefficient on the interaction term between bank capital and interest rates, irrespective of the sample of loans used. The economic effect is significant. Based on the estimates reported in column (5) of Table 3, the coefficient estimates imply that reducing interest rates from its 75th percentile of 5.25 to its 25th percentile of 1.00 is associated with an increase in loan risk ratings of 0.15 for a bank with a relatively high Tier 1 capital ratio at its 75th percentile but with an increase in loan risk ratings of 0.11 for a bank with a relatively low Tier 1 capital ratio at its 25th percentile.[10] The differential effect of 0.04 between strongly and weakly capitalized banks is significant but modest compared to the standard deviation in loan risk ratings of 0.8, and smaller

[10] Evaluated when setting other variables at their mean.

than in the sample of all loans (where the same differential effect amounts to 0.08). However, as we will see later, this effect differs markedly across U.S. regions and time periods.

Finally, in columns (3) and (6) we replace the level (but not the interactions) of the target federal funds rate with time-fixed effects to absorb any time-varying effects. Again, the difference between the two regressions is that the latter limits the sample to those loans that are not extended under previous commitment. The results on the interaction between capital ratios and federal funds rates are very similar when including time fixed effects, which suggests that our baseline results that include the level of the target federal funds rate are robust to controlling for economy-wide variation that is not captured by the target federal funds rate. In fact, the economic magnitude of our main result is somewhat larger when controlling for time-fixed effects (the same differential effect described in the previous paragraph is now 0.05).

The results with time fixed effects also give an indication of the range of interest rates over which increases in capital are associated with higher bank risk taking. Specifically, they indicate the inflection point in terms of the level of interest rates at which the effect of an increase in capital ratios on risk taking turns negative. For example, based on the regression results in column (3) using the full sample of loans, increases in Tier 1 capital ratios translate into a decrease in bank risk taking when the target federal funds rate exceeds 2.8 percent, which is the case for about half the quarters in the sample. However, for the sample of loans not under previous commitment, the level effect of capital enters insignificantly, indicating that the effect of capital on bank risk taking is negative at all levels of interest rates, consistent with the empirical prediction from our model.

Because our main interest lies in assessing the marginal effect of changes in interest rates on the riskiness of bank loans, from now on we focus on the subsample of loans that were not

extended under previous commitment. However, all the results we present are robust to using the full sample of loans instead.

B. Alternative measures of capital

Table 4 shows that the results are robust to using alternative measures of bank capital. We consider three alternative measures of capital. Column (1) of Table 3 reports results using the total capital ratio (which equals the ratio of Tier 1 plus Tier 2 capital to risk-weighted assets), which is a broader measure of regulatory capital than the Tier 1 capital ratio used in the baseline specification. The next regression replaces the Tier 1 capital ratio with the ratio of common equity to total assets, which is a measure of book leverage that (unlike the regulatory capital ratios) does not adjust for risk. In column (3), we use the ratio of stock market capitalization to total assets, which is a market-based measure of leverage of the bank. Market values tend to be more volatile than book values, and in particular tend to fluctuate more with the economic cycle. The results for the interaction term are qualitatively similar to the baseline specification, irrespective of the measure of bank capital used. Importantly, the results are robust to using measures of book leverage or market leverage. For the smaller sample of traded banks, bank size is no longer significant, while measures that relate to balance sheet liquidity (such as the liquid assets ratio and short-term deposits) gain importance.

In what follows, we focus on results obtained using the Tier 1 capital ratio, which is of primary interest to bank regulators, although results are qualitatively unaltered when using alternative measures of bank capital, including the market leverage ratio.

In robustness tests, we also include competing interaction effects using other bank characteristics, to control for channels other than bank capital. The results are summarized in

Appendix Table 2. In particular, we include interactions between the target federal funds rate and the following bank characteristics: bank size, profitability ratio, liquidity ratio, deposit to asset ratio, fraction of short-term deposits, fraction of non-retail deposits, loan to asset ratio, and fraction of C&I loans. Interestingly, we find that the association between interest rates and bank risk taking also fluctuates with bank profitability and liquidity. These effects are complementary to our main effect on bank capital in the sense that they point in the same direction (both obtain negative coefficients) and importantly the coefficient on the interaction with bank capital and its statistical significance are hardly affected by including these alternative interaction effects. These results further support our focus on bank capital as an important element of the risk taking channel of monetary policy.

C. Alternative interest rates

Table 5 shows that the results are robust to using alternative measures of the monetary policy stance. First, we replace the federal funds rate in the base specifications with Taylor rule residuals to isolate the component of the policy rate that is exogenous to changes in economic conditions (even though we already control for economic conditions by including unemployment, personal income growth, GDP growth, and inflation into the regressions). Taylor residuals are obtained from a regression of the target federal funds rate on the deviation of CPI inflation from 2% and the difference between actual GDP growth and potential GDP growth from the second quarter of 1997 to the last quarter of 2011. Our main results on the interaction between the Tier 1 capital ratio and interest rate policy variable (now captured by the Taylor rule residual) hold (column (2)). We also continue to find a significantly negative coefficient on the Taylor rule residual when not including the interaction term (column (1)).

We also tried an alternative specification in which the federal funds rate is replaced by the residual of a Taylor rule estimated over the period from the first quarter of 1985 to the second quarter of 2012 and obtain qualitatively similar results on the interaction between bank capital and the interest rate policy variable (not reported). The coefficients from this Taylor rule regression suggest relatively more sensitivity of policy interest rates with respect to inflation deviations from target than in our specification estimated over the period from the second quarter of 1997 to the last quarter of 2011.

In unreported regressions we also find that results are robust to replacing the nominal federal funds rate with the real federal funds rate, where the nominal federal funds rate is adjusted for inflation using the CPI index. This is not surprising given that over our sample period, the correlation between nominal and real effective federal funds rates is high at 0.9.

In columns (3) and (4), we find that results are robust to using the one-year Treasury yield as proxy for interest rates rather than the federal funds rate. Again, this is not surprising given the close association between federal funds rates and short-term Treasury yields.

Changes in monetary conditions can also affect risk taking by changing the term premia reflected in long-term interest rates (Hanson and Stein, 2013). In column (5), we therefore assess whether our main result is robust to controlling for the term spread between ten-year and one-year Treasury yields. We continue to find a significantly negative coefficient on the interaction term between bank capital and short-term interest rates.

Finally, we are concerned that our result on the interaction term between bank capital and the federal funds rate may be driven by the business cycle, either because bank capital fluctuates with the economic cycle or because the risk rating scale adjusts endogenously with the state of the economy, potentially generating a bias in the estimated coefficients. Specifically, if loan

officers are more optimistic with respect to risk during expansions, we would expect risk as reported to the survey to be underestimated during expansions.

For this reason, we control for economic conditions, either directly through the inclusion of the GDP growth and recession variables, or using a Taylor rule specification. In addition, to further reduce concerns that our results are driven by risk ratings or bank capital being dependent on the state of the economy, we next run a regression that directly controls for the interaction between the target federal funds rate and the state of the economy, as captured by real U.S. GDP growth and a time-specific dummy variable for NBER recessions. The regression results are presented in column (6). We indeed find that the negative association between interest rates and bank risk taking depends on GDP growth, and in particular that the effect of the level of the federal funds rate becomes more pronounced during periods of strong GDP growth. Importantly, however, the coefficients on the interactions between the target federal funds rate and banks' capital ratios are roughly unchanged when controlling for the state of the economy. These results allay concerns that our findings on the interactions between the target federal funds rate and banks' capital ratios are simply driven by a cyclical bias in risk ratings or a close association between banks' capital ratios and the state of the economy.

D. Endogeneity of monetary policy

A key assumption underlying our identification approach is that interest rate changes induced by monetary policy are exogenous to bank risk taking, or more precisely, that monetary policy does not respond to the riskiness of newly issued loans. Currently, a debate is ongoing on whether monetary policy frameworks should be revised to include financial stability as an explicit target. It is fair to say, however, that prior to the recent financial crisis, financial stability

considerations played a limited role in the setting of monetary policy (this statement holds of course particularly for central banks with an explicit inflation targeting framework), at least in advanced economies.

One way to gauge the attention given to financial stability considerations in the setting of monetary policy in the United States prior to the crisis in 2007 is to analyze the contents of the minutes of the Federal Open Market Committee (FOMC) meetings, searching for keywords that are associated with financial stability. Specifically, we count the number of times each keyword appeared in FOMC minutes, and the number of reports each word appeared in. We compute both the total count and its frequency, determined as the number of times the word has been used within a time period divided by the number of quarters in that time period. We perform these counts for a total of 14 different keywords related to financial stability, varying from "bank risk" to "financial conditions". The results are summarized in Appendix Table 1.

With the exception of the keyword "financial conditions," which is a much broader concept than financial stability, we find that most keywords related to financial stability are rarely used in FOMC minutes, especially prior to the year 2007. Keywords such as "financial stability", "bank risk", and "systemic risk" did not appear even once during this period. Since 2007, as the recent financial crisis unfolded, keywords related to financial stability appeared more frequently in FOMC minutes, although the increase was small for most keywords. These results suggest that, at least until recently, financial stability considerations played a limited direct role in the setting of monetary policy.

This is of course a rough approximation, and in no way should this be interpreted as evidence that the Federal Reserve paid too little attention to financial stability risk. Instead, it is consistent with the then-well-established view that protecting financial stability was primarily

the job of supervisory and regulatory policy and that interest rate policy was to focus on its traditional goals of price stability and moderating deviations of output from its potential (Bernanke, 2002, 2011, and Mishkin, 2010).

Nevertheless, there is some evidence consistent with the view that monetary policy responded to financial stability concerns even prior to the recent financial crisis, including in advanced economies. For example, Peek, Rosengren, and Tootell (1999) estimate reaction functions for the U.S. policy rate over the period 1968-1994 and in addition to the standard set of macro forecast variables also include a proxy for average bank health (i.e., the fraction of banks with weak supervisory ratings). They find that bank health has an independent effect on policy rates, suggesting that the FOMC pays attention to bank health in the setting of monetary policy.

Therefore, we remain concerned that policy rates respond endogenously to bank risk and that this drives our results. While limiting the sample to new loans (i.e., those not made under prior commitment) and controlling for macroeconomic conditions (both directly and through Taylor rule residuals) help mitigate these concerns, we now perform several sample splits to address specific endogeneity concerns and help identification.

First, endogeneity is likely more of a concern for nationwide banks whose loan portfolio reflects economic activity across the nation than it is for small, local banks that are affected primarily by local shocks. We can therefore run regressions on subsamples of loans from local banks, excluding large banks for which endogeneity is more of a concern from the sample. Column (1) in Table 6 reports regression results when restricting the sample to small banks, with small banks defined as those with assets below the top quintile. We continue to find a significant, negative relationship between interest rates and loan risk ratings in this sample of relatively small banks. In fact, the negative coefficient on the interaction between bank capital and interest rates

is similar to that obtained in the full sample that includes large banks. This suggests that our results are not contaminated by the inclusion of large banks.

Second, endogeneity is less likely to be a concern in states with primarily local banks. After all, such banks are less likely to transmit shocks to the overall economy, and are therefore less likely to prompt a monetary policy response. Indeed, to the extent that monetary policy responds to financial shocks, it is more likely to respond to shocks that are not localized. Therefore, in column (2) of Table 6, we limit the sample of banks from states with small banking systems by excluding from the sample those states where banks in the top 1% of the asset distribution are headquartered. We continue to obtain a significant negative coefficient on the interaction term between bank capital and interest rates.

Third, since the monetary policy stance is likely to be driven by nationwide economic conditions, in column (3), we limit the sample to states whose business cycle is "less in sync" with the overall U.S. business cycle. More precisely, we rank states by the correlation of their income growth with the U.S. GDP growth and run our main specification for the subsample of states below the median correlation. If the results were primarily driven by the reaction of monetary policy to the cycle and the associated change in risk taking, they would become less significant in the subsample of states with cycles less correlated with the national cycle. Instead, our results are, if anything, stronger in the subsample of states where the cycle is less correlated with the national cycle. The economic effect is indeed stronger than in the base case: reducing interest rates from its 75th percentile to its 25th percentile would increase loan risk ratings for a strongly capitalized bank (with Tier 1 capital ratio at its 75th percentile) by 0.10 more than for a weakly capitalized bank (with Tier 1 capital ratio at its 25th percentile). This differential effect is substantial compared to the standard deviation in loan ratings of 0.84.

Fourth, monetary policy is likely to be more responsive to bank risk when banks are in distress, so the endogeneity of monetary policy is more of a concern during periods of financial crisis. Furthermore, risk shifting may be particularly pronounced during times of distress. We therefore rerun our main regression for the non-crisis period, with the crisis period defined as the years 2008-2010. This period is generally seen as the peak of the U.S. mortgage crisis and a period during which monetary policy responded strongly to financial stability concerns. For example, it was during the third quarter of 2007 that the Federal Reserve started to aggressively lower interest rates in response to growing signs of weakness in the U.S. financial system as evidenced by the closure of two hedge funds of Bear Stearns with exposure to mortgage-backed securities and the disclosure of financial difficulties at Countrywide Financial. Moreover, it is especially during periods of financial crises that banks will find it costly to issue capital and adjust leverage. This is especially true for the recent financial crisis when interbank markets froze and the supply of external capital for U.S. banks became scarce and turned expensive due in part to heightened concerns about bank insolvencies and increased counterparty risk between financial institutions. Therefore, we expect that the negative link between interest rates and bank risk taking is more pronounced for well capitalized banks only during periods when there are no financial crises and leverage can easily be adjusted to increase risk.

Consistent with our priors, we find that the negative effect of the interaction term between capital ratios and interest rates on bank risk taking is more pronounced during non-crisis periods (column (4)). During crisis periods, this relationship breaks down, and the coefficient turns insignificant (not reported). The economic effect of our main result for the non-crisis period is substantial, and somewhat larger than when estimated over the full sample. Results are qualitatively unaltered when expanding the crisis period to the years 2008-2011 (not reported).

Finally, in column (6), we limit the sample to periods with relatively few bank failures, using the number of bank failures as an alternative proxy for bank distress. Again, the endogeneity of monetary policy is more of a concern during periods with relatively many bank failures. We obtain data on the fraction of bank failures from the FDIC. We find that reductions in interest rates have a disproportionately positive effect on bank risk taking during periods when there are relatively few bank failures, consistent with our earlier results on non-crisis periods.

Taken together, these sample split regressions indicate that results are, if anything, more pronounced when excluding from the sample those observations for which endogeneity concerns are more pronounced (such as periods of financial instability during which financial stability considerations are more likely to have influenced monetary policy). These results therefore alleviate concerns that our results are contaminated by an endogenous response of policy rates to bank risk, and lend additional support to a causal interpretation of the link between interest rates, bank capital, and bank risk taking, at least during non-crisis times. At the same time, these results support the view that financial stability considerations played an important role in the setting of monetary policy in the post-2007 years, and that this endogenous response to bank risk has altered the link between interest rates, bank capital, and bank risk taking compared to non-crisis times.

E. Alternative risk measures

Thus far we have shown that our main results are robust to the use of alternative capital and interest rates measures, and we have considered the endogenous response of policy rates to bank risk. In what follows we consider other measures of risk taking to provide evidence in support of our ex-ante measure of risk taking.

In Table 7, we first show that results are robust to using the average risk rating weighted by the loan amount as proxy for ex-ante risk taking, indicating that the results are not driven by loan size effects. These results also indicate that the risk taking channel does not only impact individual loans but also operates at the aggregate loan portfolio level. Indeed, in unreported regressions with the loan amount as dependent variable we find that the interaction between the capital ratio and the federal funds rate also enters significantly and negatively, indicating that better capitalized banks not only increase the riskiness of the average loan but also the loan amount when interest rates are low, thereby increasing also the riskiness of the overall loan portfolio.

The regression in column (2) uses the effective interest rate on a given loan as alternative measure of risk. Consistent with our main results, we find that interest rates on loans are higher for well-capitalized banks when policy rates are low, suggesting that the pricing of new loans at least in part reflects the increased riskiness of these loans. To the extent that higher loan rates also reflect higher loan risk, at least from an ex-ante perspective, this result also lends additional support to the risk ratings as a measure of ex-ante risk taking.

Finally, we analyze to what extent our measure of ex-ante risk taking forecasts loan defaults. In column (3), we replace the dependent variable with a measure of future nonperforming loans (NPLs), computed as the ratio of nonaccrual C&I loans in total C&I loans for the bank four quarters ahead In a simple regression of the NPL variable four quarters ahead on current loan risk ratings (averaged at the bank level and weighted by the loan amount) with bank fixed effects, we find that risk ratings have significant predictive power in explaining future loan defaults. Results are similar when including bank fixed effects (column (4)). These results are robust to using longer leads of the future NPL ratio (8 or 12 quarters) and to using an NPL

ratio based on nonaccruals for total loans (including loans other than C&I loans) (not reported). These results indicate that our ex-ante measure of risk taking correlates with ex-post loan performance and provide additional comfort to using loan ratings as a measure of ex-ante risk taking.

Taken together, these robustness checks and results mitigate endogeneity concerns and lend additional support to our assertion that bank leverage is a key factor driving the risk taking channel of monetary policy.

F. Nonlinearities in the effects of capital

Thus far we have not considered the possibility that there may be non-linearities in the way the interaction term between bank capital and interest rates affects risk taking. However, this may well be the case since risk-shifting is likely to become increasingly more pronounced as capital is depleted and limited liability is more likely to be binding (see for instance Dell'Ariccia, Laeven, and Marquez, 2014).

In column (1) of Table 8, we test this prediction by rerunning our base specification when limiting the sample to banks with capital ratios close to the regulatory minimum, defined as a Tier 1 ratio within 3 percentage points of the regulatory minimum of 4% (i.e., below 7%). Consistent with the prediction from the risk-shifting literature, we find that the interaction effect becomes much larger (although it loses significance in a much reduced sample) for banks with relatively low levels of capital.

Similarly, the magnitude of the interaction effect will depend on the strength of the pass-through effect, which in turn will depend on the local market structure of the banking industry. In particular, one would expect the pass-through effect to be smaller in a more concentrated market.

In such markets, market power will reduce the extent to which lending rates reflect changes in policy rates. As the pass-through effect gets smaller, the net effect due to risk shifting gets larger, and the magnitude of the interaction effect increases. This is exactly what we find when limiting the sample to banks in states with relatively high concentration. Specifically, in column (2) we limit the sample to loans from banks in states with high bank concentration, defined as a Herfindahl-Hirschman index of banks' shares in the volume of STBL loans at the state level above the sample median. The interaction term on bank capital and interest rates obtains a statistically significant coefficient that is substantially larger in absolute terms compared to our base specification, consistent with a relatively stronger risk shifting effect.

Next, we consider nonlinearities in the effects of capital by focusing on the riskiest categories of loan ratings. In columns (3) and (4), we limit the sample to exclude loans with a risk rating of 5, which are the riskiest loans. We find that the interaction effect on bank capital and interest rates remains significantly negative when excluding the riskiest loans from the sample, although the size of the estimated coefficient is somewhat smaller. This result also allays concerns that our results are driven by outliers in risk ratings or a misclassification of new loans as classified loans.

In columns (5) and (6), we focus on the riskiest loan categories by estimating the probability that loan ratings are assigned a rating of 4 or 5 using logit regressions. The interaction term between the bank's capital ratio and the federal funds rate continues to yield a significantly negative coefficient. These results are confirmed in multinomial logit regressions of bank loan ratings (see Appendix Table 3), in which we obtain negative log-odds coefficients on the interaction term between capital and interest rates, with the log-odds coefficients increasing in the risk rating and obtaining the highest value (in absolute terms) for those loans with a risk

rating of 4 or 5. Overall, these results indicate that our main effect on the interaction with capital is particularly pronounced at higher levels of capital and for the riskiest loans.

7. Conclusions

This paper provides strong evidence that a low short-term interest rate environment increases bank risk taking (at least on the new loan issuance margin). Our empirical analysis shows that a one-standard deviation decrease in interest rates would result in an increase in risk ratings for new loans of about 0.06 (compared to its standard deviation of 0.8). Moreover, consistent with theoretical models of bank leverage and risk taking that embed risk shifting behavior, we find that the effect depends on the degree of bank capitalization: the effect of interest rates on bank risk taking is less pronounced for poorly capitalized banks. (For these banks, risk shifting and portfolio rebalancing effects tend to offset each other.)

We obtain these results using loan-level data on newly issued loans, which is critical to assess the impact on general credit conditions, on the riskiness of U.S. bank loans. This is contrast to most existing studies that have largely relied on firm-level or aggregate measures of risk in other countries. By restricting our attention to the extension of new loans, we can focus on ex-ante risk taking, contrary to most existing studies that analyze ex-post loan performance which could be affected by subsequent events. Finally, by conditioning on bank leverage, our analysis links to theoretical literature on banking that predicts that risk taking is a function of a bank's capital structure.

The results survive a battery of robustness tests; in particular, those designed to allay concerns of monetary policy endogeneity. For instance, the effect is more pronounced in states

with economies less in sync with the nationwide business cycle and that are, hence, less likely to affect monetary policy decisions.

While our results are statistically significant and robust, their economic magnitude is relatively small. Taken in isolation they are unlikely to sway the debate on whether monetary policy should concern itself more explicitly with financial stability. For instance, based on our results alone, it would be hard to make the case that some financial stability indicator should be added to traditional Taylor rules. Yet, it is important to note that this paper focused on a very specific margin of risk taking: the riskiness of new loans. The effect on the overall asset portfolio of banks could be different. And there are several other channels through which interest rate policy can affect bank stability: leverage, liquidity, maturity mismatches, etc. (Adrian and Shin, 2009). As it has been the case for the lending channel literature, it might be easier to establish the existence of a risk taking channel than to quantify reliably its importance (cf. Kashyap and Stein, 2000).

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Figure 1. Interest Rates and Bank Risk Taking

This figure plots the average loan risk rating from the U.S. Survey of Terms of Business Lending against the target nominal federal funds rate based on quarterly data from the second quarter of 1997 until the fourth quarter of 2011. The solid line represents the fitted values from a regression based on the two variables.

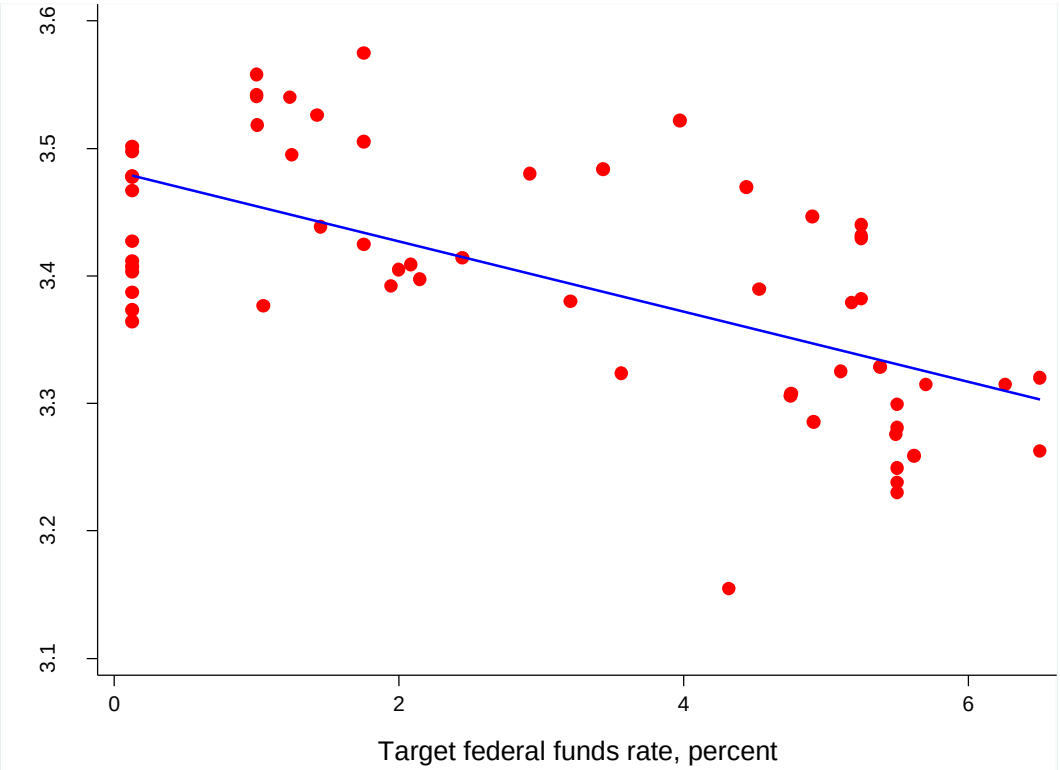

Table 1. Summary Statistics

This table reports descriptive statistics of the variables used in our baseline regressions. The sample includes loans reported to the Federal Reserve's STBL from the second quarter of 1997 to the fourth quarter of 2011. Risk rating is the internal risk rating assigned by the bank to a given loan, as reported in STBL, with 1=Minimal Risk, 2=Low Risk, 3=Moderate Risk, 4=Acceptable Risk, and 5=Special Mention or Classified Asset. Loan size, the dummy for loans secured by collateral, and loan maturity (in years) are taken from the STBL. Bank location is based on its headquarters, as reported in the NIC database. Bank total assets, capital, profitability, liquidity, deposit, and loan ratios are taken from Call Report data. Real GDP growth and state personal income growth are from the BEA, change in region CPI and state unemployment rate are from the BLS, and the change in state housing prices is based on indexes published by OFHEO/FHFA. Growth rates are reported as annual rates. Recession dates are from the NBER. Panel A includes all loans with non-missing observations. Panel B further restricts the sample by excluding loans extended under commitment established prior to the current quarter from the sample.

Panel A: Full sample

	Observations	Average	25th percentile	75th percentile	Standard deviation
Loan-level variables					
Risk rating	1,348,857	3.396	3	4	0.841
Loan size (dollars)	1,348,857	576,431	16,220	182,672	4,874,028
Dummy for loans secured by collateral	1,348,857	0.798	1	1	0.401
Loan maturity (years)	1,348,857	1.277	0.318	1.321	1.882
Bank-level variables					
Tier 1 capital ratio	12,065	0.123	0.095	0.136	0.048
Total capital ratio	12,065	0.139	0.111	0.151	0.046
Common stock / assets	12,065	0.006	0.001	0.007	0.011
Bank total assets ($ millions)	12,065	21,104	307	5,806	103,944
Net income / assets	12,065	0.006	0.003	0.010	0.009
Liquid assets / assets	12,065	0.027	0.013	0.035	0.019
Deposits / assets	12,065	0.780	0.725	0.858	0.103
Short-term deposits / deposits	12,065	0.018	0.000	0.000	0.070
Non-retail deposits / deposits	12,065	0.364	0.190	0.462	0.289
Loans / assets	12,065	0.639	0.565	0.736	0.142
C&I loans / loans	12,065	0.217	0.130	0.275	0.126
Regional variables					
State personal income growth (%)	2,602	2.114	-0.549	4.794	4.824
Change in region CPI (%)	236	2.386	1.112	3.985	2.908
State unemployment rate (%)	2,602	5.443	4.000	6.233	2.085
Change in state housing prices (%)	2,602	3.102	-0.521	7.731	8.340
Nationwide variables					
Target federal funds rate (%)	59	3.012	1.000	5.250	2.203

Real GDP growth (%)	59	2.257	1.318	3.600	2.837
NBER recession	59	0.186	0	0	0.393

Panel B: Excluding loans extended under prior commitment

	Observations	Average	25th percentile	75th percentile	Standard deviation
Loan-level variables					
Risk rating	789,194	3.423	3	4	0.836
Loan size (dollars)	789,194	552,945	18,030	177,249	5,239,055
Dummy for loans secured by collateral	789,194	0.802	1	1	0.398
Loan maturity (years)	789,194	1.306	0.326	1.332	1.904
Bank-level variables					
Tier 1 capital ratio	9,610	0.123	0.095	0.136	0.049
Total capital ratio	9,610	0.139	0.111	0.151	0.048
Common stock / assets	9,610	0.006	0.001	0.007	0.011
Total assets ($ millions)	9,610	24,299	359	6,535	115,081
Net income / assets	9,610	0.006	0.003	0.010	0.010
Liquid assets / assets	9,610	0.026	0.013	0.033	0.018
Deposits / assets	9,610	0.781	0.724	0.860	0.102
Short-term deposits / deposits	9,610	0.016	0.000	0.000	0.059
Non-retail deposits / deposits	9,610	0.360	0.189	0.462	0.284
Loans / assets	9,610	0.639	0.567	0.737	0.144
C&I loans / loans	9,610	0.213	0.130	0.270	0.120
Regional variables					
State personal income growth (%)	2,471	2.112	-0.560	4.803	4.876
Change in region CPI (%)	236	2.386	1.112	3.985	2.908
State unemployment rate (%)	2,471	5.477	4.000	6.300	2.088
Change in state housing prices (%)	2,471	2.946	-0.703	7.597	8.357
Nationwide variables					
Target federal funds rate (%)	59	3.012	1.000	5.250	2.203
Real GDP growth (%)	59	2.257	1.318	3.600	2.837
NBER recession	59	0.186	0	0	0.393

Table 2. Distribution of Risk Ratings

This table shows the annual distribution of loan risk ratings from the second quarter of 1997 to the fourth quarter of 2011 for the full sample of loans. Risk rating is the internal risk rating assigned by the bank to a given loan, as reported in STBL, with 1=Minimal Risk, 2=Low Risk, 3=Moderate Risk, 4=Acceptable Risk, and 5=Special Mention or Classified Asset.

Year	Fraction of all loans with risk rating of:					Average risk rating
	1	2	3	4	5	
1997	3%	11%	50%	31%	6%	3.27
1998	3%	10%	52%	30%	5%	3.26
1999	2%	8%	51%	33%	6%	3.32
2000	2%	9%	51%	31%	6%	3.30
2001	3%	13%	44%	32%	8%	3.28
2002	2%	8%	40%	40%	11%	3.49
2003	2%	7%	38%	42%	11%	3.53
2004	2%	8%	38%	41%	10%	3.50
2005	1%	6%	45%	39%	8%	3.47
2006	2%	6%	46%	39%	7%	3.45
2007	2%	8%	46%	37%	7%	3.40
2008	2%	9%	46%	36%	8%	3.39
2009	2%	9%	44%	34%	12%	3.44
2010	2%	9%	44%	33%	13%	3.47
2011	2%	10%	45%	34%	9%	3.39
All	3%	11%	50%	31%	6%	3.27

Table 3. Loan Risk Ratings, the Federal Funds Rate, and Bank Capital

This table reports panel regression estimates of bank loan risk ratings from the second quarter of 1997 to the fourth quarter of 2011 including interactions between the target federal funds rate and bank capital ratios. The dependent variable is the internal risk rating assigned by the bank to a given loan, as reported in the Federal Reserve's STBL. Real GDP growth and state personal income growth are from the BEA, change in region CPI and state unemployment rate are from the BLS, and the change in housing prices is based on indexes published by OFHEO/FHFA. Bank size is measured as the log of total assets, and bank assets and Tier 1 capital ratio are both taken from Call Report data. Regressions in columns (4) to (6) exclude loans extended under commitment established prior to the current quarter from the sample. Columns (3) and (6) report results of replacing the target federal funds rate with quarter-fixed effects. All regressions include state- and bank-fixed effects. Standard errors clustered by quarter are reported in brackets. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	Full sample			Loans not under commitment		
			Fixed effects			Fixed effects
	(1)	(2)	(3)	(4)	(5)	(6)
Target federal funds rate	-0.035***	0.004		-0.026***	-0.007	
	[0.006]	[0.009]		[0.004]	[0.008]	
Tier 1 capital ratio	-0.869***	0.203	1.424***	-1.915***	-1.414***	-0.047
	[0.311]	[0.352]	[0.326]	[0.363]	[0.371]	[0.366]
Tier 1 capital ratio × target		-0.447***	-0.527***		-0.220***	-0.246***
federal funds rate		[0.070]	[0.077]		[0.064]	[0.071]
Bank size	0.102***	0.106***	0.096***	0.158***	0.154***	0.150***
	[0.017]	[0.017]	[0.019]	[0.017]	[0.017]	[0.026]
Net income / assets	0.886	0.613	0.802	0.455	0.258	0.877
	[0.947]	[0.950]	[0.790]	[0.744]	[0.763]	[0.799]
Liquid assets / assets	0.199	0.371	-0.323	2.423***	2.447***	1.382**
	[0.540]	[0.547]	[0.522]	[0.672]	[0.677]	[0.568]
Deposits / assets	-0.176	-0.170	-0.210	-0.643***	-0.626***	-0.605***
	[0.142]	[0.140]	[0.155]	[0.167]	[0.166]	[0.171]
Short-term deposits / deposits	-0.326***	-0.357***	-0.472***	0.377***	0.318***	0.287***
	[0.111]	[0.111]	[0.112]	[0.113]	[0.118]	[0.101]
Non-retail deposits / deposits	0.041	0.052	-0.007	0.099	0.103	0.053
	[0.058]	[0.059]	[0.056]	[0.081]	[0.080]	[0.071]
Loans / assets	0.176	0.174	0.220	-0.395***	-0.385***	-0.364***
	[0.127]	[0.127]	[0.133]	[0.096]	[0.095]	[0.098]
C&I loans / loans	0.178	0.147	0.604***	-0.108	-0.092	0.203
	[0.123]	[0.125]	[0.137]	[0.136]	[0.137]	[0.136]
Loan size	-0.031***	-0.031***	-0.031***	-0.024***	-0.024***	-0.024***
	[0.002]	[0.002]	[0.002]	[0.001]	[0.002]	[0.002]
Dummy for secured loans	0.253***	0.253***	0.252***	0.207***	0.207***	0.207***
	[0.008]	[0.008]	[0.008]	[0.008]	[0.007]	[0.007]
Loan maturity	-0.011***	-0.011***	-0.011***	-0.013***	-0.013***	-0.014***
	[0.002]	[0.002]	[0.002]	[0.003]	[0.003]	[0.003]
GDP growth	0.001	0.001	0.000	0.001	0.001	0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]

NBER recession dummy	0.002	0.002	0.001	0.001	0.001	-0.002
	[0.002]	[0.002]	[0.008]	[0.002]	[0.002]	[0.007]
State personal income growth	-0.020***	-0.024***	-0.017***	-0.006	-0.008*	-0.013**
	[0.006]	[0.006]	[0.006]	[0.004]	[0.005]	[0.006]
Change in region CPI	0.000	0.001	0.000	0.000	0.000	0.000
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
State unemployment rate	-0.003	-0.002		0.000	0.000	
	[0.003]	[0.003]		[0.003]	[0.003]	
Change in state housing prices	-0.103***	-0.099***		-0.108***	-0.104***	
	[0.022]	[0.023]		[0.019]	[0.019]	
Constant	2.057***	1.957***	1.725***	1.626***	1.645***	1.443***
	[0.358]	[0.358]	[0.401]	[0.267]	[0.265]	[0.458]
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-year fixed effects	No	No	Yes	No	No	Yes
Observations	1,348,857	1,348,857	1,348,857	789,194	789,194	789,194
Number of banks	589	589	589	549	549	549
R^2	0.169	0.170	0.174	0.203	0.203	0.206

Table 4. Alternative Measures of Bank Capital

This table reports the results of estimating panel regressions of bank loan risk ratings from the second quarter of 1997 to the fourth quarter of 2011 including interactions between the target federal funds rate and bank capital. The dependent variable is the internal risk rating assigned by the bank a given loan, as reported in the Federal Reserve's Survey of Terms of Business Lending (STBL). State personal income growth is from the BEA, change in region CPI and state unemployment rate are from the BLS, and the change in housing prices is based on indexes published by OFHEO/FHFA. Bank size is measured as the log of total assets, and bank assets and capital ratios are both taken from Call Report data, except for the stock market capitalization-to-assets ratio. Total capital ratio is Tier 1 plus Tier 2 capital to risk-weighted assets. Market capitalization is taken from CRSP, measured at the end of the quarter at the BHC level, and is defined only for the largest bank in the BHC. Loans extended under commitment established prior to the current quarter are excluded from the sample. All regressions include state- and bank-fixed effects. Standard errors clustered by quarter are reported in brackets. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	(1)	(2)	(3)
Target federal funds rate	0.014	-0.024***	0.028*
	[0.009]	[0.004]	[0.015]
Total capital ratio	-0.829**		
	[0.392]		
Total capital ratio × target federal funds rate	-0.339***		
	[0.057]		
Common stock / assets		6.098***	
		[1.746]	
(Common stock /assets) × target federal funds rate		-0.731***	
		[0.250]	
Market capitalization / assets			0.922***
			[0.211]
(Market capitalization / assets) × target federal funds rate			-0.175***
			[0.040]
Bank size	0.151***	0.162***	0.200***
	[0.017]	[0.017]	[0.056]
Net income / assets	0.122	-0.046	0.152
	[0.772]	[0.786]	[0.863]
Liquid assets / assets	2.592***	2.241***	2.897***
	[0.701]	[0.705]	[0.915]
Deposits / assets	-0.674***	-0.594***	1.869***
	[0.173]	[0.166]	[0.285]
Short-term deposits / deposits	0.340***	0.422***	0.726***
	[0.116]	[0.121]	[0.170]
Non-retail deposits / deposits	0.113	0.158*	0.974***
	[0.083]	[0.082]	[0.132]
Loans / assets	-0.377***	-0.240***	0.667***
	[0.099]	[0.088]	[0.218]
C&I loans / loans	-0.052	0.002	-0.376
	[0.136]	[0.128]	[0.247]
Loan size	-0.024***	-0.024***	-0.048***
	[0.002]	[0.001]	[0.003]

Dummy for secured loans	0.207***	0.206***	0.276***
	[0.007]	[0.008]	[0.014]
Loan maturity	-0.013***	-0.013***	-0.022***
	[0.003]	[0.003]	[0.002]
GDP growth	-0.001	0.000	0.000
	[0.003]	[0.003]	[0.004]
NBER recession dummy	-0.102***	-0.098***	0.001
	[0.020]	[0.020]	[0.040]
State personal income growth	0.001	0.001	0.001
	[0.001]	[0.001]	[0.002]
Change in region CPI	0.001	0.001	0.004*
	[0.002]	[0.002]	[0.002]
State unemployment rate	-0.007	-0.012**	0.025**
	[0.005]	[0.005]	[0.011]
Change in state housing prices	0.001	0.001	-0.001
	[0.001]	[0.001]	[0.001]
Constant	1.679***	1.215***	-2.306**
	[0.273]	[0.275]	[1.050]
Observations	789,194	789,194	239,374
Number of banks	0.203	0.203	0.243
R^2	549	549	117

Table 5. Alternative Interest Rates

This table reports the results of estimating panel regressions of bank loan risk ratings from the second quarter of 1997 to the fourth quarter of 2011. The dependent variable is the internal risk rating assigned by the bank a given loan, as reported in the Federal Reserve's Survey of Terms of Business Lending (STBL). Loans extended under commitment established prior to the current quarter are excluded from the sample. Taylor rule residuals are obtained from a regression of the target federal funds rate on the deviation of CPI inflation from 2% and the difference between actual GDP growth and potential GDP growth from 1997:2 to 2011:4. 1-year Treasury yield is the one-year yield on U.S. Treasuries. The term spread is the difference between the 10-year Treasury yield and the 1-year Treasury yield. The regression in column (6) includes interactions between the target federal funds rate and bank capital, as well as interactions between the target federal funds rate and both real U.S. GDP growth and a time-specific dummy for NBER recessions. All panel regressions include state- and bank-fixed effects. Standard errors clustered by quarter are reported in brackets. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	(1)	(2)	(3)	(4)	(5)	(6)
Target federal funds rate						0.003
						[0.008]
Taylor rule residual	-0.027***	-0.008				
	[0.004]	[0.008]				
1-year Treasury yield			-0.026***	-0.004	0.038	
			[0.005]	[0.009]	[0.032]	
Term spread					0.059	
					[0.044]	
Tier 1 capital ratio	-1.920***	-2.081***	-1.980***	-1.419***	-0.292	-1.341***
	[0.363]	[0.372]	[0.364]	[0.378]	[1.032]	[0.380]
Tier 1 capital ratio × Target federal funds rate						-0.213***
						[0.065]
Tier 1 capital ratio × Taylor rule residual		-0.204***				
		[0.066]				
Tier 1 capital ratio × 1-year Treasury yield				-0.236***	-0.447**	
				[0.067]	[0.188]	
Tier 1 capital ratio × Term spread					-0.310	
					[0.290]	
Bank size	0.158***	0.154***	0.153***	0.149***	0.163***	0.151***
	[0.017]	[0.017]	[0.018]	[0.018]	[0.021]	[0.018]
Net income / assets	0.470	0.299	0.451	0.247	0.267	0.058
	[0.745]	[0.765]	[0.738]	[0.758]	[0.757]	[0.767]
Liquid assets / assets	2.425***	2.456***	2.525***	2.564***	2.369***	2.271***
	[0.672]	[0.676]	[0.683]	[0.690]	[0.659]	[0.702]
Deposits / assets	-0.643***	-0.626***	-0.666***	-0.656***	-0.636***	-0.665***
	[0.167]	[0.167]	[0.173]	[0.172]	[0.174]	[0.164]
Short-term deposits / deposits	0.380***	0.329***	0.309**	0.253*	0.260*	0.331***
	[0.112]	[0.118]	[0.124]	[0.130]	[0.132]	[0.118]
Non-retail deposits / deposits	0.099	0.103	0.100	0.102	0.093	0.085
	[0.080]	[0.080]	[0.082]	[0.082]	[0.081]	[0.081]
Loans / assets	-0.392***	-0.382***	-0.393***	-0.385***	-0.392***	-0.374***
	[0.096]	[0.096]	[0.097]	[0.096]	[0.097]	[0.097]

C&I loans / loans	-0.106	-0.095	-0.126	-0.111	-0.117	-0.069
	[0.136]	[0.137]	[0.137]	[0.138]	[0.140]	[0.144]
Loan size	-0.024***	-0.024***	-0.024***	-0.024***	-0.024***	-0.024***
	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]	[0.002]
Dummy for secured loans	0.207***	0.207***	0.207***	0.207***	0.207***	0.206***
	[0.008]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]
Loan maturity	-0.013***	-0.013***	-0.013***	-0.013***	-0.013***	-0.013***
	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]
GDP growth	-0.002	-0.002	-0.001	-0.001	-0.001	0.009*
	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.005]
GDP growth × Target federal funds rate						-0.004***
						[0.001]
NBER recession dummy	-0.108***	-0.104***	-0.117***	-0.113***	-0.105***	-0.063*
	[0.019]	[0.019]	[0.020]	[0.020]	[0.020]	[0.033]
NBER recession dummy × Target federal funds rate						-0.013
						[0.011]
State personal income growth	0.001	0.001	0.000	0.000	0.000	0.000
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Change in region CPI	-0.007	-0.008*	-0.003	-0.004	-0.005	-0.008*
	[0.004]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]
State unemployment rate	-0.001	-0.001	0.001	0.001	0.000	0.000
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Change in state housing prices	0.000	0.000	0.001	0.001	0.001	0.000
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Constant	1.561***	1.629***	1.733***	1.746***	1.284***	1.707***
	[0.265]	[0.259]	[0.276]	[0.273]	[0.442]	[0.278]
Observations	789,194	789,194	789,194	789,194	789,194	789,194
Number of banks	549	549	549	549	549	549
R^2	0.203	0.203	0.203	0.203	0.203	0.203

Table 6. Bank Size, State Cyclicality, and Financial Stability Considerations

This table reports the results of estimating panel regressions of bank loan risk ratings from the second quarter of 1997 to the fourth quarter of 2011, including interactions between the target federal funds rate and bank capital ratios. Regression in column (1) restricts the sample to small banks. Small banks are defined as those with assets below the top quintile. Regression in column (2) excludes from the sample those states where banks in the top 1% of the asset distribution are headquartered. The sample in column (3) is loans by banks located in states where state income growth is not highly correlated with US GDP growth (i.e., below median correlation). The sample in column (4) excludes financial crisis periods (2008-2010). The sample in column (5) excludes periods with many bank failures, defined as above sample median bank failure rates, where the fraction of bank failures is taken from the FDIC and is computed relative to the number of insured banks. The dependent variable is the internal risk rating assigned by the bank to a given loan, as reported in the Federal Reserve's STBL. All other variables are defined as in Table 3. All regressions include state- and bank-fixed effects. Standard errors clustered by quarter are reported in brackets. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	(1) Small banks	(2) States without large banks	(3) States with low correlation with US GDP	(4) Noncrisis years	(5) Years with few bank failures
Target federal funds rate	0.024*	-0.011	0.035***	0.007	0.006
	[0.013]	[0.011]	[0.009]	[0.009]	[0.010]
Tier 1 capital ratio	-0.552	-0.674**	-1.873***	-0.867	-1.068**
	[0.455]	[0.317]	[0.477]	[0.624]	[0.522]
Tier 1 capital ratio × target federal funds rate	-0.373***	-0.325***	-0.564***	-0.420***	-0.216**
	[0.096]	[0.075]	[0.087]	[0.100]	[0.091]
Bank size	0.096***	0.119***	0.095***	0.164***	0.115***
	[0.028]	[0.019]	[0.022]	[0.017]	[0.027]
Net income / assets	0.965	2.795***	4.713***	-0.281	-1.845
	[0.939]	[0.916]	[0.937]	[1.255]	[1.535]
Liquid assets / assets	1.383*	3.601***	1.186	3.925***	0.868
	[0.794]	[0.616]	[0.800]	[0.670]	[0.751]
Deposits / assets	-0.222	-0.580**	-0.351	-0.686***	-0.699***
	[0.220]	[0.238]	[0.247]	[0.205]	[0.237]
Short-term deposits / deposits	0.761**	0.482***	-1.007***	0.281*	0.383**
	[0.318]	[0.151]	[0.155]	[0.149]	[0.187]
Non-retail deposits / deposits	-0.038	0.255***	0.083	0.059	-0.111
	[0.097]	[0.094]	[0.089]	[0.090]	[0.070]
Loans / assets	0.460***	-0.493***	-0.449***	-0.250*	-0.001
	[0.120]	[0.132]	[0.122]	[0.134]	[0.143]
C&I loans / loans	-0.404**	-0.478***	0.223	-0.260	-0.364*
	[0.153]	[0.144]	[0.142]	[0.177]	[0.213]
Loan size	-0.016***	-0.031***	0.000	-0.025***	-0.026***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Dummy for secured loans	0.086***	0.150***	0.165***	0.210***	0.204***
	[0.013]	[0.012]	[0.009]	[0.010]	[0.011]
Loan maturity	0.002	-0.007**	-0.022***	-0.010***	-0.008**
	[0.003]	[0.003]	[0.002]	[0.003]	[0.004]

GDP growth	-0.007*	0.000	0.005*	-0.009***	-0.011***
	[0.004]	[0.003]	[0.003]	[0.003]	[0.003]
NBER recession dummy	-0.060*	-0.154***	-0.042**	-0.104***	-0.097***
	[0.030]	[0.023]	[0.020]	[0.027]	[0.025]
State personal income growth	0.002	0.002**	0.002**	0.000	0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Change in region CPI	0.004	0.003	0.004**	-0.002	-0.003
	[0.003]	[0.002]	[0.002]	[0.002]	[0.002]
State unemployment rate	0.012**	-0.017***	0.004	-0.024**	0.075***
	[0.006]	[0.005]	[0.006]	[0.012]	[0.020]
Change in state housing prices	0.000	0.000	0.000	0.000	0.000
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Constant	2.025***	2.565***	2.259***	1.527***	1.966***
	[0.568]	[0.359]	[0.468]	[0.350]	[0.521]
Observations	180,227	474,011	357,846	546,749	457,653
Number of banks	490	522	227	530	462
R^2	0.335	0.243	0.149	0.224	0.244

Table 7. Alternative Measures of Risk and Non-Performing Loans

Regressions in columns (1) and (2) report the results of estimating loan-level panel regressions of weighted-average risk ratings and effective interest rates, respectively, from the second quarter of 1997 to the fourth quarter of 2011. The dependent variable in column (1) is the internal risk rating assigned by the bank a given loan, as reported in the Federal Reserve's Survey of Terms of Business Lending (STBL), and with observations weighted by loan size. The dependent variable in column (2) is the effective interest rate on a given loan, as reported in the STBL. Regression in column (3) reports the results of estimating panel regressions of bank-level future non-performing loans on average loans risk ratings. The dependent variable in column (3) is the ratio of nonaccrual C&I loans to total C&I loans 4 quarters ahead, as reported in the bank's Call Report. Average loan risk rating, Fraction of collateralized loans, and Average loan maturity are weighted by the loan amount. Loans extended under commitment established prior to the current quarter are excluded from the sample. The sample of banks corresponds to respondents to the STBL from the second quarter of 1997 to the fourth quarter of 2011. All regressions include state- and bank-fixed effects, except the regression in column (3) which only includes bank fixed effects. Standard errors clustered by quarter are reported in brackets. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	Ratings, WLS	Interest	Future NPLs
	(1)	(2)	(3)
Target federal funds rate	-0.006	1.094***	
	[0.007]	[0.026]	
Tier 1 capital ratio	-1.604***	4.635**	
	[0.358]	[2.294]	
Tier 1 capital ratio × target federal funds rate	-0.230***	-1.360***	
	[0.062]	[0.215]	
Average loan risk rating			0.001***
			[0.000]
Bank size	0.162***	-0.061	
	[0.017]	[0.059]	
Net income / assets	0.465	-7.156***	
	[0.791]	[1.919]	
Liquid assets / assets	2.567***	4.759***	
	[0.655]	[1.359]	
Deposits / assets	-0.677***	-0.384	
	[0.165]	[0.366]	
Short-term deposits / deposits	0.292**	-0.370	
	[0.112]	[0.417]	
Non-retail deposits / deposits	0.089	-0.455***	
	[0.079]	[0.130]	
Loans / assets	-0.397***	-0.578***	
	[0.094]	[0.196]	
C&I loans / loans	-0.044	-0.109	
	[0.131]	[0.301]	
Loan size	-0.030***	-0.203***	
	[0.002]	[0.005]	
Dummy for secured loans	0.223***	0.107***	
	[0.007]	[0.018]	

Loan maturity	-0.012***	0.070***	
	[0.003]	[0.007]	
GDP growth	0.000	0.008	
	[0.003]	[0.006]	
NBER recession dummy	-0.106***	-0.170***	
	[0.019]	[0.060]	
State personal income growth	0.001	-0.005	
	[0.001]	[0.004]	
Change in region CPI	0.001	-0.014***	
	[0.002]	[0.005]	
State unemployment rate	-0.008	0.098***	
	[0.005]	[0.013]	
Change in state housing prices	0.000	-0.002	
	[0.001]	[0.001]	
Constant	1.586***	6.653***	0.010***
	[0.270]	[1.089]	[0.001]
Observations	789,194	1,032,079	12,391
Number of banks	549	584	537
R^2	0.204	0.738	0.427

Table 8. Nonlinearities in the Effects of Capital

This table reports the results of estimating panel regressions of bank loan risk ratings from the second quarter of 1997 to the fourth quarter of 2011 including interactions between the target federal funds rate and bank capital. The dependent variable is the internal risk rating assigned by the bank a given loan, as reported in the Federal Reserve's Survey of Terms of Business Lending (STBL). The sample in column (1) includes only banks with tier 1 capital ratios within 3 percentage points of 4%. The sample in column (2) includes only loans from banks in states with high bank concentration defined as a Herfindahl-Hirschman index of banks' shares in the volume of STBL loans at the state level above the sample median. The sample in regressions (3) and (4) exclude loans with the highest risk rating of 5. Regressions in columns (5) and (6) report the results of estimating logit regressions of the probability that a loan is rated as very risky using loans from the second quarter of 1997 to the fourth quarter of 2011. The dependent variable in columns (5) and (6) is the probability that the internal risk rating assigned by the bank to a given loan, as reported in the Federal Reserve's Survey of Terms of Business Lending (STBL), is 5 or 4 (the two riskiest categories). Loans extended under commitment established prior to the current quarter are excluded from the sample. All regressions except the logit regressions include state- and bank-fixed effects. Standard errors clustered by quarter are reported in brackets. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	Banks with capital ratios close to regulatory minimum	High state-level bank concentration	Excluding loans with risk rating of 5	Excluding loans with risk rating of 5	Logit of very risky loan	Logit of very risky loan
	(1)	(2)	(3)	(4)	(5)	(6)
Target federal funds rate	0.503	0.057**	-0.023***	-0.007	-0.070***	0.149***
	[0.348]	[0.023]	[0.003]	[0.006]	[0.015]	[0.034]
Tier 1 capital ratio	16.512*	-5.318***	-0.902***	-0.496*	-10.370***	-5.949***
	[9.719]	[0.694]	[0.267]	[0.268]	[1.401]	[1.338]
Tier 1 capital ratio × target federal funds rate	-6.753	-0.974***		-0.175***		-2.406***
	[5.096]	[0.211]		[0.050]		[0.383]
Bank size	-0.125	0.263***	0.166***	0.163***	-0.098***	-0.110***
	[0.171]	[0.045]	[0.015]	[0.015]	[0.014]	[0.013]
Net income / assets	-1.388	6.566***	-0.298	-0.456	5.318**	3.782
	[1.694]	[1.527]	[0.526]	[0.544]	[2.498]	[2.307]
Liquid assets / assets	10.787***	10.344***	2.563***	2.583***	5.001**	5.964***
	[3.819]	[1.494]	[0.571]	[0.575]	[1.942]	[1.880]
Deposits / assets	-2.137**	-1.576***	-0.284**	-0.270**	-2.640***	-2.800***
	[0.966]	[0.335]	[0.134]	[0.134]	[0.444]	[0.424]
Short-term deposits / deposits	0.860	-0.578*	0.494***	0.444***	1.333***	1.234***
	[0.670]	[0.294]	[0.108]	[0.109]	[0.428]	[0.449]
Non-retail deposits / deposits	-0.301	-0.096	0.149**	0.152**	-0.422***	-0.469***
	[0.294]	[0.163]	[0.068]	[0.067]	[0.150]	[0.137]
Loans / assets	-1.037	-1.420***	-0.317***	-0.309***	-0.366*	-0.391*
	[0.871]	[0.206]	[0.064]	[0.063]	[0.217]	[0.216]
C&I loans / loans	-1.412	0.756***	0.147	0.161	-1.877***	-1.954***
	[1.499]	[0.283]	[0.110]	[0.112]	[0.216]	[0.216]
Loan size	-0.057***	-0.013***	-0.027***	-0.028***	-0.049***	-0.051***
	[0.007]	[0.003]	[0.001]	[0.001]	[0.005]	[0.005]
Dummy for secured loans	0.304***	0.136***	0.165***	0.165***	0.622***	0.621***

	[0.019]	[0.012]	[0.007]	[0.007]	[0.029]	[0.028]
Loan maturity	-0.048***	-0.006	0.001	0.001	-0.048***	-0.048***
	[0.004]	[0.005]	[0.002]	[0.002]	[0.012]	[0.012]
GDP growth	-0.005	-0.006	-0.001	-0.001	-0.014	-0.012
	[0.005]	[0.005]	[0.002]	[0.002]	[0.011]	[0.010]
NBER recession dummy	0.110**	-0.258***	-0.098***	-0.095***	-0.332***	-0.297***
	[0.048]	[0.039]	[0.017]	[0.017]	[0.087]	[0.077]
State personal income growth	-0.001	0.004**	0.001	0.001	-0.002	-0.003
	[0.004]	[0.001]	[0.001]	[0.001]	[0.004]	[0.004]
Change in region CPI	0.002	0.008**	0.001	0.000	0.007	0.004
	[0.005]	[0.003]	[0.001]	[0.001]	[0.006]	[0.006]
State unemployment rate	0.127***	0.001	-0.025***	-0.026***	0.040**	0.031*
	[0.026]	[0.011]	[0.004]	[0.004]	[0.019]	[0.018]
Change in state housing prices	-0.001	0.001	0.001	0.001	-0.003	-0.002
	[0.003]	[0.001]	[0.001]	[0.001]	[0.004]	[0.004]
Constant	6.546*	0.977	1.004***	1.014***	5.174***	5.205***
	[3.539]	[0.889]	[0.215]	[0.215]	[0.547]	[0.516]
Observations	78,217	285,759	719,352	719,352	789,194	789,194
Number of banks	34	309	548	548	549	549
R^2	0.136	0.186	0.243	0.243		
Pseudo- R^2					0.037	0.039

Appendix Table 1. Frequency of Keywords Appearing in FOMC Minutes

This table reports the number of times and the frequency with which keywords related to financial stability are used in the minutes of the Federal Open Market (FOMC) meetings from the second quarter of 1997 to the fourth quarter of 2011. Frequency is the number of times a keyword has been used within a period divided by the number of quarters in that period. The conservative definition only considers the number of reports in which the keyword appears, regardless of the number of times the keyword is repeated in the same report (i.e., if a keyword appears several times in the same report, the keyword is still counted only once). The liberal definition considers the total number of times the keyword appears in the same report.

Keyword	# of times the keyword was used in FOMC meetings from 1997Q2 to 2011Q4		# of times the keyword was used in FOMC meetings from 1997Q2 to 2006Q4		# of times the keyword was used in FOMC meetings from 2007Q1 to 2011Q4		Frequency of times the keyword was used in FOMC meetings from 1997Q2 to 2006Q4		Frequency of times the keyword was used in FOMC meetings from 2007Q1 to 2011Q4	
	Conservative	Liberal	Conservative	Liberal	Conservative	Liberal	Conservative	Liberal	Conservative	Liberal
Bank risk	0	0	0	0	0	0	0.000	0.000	0.000	0.000
Banking risk	0	0	0	0	0	0	0.000	0.000	0.000	0.000
Banking sector	10	14	1	1	9	13	0.026	0.026	0.450	0.650
Banking system	15	19	3	3	12	16	0.077	0.077	0.600	0.800
Condition of the banking system	2	2	2	2	0	0	0.051	0.051	0.000	0.000
Financial conditions	112	351	74	187	39	167	1.897	4.795	1.950	8.350
Financial stability	14	17	0	0	14	17	0.000	0.000	0.700	0.850
Financial system	11	19	1	2	10	17	0.026	0.051	0.500	0.850
Health of the banking system	0	0	0	0	0	0	0.000	0.000	0.000	0.000
Risks to the financial system	1	1	0	0	1	1	0.000	0.000	0.050	0.050
Stability of the financial system	2	3	0	0	2	3	0.000	0.000	0.100	0.150
Systemic	2	4	0	0	2	4	0.000	0.000	0.100	0.200
Systemic risk	0	0	0	0	0	0	0.000	0.000	0.000	0.000
Troubles of the banking system	1	1	0	0	1	1	0.000	0.000	0.050	0.050

Appendix Table 2. Loan Risk Rating, the Federal Funds Rate, and Bank Characteristics

This table reports the results of estimating panel regressions of bank loan risk ratings from the second quarter of 1997 to the fourth quarter of 2011 including interactions between the target federal funds rate and all bank characteristics. The dependent variable is the internal risk rating assigned by the bank a given loan, as reported in the Federal Reserve's Survey of Terms of Business Lending (STBL). Loans extended under commitment established prior to the current quarter are excluded from the sample. All regressions include state- and bank-fixed effects. Standard errors clustered by quarter are reported in brackets. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Target federal funds rate	-0.007	0.016	0.000	0.024**	-0.048*	-0.002	-0.001	0.002	-0.002
	[0.008]	[0.023]	[0.008]	[0.010]	[0.025]	[0.009]	[0.011]	[0.023]	[0.010]
Tier 1 capital ratio	-1.414***	-1.359***	-1.470***	-1.114***	-1.298***	-1.375***	-1.396***	-1.398***	-1.405***
	[0.371]	[0.364]	[0.378]	[0.366]	[0.364]	[0.361]	[0.370]	[0.377]	[0.374]
Tier 1 capital ratio × target federal funds rate	-0.220***	-0.258***	-0.218***	-0.229***	-0.262***	-0.246***	-0.231***	-0.232***	-0.218***
	[0.064]	[0.059]	[0.063]	[0.062]	[0.066]	[0.063]	[0.067]	[0.080]	[0.063]
Bank size	0.154***	0.155***	0.153***	0.155***	0.159***	0.155***	0.157***	0.153***	0.154***
	[0.017]	[0.017]	[0.017]	[0.018]	[0.018]	[0.017]	[0.019]	[0.017]	[0.017]
Bank size × target federal funds rate		-0.001							
		[0.001]							
Net income / assets	0.258	0.242	1.153	0.013	0.150	0.231	0.253	0.296	0.238
	[0.763]	[0.765]	[0.861]	[0.785]	[0.763]	[0.765]	[0.764]	[0.755]	[0.764]
(Net income /assets) × target federal funds rate			-0.695**						
			[0.344]						
Liquid assets / assets	2.447***	2.581***	2.454***	4.974***	2.550***	2.494***	2.443***	2.427***	2.435***
	[0.677]	[0.672]	[0.676]	[0.875]	[0.684]	[0.664]	[0.678]	[0.664]	[0.671]
(Liquid assets / assets) × target federal funds rate				-0.985***					
				[0.181]					
Deposits / assets	-0.626***	-0.625***	-0.623***	-0.622***	-0.826***	-0.638***	-0.631***	-0.614***	-0.626***
	[0.166]	[0.166]	[0.168]	[0.165]	[0.211]	[0.166]	[0.168]	[0.164]	[0.166]
(Deposits / assets) × target federal funds rate					0.063*				
					[0.034]				
Short-term deposits /deposits	0.318***	0.350***	0.330***	0.295**	0.309**	0.461*	0.315**	0.306**	0.311**
	[0.118]	[0.120]	[0.118]	[0.120]	[0.118]	[0.250]	[0.118]	[0.126]	[0.121]
(Short-term deposits / deposits) × target federal funds rate						-0.036			
						[0.055]			
Non-retail deposits / deposits	0.103	0.103	0.103	0.092	0.099	0.096	0.126	0.106	0.106
	[0.080]	[0.081]	[0.081]	[0.080]	[0.081]	[0.080]	[0.081]	[0.083]	[0.081]

(Non-retail deposits / deposits) × target federal funds rate							-0.010		
							[0.016]		
Loans / assets	-0.385***	-0.394***	-0.394***	-0.414***	-0.399***	-0.389***	-0.384***	-0.364***	-0.371***
	[0.095]	[0.095]	[0.097]	[0.096]	[0.094]	[0.097]	[0.095]	[0.103]	[0.094]
(Loans / assets) × target federal funds rate								-0.011	
								[0.024]	
C&I loans / loans	-0.092	-0.106	-0.093	0.005	-0.050	-0.080	-0.071	-0.099	-0.021
	[0.137]	[0.140]	[0.137]	[0.132]	[0.135]	[0.136]	[0.134]	[0.136]	[0.164]
(C&I loans / loans) × target federal funds rate									-0.022
									[0.024]
Loan size	-0.024***	-0.024***	-0.024***	-0.024***	-0.024***	-0.024***	-0.024***	-0.024***	-0.024***
	[0.002]	[0.002]	[0.002]	[0.001]	[0.002]	[0.002]	[0.001]	[0.002]	[0.001]
Dummy for secured loans	0.207***	0.207***	0.207***	0.206***	0.207***	0.207***	0.207***	0.207***	0.206***
	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.008]	[0.007]	[0.007]	[0.007]
Loan maturity	-0.013***	-0.013***	-0.013***	-0.013***	-0.013***	-0.013***	-0.013***	-0.013***	-0.013***
	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]
GDP growth	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000	0.000
	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]
NBER recession dummy	-0.104***	-0.104***	-0.103***	-0.104***	-0.106***	-0.105***	-0.106***	-0.103***	-0.104***
	[0.019]	[0.020]	[0.021]	[0.018]	[0.020]	[0.020]	[0.020]	[0.019]	[0.019]
State personal income growth	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Change in region CPI	0.001	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.001
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
State unemployment rate	-0.008*	-0.007	-0.006	0.001	-0.008*	-0.007	-0.008*	-0.008*	-0.008*
	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]
Change in state housing prices	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Constant	1.645***	1.615***	1.643***	1.472***	1.681***	1.613***	1.570***	1.626***	1.611***
	[0.265]	[0.257]	[0.270]	[0.278]	[0.265]	[0.261]	[0.286]	[0.273]	[0.278]
Observations	789,194	789,194	789,194	789,194	789,194	789,194	789,194	789,194	789,194
Number of banks	549	549	549	549	549	549	549	549	549
R^2	0.203	0.203	0.203	0.204	0.203	0.203	0.203	0.203	0.203

Appendix Table 3. Loan Risk Rating, the Federal Funds Rate, and Bank Capital: Multinomial logit regressions

This table reports the results of estimating multinomial logit regressions of bank loan risk ratings from the second quarter of 1997 to the fourth quarter of 2011 including interactions between the target federal funds rate and bank capital. The dependent variable is the internal risk rating assigned by the bank a given loan, as reported in the Federal Reserve's Survey of Terms of Business Lending (STBL). Loans extended under commitment established prior to the current quarter are excluded from the sample. Standard errors clustered by quarter are reported in brackets below the corresponding log-odds coefficients. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	Risk rating = 2	Risk rating = 3	Risk rating = 4	Risk rating = 5
Target federal funds rate	0.101**	0.159***	0.309***	0.228***
	[0.047]	[0.037]	[0.061]	[0.063]
Tier 1 capital ratio	-0.299	1.537*	-4.800***	-3.947**
	[1.342]	[0.876]	[1.519]	[1.874]
Tier 1 capital ratio × target federal funds rate	-0.121	-1.328***	-3.527***	-3.370***
	[0.368]	[0.251]	[0.555]	[0.614]
Bank size	0.113***	0.255***	0.108***	0.143***
	[0.024]	[0.011]	[0.018]	[0.024]
Net income / assets	9.818**	10.551**	14.467***	10.478*
	[4.692]	[4.414]	[4.605]	[5.610]
Liquid assets / assets	-15.401***	3.964	9.401**	-1.565
	[4.181]	[2.820]	[3.812]	[4.785]
Deposits / assets	-1.110	0.805**	-2.059***	-3.343***
	[1.012]	[0.389]	[0.564]	[0.765]
Short-term deposits / deposits	-2.161***	-1.602***	0.108	-2.509***
	[0.467]	[0.545]	[0.627]	[0.917]
Non-retail deposits / deposits	0.109	0.325*	-0.141	-0.371
	[0.329]	[0.183]	[0.184]	[0.253]
Loans / assets	0.970**	0.989***	0.431	1.206***
	[0.474]	[0.209]	[0.289]	[0.320]
C&I loans / loans	-0.721**	1.036***	-1.753***	0.446
	[0.311]	[0.254]	[0.331]	[0.350]
Loan size	0.055***	-0.102***	-0.147***	-0.039***
	[0.012]	[0.009]	[0.009]	[0.014]
Dummy for secured loans	-0.570***	-0.280***	0.373***	0.048

		[0.072]	[0.046]	[0.055]	[0.062]
Loan maturity		0.059***	0.084***	0.053***	-0.142***
		[0.010]	[0.010]	[0.013]	[0.017]
GDP growth		0.025	-0.015	-0.025*	-0.002
		[0.019]	[0.012]	[0.014]	[0.017]
NBER recession dummy		0.139	-0.084	-0.340***	-0.345***
		[0.123]	[0.063]	[0.097]	[0.092]
State personal income growth		-0.001	-0.006	-0.008	-0.010
		[0.007]	[0.006]	[0.007]	[0.007]
Change in region CPI		0.010	0.016***	0.019**	0.016
		[0.010]	[0.006]	[0.009]	[0.010]
State unemployment rate		0.183***	0.052***	0.105***	0.094***
		[0.034]	[0.019]	[0.017]	[0.024]
Change in state housing prices		-0.002	-0.003	-0.005	-0.004
		[0.005]	[0.004]	[0.006]	[0.005]
Constant		-1.441	-2.234***	3.669***	1.460
		[1.619]	[0.461]	[0.706]	[0.957]
Observations	789,194				
Number of banks	549				
Pseudo R^2	0.041				