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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 banks' internal ratings 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 (measured by the risk rating of new loans) is negatively associated with increases in short-term 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 of financial distress.

JEL classifications: E43, E52, G21

Keywords: Interest rates, monetary policy, banks, leverage, risk

Non-Technical Summary

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. Some hold the view that interest rates were held too low for too long in the run up to the crisis, and that this helped fuel an asset price boom, spurring financial intermediaries to increase leverage and take on excessive risks.

This paper presents evidence of a risk-taking channel of monetary policy for the U.S. banking system. We use confidential data on banks' internal ratings on the quality of loans to businesses from the Federal Reserve's survey of terms of business lending. We find that the quality of lending – measured by the risk rating of new loans – goes down when short-term interest rates decrease. Consistent with a risk-shifting channel whereby equity owners of the bank transfer risk onto its debtholders, 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. Moreover, this relationship is more pronounced in regions that fluctuate less with the nationwide business cycle and less pronounced during periods when banking conditions are weak.

Taken together, our results indicate that interest rates have a small but economically meaningful effect on bank risk taking. Importantly our results are not well suited to answer whether or not the additional risk taking of banks in response to lower interest rates is excessive from society's standpoint. Moreover these results focus on a very specific margin of risk taking – the riskiness of new loans – and the effect on riskiness of the overall asset portfolio of banks could be different.

I. 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.[1] 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, 2010), and Acharya and Naqvi (2012)).

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-Jorgensen (2011), Farhi and Tirole (2012), 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) and Stein (2014)).

Theory offers ambiguous predictions on the relationship between the real interest rate and bank risk taking. Traditional portfolio allocation models predict that an exogenous increase in

[1] Financial accelerator models, while considering credit risk, have little to say about the implications of changes in interest rates on bank risk taking. In these models, monetary policy tightening, by increasing risk-free interest rates, leads to more severe agency problems by depressing borrowers net worth (Bernanke and Gertler (1989); and Bernanke, Gertler, and Gilchrist (1996)). The resulting equilibrium is one in which firms and banks more affected by agency problems find it harder to obtain external financing as more credit goes to firms with higher net worth. These models have little to say about overall credit risk in the system: while agency problems increase across the board, the marginal firm obtaining financing is of relatively better quality.

interest rates will reduce risk taking. A higher interest rate on safe assets leads to a reallocation from riskier securities towards safe assets, thus reducing the riskiness of the overall portfolio (Fishburn and Porter (1976)). At the same time, an increase in the risk-free rate may also affect the composition of the pool of risky securities. In particular, assuming that investment projects have limited scalability, a higher risk-free rate raises the hurdle rate for investment and induces agents to cut projects that have low return or/and high risk. The impact on the riskiness of the investment pool is ambiguous (Chodorow-Reich (2014)).

In contrast, the risk-shifting channel of monetary policy predicts a positive relationship between interest rates and bank risk taking. In these models, the asymmetric information between banks and their borrowers prevents bank creditors (and depositors) from pricing risk at the margin. This friction together with limited liability leads banks to take excessive risk. As a result, an increase in the interest rate banks have to pay on deposits will exacerbate the agency problem associated with limited liability and inefficiently increase bank risk taking. 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 (see, for instance, Stiglitz and Weiss (1981), Hellman, Murdock, and Stiglitz (2000), and Acharya and Viswanathan (2011)). Thus, in traditional 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 (Dell'Ariccia, Laeven, and Marquez (2014)).

Specifically, Dell'Ariccia, Laeven, and Marquez (2014) find that the way changes in risk-free rates affect bank risk taking depends on how much banks are able to pass these changes onto lending rates and on how they optimally adjust their capital structure in response to such changes (the Appendix presents a simplified version of this model). The pass-through effect acts through the asset side of a bank's balance sheet. A reduction in the reference real interest rates is reflected in a reduction of the interest rate on bank loans. This, in turn, reduces the banks gross return conditional on its portfolio repaying, reducing the incentive for the bank to monitor. Since the strength of the risk-shifting effect is a function of leverage, the impact of monetary policy on risk taking will be mediated by the degree of bank capitalization. And since the two effects tend to offset each other, it will be the risk taking of better capitalized banks that will be more sensitive to changes in interest rates.

Along the same principle as the risk-shifting channel, but going in the opposite direction, there could be a "search for yield" effect for financial intermediaries with long-term liabilities and shorter-term assets (i.e., negative maturity mismatches), such as life insurance companies and pension funds (Rajan (2005), and Dell'Ariccia and Marquez (2013)).[2] These financial intermediaries may be induced to switch to riskier assets with higher expected yields when monetary easing compresses their margins by lowering the yield on their short-term assets

[2] This is at odds with the notion that banks' liabilities tend to have shorter maturities than banks' assets.

relative to that on their long-term liabilities, and this effect would be more pronounced for lowly capitalized financial institutions.[3]

The net effect of interest rates on bank risk taking, and its interaction with bank leverage, is therefore an empirical question. A more negative effect for highly capitalized banks would be consistent with the classical risk-shifting effect while a more negative effect for lowly capitalized banks would be consistent with a "search for yield" effect.

In this paper, we study the link between short-term interest rates, bank leverage, 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).[4]

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[5]—and that, consistent with the classical risk-taking channel, this negative relationship is more pronounced for highly capitalized banks. Our empirical analysis shows that, for the

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[3] Similarly, expectations of accommodative monetary policy following systemic liquidity crises could encourage banks to increase leverage and fund more illiquid projects ex ante, thus increasing inefficient risk taking (Diamond and Rajan (2012)).

[4] 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)).

[5] 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.

typical new loan, a one-standard deviation decrease in interest rates is associated with an increase in loan risk ratings of 0.11 (compared to its standard deviation of 0.8). Moreover, 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 their 75th percentile to their 25th percentile would increase loan risk ratings for a strongly capitalized bank (with Tier 1 capital ratio at its 75th percentile) by 0.08 more than for a weakly capitalized bank (with Tier 1 capital ratio at its 25th percentile).

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 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 show that results only hold when we limit the sample 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 observations in U.S. states whose economic cycles exhibit a low correlation with the U.S. cycle. Economic conditions in these states are less likely to affect monetary policy. 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. Fourth, 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. Finally, we obtain similar results at different margins of bank risk taking, including loan growth and the purchase of risky securities. Taken together, these results alleviate endogeneity concerns and provide evidence in support of a more causal interpretation of the link between interest rates, bank capital, and bank risk taking, in the sense that our findings are unlikely to be explained by monetary policy rates reacting to our measures of bank risk taking.

The paper makes two important contributions to the literature on the risk taking channel of monetary policy. First, to our knowledge, the paper is the first to present evidence of a risk-shifting channel of monetary policy for banks by showing that the inverse relationship between interest rates and bank risk taking is increasing in bank capital. This evidence provides a link with the theoretical banking literature on risk-shifting which predicts that risk taking is a function of a bank's capital.

Second, the paper constructs an ex-ante measure of bank risk taking using information on the perceived riskiness of loans to analyze the link between interest rates and bank risk taking. 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).

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)).[6] 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) and Ioannidou, Ongena, and Peydro (2015)). For instance, Jimenez et al. (2014) 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 theirs because it 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. This has the advantage that it accounts for differences in loan characteristics such as collateral, loan covenants, and loan pricing.[7] Other papers using loan-level data use either information on syndicated loans or aggregate measures of risk (Paligorova and Santos (2012), Aramonte, Lee, and Stebunovs (2015), Delis, Hasan, and Mylolonidis (2013), and Buch, Eickmeier, and Prieto (2011)). But syndicated loans are restricted to relatively large corporations which may not be representative of broader credit markets. The STBL is a much more

[6] In these papers, 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.

[7] 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.

comprehensive dataset of commercial bank loans, including syndicated loans, and therefore allows assessing the impact on general credit conditions.

Our paper is most closely related to Jimenez et al. (2014), who use detailed information on borrower quality from credit registry databases for Spain. 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. Our paper finds evidence consistent with traditional risk-shifting by less capitalized banks. 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. Their results are more consistent with a search for yield channel. These particular results in the two papers are not easily compared.[8] These different findings indicate that the link between interest rates, leverage and bank risk-taking is likely to depend on country circumstances. Other papers providing evidence of a search-for-yield effect following monetary accommodation include Becker and Ivashina (2015), Chodorow-Reich (2014), and Di Maggio and Kacperczyk (2014). However,

[8] 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), and we do not have access to the confidential Spanish dataset to make a direct comparison of the results.

these papers focus on nonbanks such as money market funds, mutual funds, and insurance companies.

The paper proceeds as follows: Section II presents the methodology used to assess the link between interest rates and bank risk taking. Section III presents the data and descriptive statistics of the main variables used in the empirical analysis of this paper. Section IV presents and interprets the empirical results, including a number of robustness tests and extensions. Section V concludes.

II. 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:

$$\sigma_{kit} = \alpha_i + \lambda_j + \beta r_t + \gamma K_{it} + \theta X_{kit} + \mu Y_{it} + \rho Z_{jt} + \varepsilon_{kit}, \tag{1}$$

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, loan spread, 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 across banks and within quarters, standard errors are two-way clustered by bank and 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 (1) by including an interaction term as follows:

$$\sigma_{kit} = \alpha_i + \lambda_j + \beta r_t + \gamma K_{it} + \delta K_{it} r_t + \theta X_{kit} + \mu Y_{it} + \rho Z_{jt} + \varepsilon_{kit}. \quad (2)$$

The focus of this specification is on the interaction term between interest rates and bank capital. A negative coefficient δ on the interaction between measures of bank capital and interest rates would be consistent with a traditional risk-shifting channel.

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

$$\sigma_{kit} = \alpha_i + \lambda_j + \tau_t + \gamma K_{it} + \delta K_{it} r_t + \theta X_{kit} + \mu Y_{it} + \rho Z_{jt} + \varepsilon_{kit}, \quad (3)$$

where τ_t are quarter-specific fixed effects.

Note that, strictly speaking, the models in equations (2) and (3) 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 if rigidities prevent prices from adjusting immediately. Indeed, over our sample period (1997 to 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.

III. Data and Descriptive Statistics

A. Survey of Terms of Business Lending

This paper uses confidential loan-level data over the period 1997 to 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% of all assets of U.S. commercial banks.[9] Almost half the loans are syndicated loans (i.e., loans made under participation or syndicate) but the survey also covers many small loans. 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). As a result, we have information on each loan only during one week each quarter, not the whole quarter. 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.[10] The publicly available release of this survey encompasses an aggregate version of the terms of business lending, reported by type of banks. In this paper, we use the confidential data on individual loans with additional bank- and regional-level controls.

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[9] 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.

[10] The survey data is subject to validity and quality verification by Federal Reserve staff. Validity verification refers to answers being a feasible response to a given question. Quality verification is designed to measure the reasonableness of micro data. If a data item is judged by Federal Reserve staff to represent a probable reporting error, Federal Reserve staff contact the respondent to verify that the information has been reported correctly or to obtain the correct information. If a data entry fails quality verification, the respondent is asked to verify the record and is given an opportunity to provide an explanation.

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. Given the confidential nature of the data, banks tend to accept to participate in the survey.

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 one of the Federal Reserve's main sources 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 to 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 monetary policy transmission. 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, Whitesell, and Zakrajšek (2001) use 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) use STBL data 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.

B.1. 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. The latter category applies primarily to workout loans. The survey asks the respondents to report that rating among the five ratings that corresponds most closely to their internal risk rating for each loan reported.[11] Importantly, these risk classifications take account of both the characteristics of the borrower and the protections provided in the loan contract. Loans in the category "Minimal Risk" have virtually no chance of resulting in a loss; "Low Risk" loans are very unlikely to result in a loss; "Moderate risk" loans have little chance of resulting in a loss; and "Acceptable risk" loans have a limited chance of resulting in a loss.

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

[11] For detailed instructions for survey respondents, including on loan risk ratings, see http://www.federalreserve.gov/reportforms/forms/FR_2028a--s20150803_i.pdf

collateral, the pricing of the loan (interest rate), and whether or not the loan was made under previous commitment. Commitments are broadly defined to include all promises to lend that are expressly conveyed, orally or in writing, to the borrower. Commitments generally fall into two types of arrangements: formal commitments and informal lines of credit. We define loans made under commitment as loans with a commitment established at least 30 days prior to the loan initiation date, and compute the loan spread as the interest rate on the loan minus the closest-maturity U.S. dollar LIBOR interest rate, obtained from ICE Benchmark Administration. We exploit all these loan-specific variables in our empirical strategy.

B.2. 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) for commercial banks (Call Reports). 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 *Equity / assets*, the ratio of common equity to total assets, as an alternative bank capitalization measure.

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 or state data.

B.3. 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.

B.4. 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 median of rates on transactions provided by domestic banks and U.S. branches and agencies of foreign banks and calculated daily by the Federal Reserve Bank of New York.

As alternative short-term interest rate we use the one-year yield on U.S. Treasury securities. 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 rolling regressions of the target federal funds rate on the deviation of CPI inflation from 2% and the difference between actual and potential GDP growth.

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 that excludes loans that were 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 that excludes loans that were extended under previous commitment.

The average loan risk rating in the sample is 3.35, with a standard deviation of 0.85, 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$668,396 but the variation is large, reflecting that the STBL covers business loans to firms of all sizes. The average loan maturity is quite short, about 1.4 years, indicating that a substantial fraction of loans are for working capital financing and other short-term financing needs. The average loan spread is about 7.6 percentage points, with much variation across loans and over time, reflecting differences in credit risk. The banks in the sample have a Tier 1 capital ratio of 12.2% on average, but the dispersion is significant, with a standard deviation of 4.8%. Banks also vary significantly in size, averaging US$21 billion in total assets but with a standard deviation of over US$105 billion, indicating that the sample includes both small and large banks. Indeed, the bank at the 25th percentile of total assets has US$312 million in assets. Banks on average are profitable (with average net income of 0.6% of total assets) but the variation is substantial. And loans constitute the largest component of banks' balance sheets, averaging 64% of total assets, with C&I loans being an important component of total loans, at 22% 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% in nominal terms but with a standard deviation of 2.2%. 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, with the average loan risk rating 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 aggregate STBL data shown in 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.

Before presenting our main regression analysis, we first analyze the link between loan risk ratings and information on observable loan characteristics to assess the extent to which risk ratings incorporate loan observables. We consider the following loan characteristics: Loan spread (percentage points), loan size (in logs), a dummy for secured loan (equal to 1 for loans secured by collateral), and loan maturity (in years). Risk rating may also vary by bank depending on the credit scoring model used, the degree to which ratings reflect qualitative assessment by loan officers, and other bank characteristics such as capitalization, profitability, and liquidity. We absorb such differences across banks using bank fixed effects.

Table 3 reports the results from OLS regressions of bank loan risk ratings on observable loan characteristics from the second quarter of 1997 to the fourth quarter of 2011. Regressions include time and/or bank fixed effects, and are estimated at the loan level with standard errors two-way clustered at the bank and quarter level.

The results indicate that loan characteristics explain only a modest portion of the variation in risk ratings, as indicated by the low *R*-squared. Results also show a significant bank fixed effect, explaining about an additional 10% of the variation in risk ratings over and above that explained by loan characteristics.

IV. 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 4 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 two-way clustered at the bank and quarter level. Obviously, loan risk ratings depend on loan characteristics such as loan interest rate spread, maturity, collateral, and loan 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 the following loan characteristics: loan spread (percentage points), loan size (in logs), a dummy for secured loan (equal to 1 for loans secured by collateral), and loan maturity (in years). We supplement this set of loan controls 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 subset of loans not under commitment represents about 57% 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 4, where we exclude loans extended under previous commitment from the sample, a one-standard deviation decrease in interest rates of 2.2 percentage points would suggest an increase in loan risk ratings of 0.11. 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.

Next, we consider the differential effect of bank capital on the link between interest rates and loan risk ratings to gauge the importance of the traditional risk-shifting channel. In columns (2) and (5), we estimate model (2) 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 (5) on the subset of loans that were not extended under previous commitment.

Consistent with a traditional risk-shifting channel, 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 4, 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 0.26 for a bank with a relatively high Tier 1 capital ratio at its 75th percentile but with an increase in loan risk ratings of 0.18 for a bank with a relatively low Tier 1 capital ratio at its 25th percentile.[12] The differential effect of 0.08 between strongly and weakly capitalized banks is significant but modest compared to the standard deviation in loan risk ratings of 0.8. However, as we will see later, this effect differs markedly across U.S. regions and time periods, and is larger when accounting for sampling weights in the survey.

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 to estimate equation (3). Again, the difference between the two regressions is that the latter excludes from the sample those loans that were 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

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

rate. In fact, the economic magnitude of our main result is similar when controlling for time-fixed effects (the differential effect described in the previous paragraph is also 0.08).

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 2.7%, 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 a traditional risk-shifting channel.

Regressions in columns (1) to (3) of Table 5 replicate the regressions in columns (1) to (3) of Table 4 for the sample of loans under commitment. This subsample of loans is a good placebo group for the main results because these loans should not be affected by bank behavior in response to changes in monetary policy. As expected, our main variables of interest do not enter significantly in these regressions.

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. Bank Sampling

The STBL survey covers a representative sample of banks. Respondents are stratified into groups by their C&I loans on the most recent Call Report, and blowup factors are calculated for each stratum. In addition, some respondents report on fewer than 5 days or at fewer than 100% of their branches. Additional blowup factors are applied to these respondents. This is particularly relevant for estimating aggregate terms of business lending.

Appendix Table A.1 reproduces the baseline regressions in Table 4 using weights that control for the fraction of the survey week that the bank reports, the fraction of branches of the bank that it reports, and the portion of the commercial bank category that the reporting bank represents (sampling weights). Our main results are robust, and if anything stronger, to controlling for these sampling weights and blowup factors. The differential effect described in the previous section increases from 0.08 to 0.09 when applying sampling weights (column 5) and to 0.10 when also including fixed effects (column 6).

Additionally, our sample does not consist of a constant sample of banks, as banks are replaced over time. Without restricting attention to loans not under commitment, the average number of quarters a bank stays in our sample is 22.5 quarters (out of 58 possible quarters between 1997Q2 and 2011Q4). The 25th percentile of the distribution of quarters in the sample is 7 quarters, the median is 17 quarters, and the 75th percentile is 36 quarters. When restricting attention to loans not under commitment, the average number of quarters a bank stays in our sample is 21.6 quarters (out of 58 possible quarters between 1997Q2 and 2011Q4). The 25th percentile of the distribution of quarters in the sample is 6 quarters, the median is 16 quarters, and the 75th percentile is 58 quarters.

For robustness, we re-estimate our main regression model for banks that are in the sample throughout the sample period. Appendix Table A.2 reproduces the baseline regressions in Table

4 using a “constant” sample of banks, that is, banks that report to the survey for the entire sample of our regressions (1997Q2 to 2011Q4). This constant sample is biased towards large banks, and we lose about half of loans in the sample. In Table 4, before the constant sample restriction, we have 1,348,554 loans observations for 589 banks (without restricting to loans not under commitment); after the constant sample restriction, we end up with 715,864 loan observations with 53 banks. Our results are robust to restricting our regressions to this constant sample, and the economic effects are if anything stronger.

C. Other Bank Characteristics

One possibility is that the effect we focus on is driven by differences in bank liquidity, not bank capital. For instance, Kashyap and Stein (2000) have shown that more liquid banks are more affected by interest rate changes. Table 6 reports results when we add controls for bank liquidity. As alternative measures of liquidity conditions we use the liquid assets ratio, defined as the ratio of cash and balances due from depository institutions to total assets, and the Kashyap and Stein (2000) measure of liquidity, defined as the ratio of securities excluding trading account and federal funds sold to total assets. For the Kashyap and Stein (2000) measure of liquidity we find that more liquid banks lower risk-taking when the federal funds rate is low. This is consistent with the result in Kashyap and Stein (2000) that more liquid banks are less affected by interest rate changes. The liquid assets ratio enters insignificantly in columns (1) through (3). Importantly, our main result on the interaction with capital is qualitatively unaltered when simultaneously controlling for liquidity conditions.

In robustness tests, we also include competing interaction effects using other bank characteristics, to control for channels other than bank capital and bank liquidity. The results are summarized in Appendix Table A.3. In particular, we include interactions between the target federal funds rate and the following bank characteristics: bank size, profitability 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. We find that none of these other interaction terms enters significantly. 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.

D. Alternative Measures of Capital and Interest Rates

Table 7 shows that the results are robust to using the ratio of common equity to total assets as an alternative measure of bank capital. The ratio of common equity to total assets is a measure of book leverage that unlike the Tier 1 regulatory capital ratio does not adjust for risk. In columns (1) to (3), we find that the results for the interaction term are qualitatively robust to using book leverage as a measure of bank capital. 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 book leverage ratio as alternative measure of bank capital.

The remainder of Table 7 shows that the results are robust to using alternative interest rates as measures of the monetary policy stance. In columns (4) and (5), 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 (2015)). In columns (6) and (7), 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.

In columns (1) to (3) of Table 8, we show that results are robust to using Taylor rule residuals as alternative measures of the monetary policy stance. In these regressions, we replace the federal funds rate in the base specifications of Table 4 with Taylor rule residuals to isolate the component of the policy rate that is exogenous to changes in economic conditions. Taylor residuals are obtained from rolling regressions of the target federal funds rate on the deviation of CPI inflation from 2% and the difference between the median Survey of Professional Forecasters (SPF)-forecast of current-quarter GDP growth and potential GDP growth from the second quarter of 1997 to the last quarter of 2011. Each rolling Taylor regression starts in the first quarter of 1985 and ends in the quarter previous to the current quarter in the loan-level regressions. We use the forecast of growth instead of actual growth to better capture expectations of future economic conditions. 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, both without and with quarter-year fixed effects (columns (2) and (3)). We also continue to find a significantly negative coefficient on the Taylor rule residual when not including the interaction term (column (1)).

E. Changes in Economic Conditions

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 already control for changes in 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 (4) of Table 8. We find that the coefficient on the interaction 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.

Still, our results may simply reflect differences in risk management across banks. For instance, better capitalized banks may have risk management systems that are more sensitive to economic conditions. If future economic conditions are proxied for by the federal funds rate, then this could explain why risk ratings of better capitalized banks are more sensitive to monetary policy. However, results are robust to controlling for SPF consensus forecasts of future GDP growth and its interaction with the capital ratio, suggesting that the federal funds rate is not simply reflecting future economic conditions. Appendix Table A.4 reproduces the results of the baseline regressions in Table 4 including the median GDP growth forecast in the Survey of Professional Forecasters for the current quarter and each of the next three quarters. We also include the interactions of the GDP growth forecasts with the capital ratio. The interaction between the federal funds rate and the capital ratio remains negative and statistically significant.

F. Role of Securitization

Thus far we have not considered that banks often issue loans that are subsequently securitized or sold in the syndicated loan market. In such cases, the risk is (at least partially) transferred to another entity. If highly capitalized banks have better access to securitized funding when economic conditions are uncertain, then this could explain why we observe that they lend more to riskier borrowers when interest rates are lower. We therefore control for the fraction of C&I loans securitized or sold by computing the ratio of outstanding principal balance of C&I loans and leases sold and securitized to total C&I loans and leases using information from Schedule RC-S of the Call Report.

We add both the level of the loan securitization variable and its interaction with the federal funds rate as additional variables to our base specification in Table 4. The results are presented in Table 9. We lose a large number of observations because information on loan sales and securitization is available only since mid-2000 and for about 80% of banks in our original sample. We find that banks with a higher fraction of C&I loans securitized or sold tend to extend safer loans on average. However this pattern does not vary with the level of the federal funds rate. Importantly our main results are unaffected after controlling for loan securitization.

G. 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 A.5.

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 to 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 truly 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 10 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 10, 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 0.12 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 0.8.

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 to 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 in column (4) 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. 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 to 2011 (not reported).

Finally, in column (5), 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.

H. 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 11, 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 from the federal funds rate to lending rates, which in turn will depend on the local market structure of the banking industry (see the stylized model described in the Appendix). 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 column (3), we exclude from the sample loans with a risk rating of 5, which are the riskiest loans in the STBL scale. 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 (larger in absolute value). 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 column (4), 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 A.6), 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.

I. Alternative Risk Measures

Thus far we have only considered risk taking through C&I lending. Obviously, banks can increase risk in other ways, including through an increase in lending (in addition to lending to riskier borrowers) and the purchase of risky securities.

Table 12 reports results when we replace the outcome variable with two alternative measures of risk taking: either the one-quarter percentage change in C&I loans for the bank or the ratio of securities held by the bank that are not guaranteed by the U.S. Treasury to total assets, using Call report data. The number of banks in these regressions includes all banks in the Call Report data and not only those responding to the STBL. The regressions are estimated over the same sample period as our main regressions in Table 4. We find that similar results along these margins of risk taking as well. Highly capitalized banks disproportionately expand C&I loans and hold risky securities when interest rates are low.

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

V. 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 0.11 (compared to its standard deviation of 0.8). Moreover, consistent with a traditional risk-shifting channel, 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 differential effect of an interquartile reduction in interest rates between strongly and weakly capitalized banks is an increase in risk ratings of about 0.08 to 0.10, or about one-tenth to one-eight its standard deviation.

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.

Our findings on the average relationship between the policy rate and bank risk taking are consistent with those in Jimenez et al. (2014). However, our findings in favor of risk-shifting are in stark contrast with their results. 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. Their results are more consistent with a search for yield channel. While these results are not easily compared given that they are based on different measures of risk taking and different country samples, these findings imply that the theoretical literature on bank leverage and monetary policy should consider alternative channels of risk taking—traditional risk-shifting and search for yield—in addition to traditional portfolio rebalancing channels.

Our 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. At one level this is not surprising given that the portfolio rebalancing and risk-shifting effects point in opposite effects, such that the net effect is small. At the same time, the effect is not trivial, given that even in the most closely scrutinized part of the banking business (i.e., making loans) banks appear to engage in this form of risk taking at a detectable scale.

Taken in isolation our results 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. Our results may therefore be seen as comforting to those claiming monetary policy should abstract from financial stability (e.g., Svensson (2015)). Further, as it is the case with many other empirical results in this literature, our results are not well suited to answer whether or not the additional risk taking of banks facing more accommodative monetary policy is excessive from a social welfare standpoint (for an exception, see Stein (2012)).[13]

Yet, it is important to note that this paper focused on a very specific margin of risk taking: the riskiness of new loans. While we find similar effects for banks' holdings of risky securities, 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, including leverage, liquidity, and maturity mismatches (Adrian and Shin (2009)). Moreover risky activity may flow from banks to other parts of the financial system (e.g., Chodorow-Reich (2014) and the discussion in Vissing-Jorgensen (2014)).

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)).

[13] 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.

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

In the introduction, we discussed how different theoretical approaches predict different relationships between monetary policy and bank risk taking: most portfolio models entail that risk taking will decrease with the interest rate on safe assets; while the prediction of models based on moral hazard depends on type of maturity mismatch on an intermediary balance sheet. An agent with short-term liabilities and long-term assets will see intermediation margins compress when monetary policy is tightened, leading to greater risk taking (risk-shifting). One with the opposite maturity mismatch (such as a pension fund) will tend to go the other way (search for yield). It follows that, for the former, this effect will work against the direct effect of portfolio reallocation; for the latter, it will strengthen it. In both cases, the effect will be greater the more severe the agency problem (i.e., the more levered the agent). Then, when looking at the net effect, in the case of risk-shifting it will be the more capitalized banks (those for which risk-shifting deducts the least from the portfolio effect) that are more sensitive to interest rates; for the case of search for yield, the opposite will happen.

To provide an example of the forces at work in this type of models, in what follows, 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. To guarantee that the loan repays with probability q, the bank exerts a monitoring effort of q. 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, Laeven, and Marquez (2014) show that similar results are obtained when k is endogenized.

Banks are protected by limited liability and repay depositors only in case the loan itself is repaid. 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 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 loan repayment, q.[14] The term ξ represents an equity premium in line with existing literature (see, for instance, Hellmann, Murdock, and Stiglitz (2000), Repullo (2004), Dell'Ariccia and Marquez (2006), and Allen, Carletti, and Marquez (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

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[14] 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)).

2, banks then choose how much to monitor the riskiness of their portfolio, q. We solve the model by backward induction starting from the last stage. The bank's expected profit can be written as:

$$\Pi = \left(q\left(r_L - r_D(1-k)\right) - qr_E k - \left(\frac{1}{2}\right) cq^2\right) L(r_L), \quad \text{(A1)}$$

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 (A1) as:

$$\Pi = (q(r_L - r^*(1-k)) - (r^* + \xi)k - (1/2)cq^2)L(r_L). \quad \text{(A2)}$$

Maximizing (A2) with respect to q yields:

$$\hat{q} = min\left\{\frac{r_L - r^*(1-k)}{c}, 1\right\}. \quad \text{(A3)}$$

From (A3) we note that limited liability, leverage, and the fact that depositors do not price risk at the margin generate a moral hazard problem. To illustrate the role of these factors in explaining the moral hazard friction in the model, consider the fist-best allocation chosen by a planner that takes into account the profit of banks as well as the welfare of depositors and equity holders. The first-best level of effort is:

$$q^{FB} = min\left\{\frac{r_L}{c}, 1\right\}. \quad \text{(A4)}$$

Comparing (A3) and (A4) shows that a bank fully funded with equity would exert the first-best level of effort. However, the monitoring effort of a levered bank is diminished compared with the first-best allocation as the bank does not take into account the losses that failure would impose on depositors, because of limited liability. In addition, banks that are fully liable to pay depositors even in the event of loan default would choose the first best allocation regardless of their leverage (as the term $r^*(1-k)$ in the (A2) would not be multiplied by q when banks face full deposit liability). Similarly, if depositors adjusted their required expected rate of return to changes in the loan default probability, then the term $q * r^*(1-k)$ in the bank expected profit would be independent of q, and thus banks would optimally exert the first-best level of effort.

Substituting $\hat{q}$ back into the profit function (A2), we get:

$$\Pi(\hat{q}) = \left[\frac{\left(r_L - r^*(1-k)\right)^2}{2c} - (r^* + \xi)k\right] L(r_L)\,, \tag{A5}$$

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

$$r_L = r^*(1-k) + \sqrt{2ck(r^* + \xi)}. \tag{A6}$$

Substituting r_L back into equation (A3), we get:

$$q^* = \frac{\sqrt{2ck(r^*+\xi)}}{c}. \tag{A7}$$

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 (A3) 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: An increase in the rate the bank has to pay on its deposits reduces bank profits in case of success (other things equal) and, hence, lowers the bank's incentive to monitor its own 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 to monitor. The relative strength of these two channels depends on the degree of bank capitalization. The risk-shifting effect will be maximized as leverage tends to 1 (k goes to 0) and goes to zero for a bank fully funded with capital (for which limited liability is irrelevant).

Note that equation (A7) confirms the role of leverage in determining bank effort. More levered banks will exert less monitoring effort. The equilibrium monitoring effort will be at its "first best" solution for fully capitalized banks ($k = 1$). In that case, monitoring continues to depend on the reference rate, but only through its effect on the lending rate (determined by the zero profit condition).

Equation (A7) also implies that a perfectly competitive market with fully levered banks ($k = 0$) would not be strictly viable under limited liability protection (as, in equilibrium, q would be equal to zero and the cost of equity would go to infinity). This essentially bounds k from below (see Dell'Ariccia, Laeven, and Marquez (2014) for a discussion).

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.

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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 of average risk ratings on the target federal funds rate and a constant.

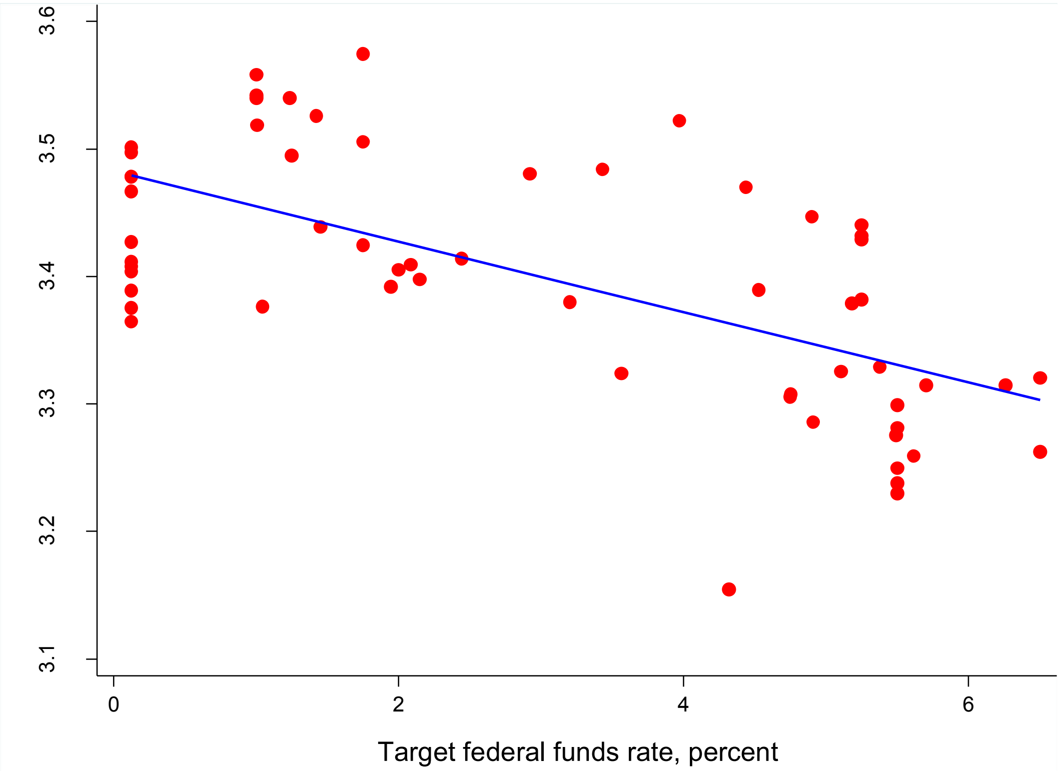

Table 1. Summary Statistics

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 the STBL, with 1=Minimal Risk, 2=Low Risk, 3=Moderate Risk, 4=Acceptable Risk, and 5=Special Mention or Classified Asset. The variables Loan size, the dummy for collateralized loans, and loan maturity (in years) are all taken from the STBL. Bank location is based on its headquarters, as reported in the NIC database. Bank total assets, and capital, profitability, liquidity, deposit, and loan ratios are all 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. Federal funds rate is the target federal funds rate. 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	1,348,554	3.396	3	4	0.841
Loan size (dollars)	1,348,554	576,206	16,214	182,481	4,874,293
Loan spread (percentage points)	1,348,554	6.734	2.228	10.616	6.956
Dummy for collateralized loans	1,348,554	0.799	1	1	0.401
Loan maturity (years)	1,348,554	1.273	0.312	1.315	1.882
Bank-level variables					
Tier 1 capital ratio	12,063	0.123	0.095	0.136	0.048
Equity / assets	12,063	0.007	0.001	0.007	0.011
Bank total assets ($ millions)	12,063	21,075	307	5,798	103,928
Net income / assets	12,063	0.006	0.003	0.010	0.009
Liquid assets / assets	12,063	0.027	0.013	0.035	0.019
Deposits / assets	12,063	0.780	0.725	0.858	0.103
Short-term deposits / deposits	12,063	0.018	0.000	0.000	0.070
Non-retail deposits / deposits	12,063	0.364	0.190	0.462	0.289
Loans / assets	12,063	0.639	0.565	0.736	0.142
C&I loans / loans	12,063	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					
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	773,812	3.351	3	4	0.847
Loan size (dollars)	773,812	668,396	15,000	179,214	5,352,840
Loan spread (percentage points)	773,812	7.607	2.659	12.125	7.549
Dummy for collateralized loans	773,812	0.793	1	1	0.406
Loan maturity (years)	773,812	1.427	0.315	1.567	2.130
Bank-level variables					
Tier 1 capital ratio	11,664	0.122	0.095	0.136	0.048
Equity / assets	11,664	0.006	0.001	0.007	0.011
Total assets ($ millions)	11,664	21,193	312	5,836	105,038
Net income / assets	11,664	0.006	0.003	0.010	0.009
Liquid assets / assets	11,664	0.027	0.014	0.035	0.019
Deposits / assets	11,664	0.781	0.726	0.859	0.102
Short-term deposits / deposits	11,664	0.018	0.000	0.000	0.071
Non-retail deposits / deposits	11,664	0.359	0.189	0.458	0.262
Loans / assets	11,664	0.641	0.567	0.737	0.140
C&I loans / loans	11,664	0.219	0.131	0.277	0.127
Regional variables					
State personal income growth	2,596	2.1133	-0.551	4.796	4.827
Change in region CPI (%)	236	2.386	1.112	3.985	2.908
State unemployment rate (%)	2,596	5.436	4.000	6.233	2.078
Change in state housing prices	2,596	3.105	-0.503	7.728	8.344
Nationwide variables					
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 the 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	2%	9%	45%	36%	8%	3.40

Table 3. Loan Risk Ratings and Loan 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 on loan terms (loan spread, loan size, an indicator for collateralized loans, and loan maturity). 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 regressions include a constant (not reported). Two-way clustered standard errors by bank and quarter are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	(1)	(2)	(3)	(4)
Loan spread	0.001	0.002*	0.004***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Loan size	-0.022*	-0.029**	-0.021*	-0.029**
	(0.012)	(0.013)	(0.011)	(0.014)
Dummy for collateralized loans	0.231***	0.254***	0.223***	0.250***
	(0.067)	(0.034)	(0.064)	(0.032)
Loan maturity	-0.021***	-0.013***	-0.020***	-0.012**
	(0.006)	(0.005)	(0.007)	(0.005)
Bank fixed effects	No	Yes	No	Yes
Time fixed effects	No	No	Yes	Yes
Observations	1,348,554	1,348,554	1,348,554	1,348,554
Number of banks	589	589	589	589
R^2	0.019	0.160	0.032	0.173

Table 4. 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. 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. Bank assets, Tier 1 capital ratio, net income, liquid assets, deposits, loans, and C&I loans are all taken from Call Report data. Regressions in columns (4) to (6) exclude loans extended under commitment established prior to the quarter to the survey. Columns (3) and (6) report results replacing the federal funds rate with quarter-fixed effects. All regressions include state- and bank-fixed effects. Two-way clustered standard errors by bank and quarter are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	Full sample			Loans not under commitment		
	(1)	(2)	(3)	(4)	(5)	(6)
Federal funds rate	-0.040***	-0.001		-0.052***	-0.011	
	(0.014)	(0.025)		(0.014)	(0.028)	
Tier 1 capital ratio	-0.895	0.161	1.391*	-1.310	0.053	0.882
	(1.197)	(0.888)	(0.838)	(1.541)	(1.003)	(0.998)
Tier 1 capital ratio ×		-0.440*	-0.520**		-0.450*	-0.475**
Federal funds rate		(0.232)	(0.219)		(0.249)	(0.233)
Bank size	0.102**	0.107**	0.097	0.034	0.042	0.026
	(0.046)	(0.045)	(0.065)	(0.036)	(0.034)	(0.051)
Net income / assets	0.920	0.652	0.838	4.057**	3.859**	2.958
	(1.296)	(1.283)	(1.391)	(1.670)	(1.623)	(2.338)
Liquid assets / assets	0.189	0.359	-0.345	-0.212	0.020	-0.059
	(1.249)	(1.204)	(1.170)	(1.281)	(1.219)	(1.160)
Deposits / assets	-0.181	-0.175	-0.216	0.433	0.406	0.532
	(0.256)	(0.254)	(0.311)	(0.396)	(0.384)	(0.391)
Short-term deposits / deposits	-0.320	-0.351	-0.466	-0.571	-0.597	-0.539
	(0.382)	(0.390)	(0.372)	(0.372)	(0.380)	(0.370)
Non-retail deposits / deposits	0.041	0.052	-0.008	0.122	0.134	0.125
	(0.123)	(0.121)	(0.127)	(0.140)	(0.136)	(0.134)
Loans / assets	0.176	0.174	0.221	0.270	0.267	0.282
	(0.318)	(0.312)	(0.328)	(0.389)	(0.379)	(0.382)
C&I loans / loans	0.170	0.139	0.601*	0.064	0.019	0.225
	(0.307)	(0.300)	(0.309)	(0.342)	(0.339)	(0.345)
Loan spread	0.005***	0.005***	0.005***	0.004***	0.004***	0.004***

	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Loan size	-0.030**	-0.030**	-0.030**	-0.037***	-0.037***	-0.037***
	(0.012)	(0.013)	(0.012)	(0.010)	(0.010)	(0.010)
Dummy for collateralized loans	0.252***	0.252***	0.251***	0.267***	0.267***	0.267***
	(0.032)	(0.033)	(0.034)	(0.032)	(0.032)	(0.034)
Loan maturity	-0.012**	-0.012**	-0.012**	-0.007	-0.007	-0.007
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)
GDP growth	-0.003	-0.002		-0.006	-0.005	
	(0.004)	(0.004)		(0.004)	(0.004)	
NBER recession dummy	-0.102*	-0.098*		-0.100	-0.098	
	(0.057)	(0.058)		(0.063)	(0.063)	
State personal income growth	0.001	0.001	0.000	0.002	0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Change in region CPI	0.002	0.002	0.001	0.006	0.006	0.006
	(0.004)	(0.003)	(0.010)	(0.005)	(0.005)	(0.015)
State unemployment rate	-0.020	-0.024	-0.017	-0.017	-0.022	0.005
	(0.022)	(0.022)	(0.026)	(0.023)	(0.021)	(0.026)
Change in state housing prices	0.000	0.001	0.000	0.000	0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
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	1,348,554	1,348,554	1,348,554	773,812	773,812	773,812
Number of banks	589	589	589	585	585	585
R^2	0.171	0.171	0.175	0.191	0.192	0.196

Table 5. Loan Risk Ratings, the Federal Funds Rate, and Bank Capital: Loans Under Commitment

This table reports panel regression estimates 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 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. Bank assets, Tier 1 capital ratio, net income, liquid assets, deposits, loans, and C&I loans are all taken from Call Report data. Regressions include only loans extended under a commitment established prior to the quarter of the survey. Column (3) report results replacing the federal funds rate with quarter-fixed effects. All regressions include state- and bank-fixed effects. Two-way clustered standard errors by bank and quarter are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	Loans under commitment		
	(1)	(2)	(3)
Federal funds rate	-0.021*	-0.016	
	(0.013)	(0.021)	
Tier 1 capital ratio	-1.298	-1.235	0.148
	(0.981)	(0.964)	(1.002)
Tier 1 capital ratio ×		-0.070	-0.131
Federal funds rate		(0.232)	(0.236)
Bank size	0.215***	0.214***	0.219**
	(0.057)	(0.057)	(0.091)
Net income / assets	-0.393	-0.434	0.588
	(1.315)	(1.302)	(1.653)
Liquid assets / assets	3.904**	3.898**	3.240***
	(1.726)	(1.721)	(1.252)
Deposits / assets	-1.064*	-1.053*	-1.094*
	(0.543)	(0.539)	(0.603)
Short-term deposits / deposits	0.300	0.290	0.432
	(0.477)	(0.488)	(0.457)
Non-retail deposits / deposits	0.082	0.082	0.005
	(0.165)	(0.165)	(0.169)
Loans / assets	-0.626	-0.618	-0.555
	(0.398)	(0.388)	(0.468)
C&I loans / loans	0.065	0.074	0.236
	(0.277)	(0.277)	(0.297)
Loan spread	0.007***	0.007***	0.007***
	(0.002)	(0.002)	(0.002)

Loan size	-0.020	-0.020	-0.020
	(0.016)	(0.016)	(0.016)
Dummy for collateralized loans	0.222***	0.222***	0.225***
	(0.039)	(0.039)	(0.039)
Loan maturity	-0.028***	-0.028***	-0.027***
	(0.008)	(0.008)	(0.008)
GDP growth	0.002	0.002	
	(0.004)	(0.004)	
NBER recession dummy	-0.104	-0.104	
	(0.069)	(0.069)	
State personal income growth	0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)
Change in region CPI	0.000	0.000	-0.003
	(0.002)	(0.002)	(0.009)
State unemployment rate	0.000	-0.001	-0.017
	(0.019)	(0.019)	(0.019)
Change in state housing prices	0.001	0.001	0.000
	(0.001)	(0.001)	(0.001)
Bank fixed effects	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes
Quarter-year fixed effects	No	No	Yes
Observations	574,742	574,742	574,742
Number of banks	272	272	272
R^2	0.182	0.182	0.184

Table 6. Bank Capital or Liquidity?

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, tier 1 capital, and bank liquidity. The dependent variable is the internal risk rating assigned by the bank to a given loan, as reported in the Federal Reserve's STBL. Liquid assets are cash and balances due from depository institutions to total assets; Kashyap-Stein liquidity is the ratio of securities excluding trading account and federal funds sold to total assets, following the definition in Kashyap and Stein (2000). All other variables are as defined in Table 4. Regressions control for all loan-, bank-, and regional-level explanatory variables included in Table 4 but their coefficients are not reported unless shown otherwise. Loans extended under commitment established prior to the current quarter are excluded from the sample. All regressions include state- and bank-fixed effects. Regressions that exclude quarter fixed effects control for U.S. GDP growth and a dummy for NBER recession periods. Two-way clustered standard errors by bank and quarter are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	(1)	(2)	(3)	(4)	(5)	(6)
Federal funds rate	-0.052***	0.002		-0.034	-0.028	
	(0.014)	(0.036)		(0.025)	(0.028)	
Tier 1 capital ratio	-1.310	0.118	0.894	-0.129	0.195	1.404
	(1.526)	(0.971)	(1.005)	(1.040)	(1.006)	(1.010)
Tier 1 capital ratio ×		-0.464*	-0.472**		-0.336*	-0.347*
Federal funds rate		(0.253)	(0.232)		(0.198)	(0.181)
Liquid assets / assets	-0.212	1.232	-0.937			
	(1.281)	(2.310)	(2.552)			
(Liquid assets / assets) ×		-0.290	0.200			
Federal funds rate		(0.479)	(0.488)			
Kashyap-Stein liquidity				-0.275	-0.474	-0.961
				(0.883)	(0.871)	(0.985)
Kashyap-Stein liquidity ×					0.149**	0.151*
Federal funds rate					(0.075)	(0.080)
Bank-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Loan-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Regional controls	Yes	Yes	Yes	Yes	Yes	Yes
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	773,812	773,812	773,812	773,812	773,812	773,812
Number of banks	585	585	585	585	585	585
R^2	0.191	0.192	0.196	0.220	0.221	0.225

Table 7. Alternative Measures of Bank Capital and 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 STBL. Loans extended under commitment established prior to the current quarter are excluded from the sample. Equity / assets is the ratio of the bank's common equity over total assets. 1-year Treasury yield is the 1-year yield on U.S. Treasuries. The term spread is the difference between the 10-year and 1-year Treasury yield. All other variables are as defined in Table 4. Regressions control for all loan-, bank-, and regional-level explanatory variables included in Table 4 but their coefficients are not reported unless shown otherwise. All regressions include state- and bank-fixed effects. Regressions that exclude quarter fixed effects control for U.S. GDP growth and a dummy for NBER recession periods. Two-way clustered standard errors by bank and quarter are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Federal funds rate	-0.051***	-0.047***					
	(0.015)	(0.015)					
1-year Treasury yield				-0.010		0.050	0.084
				(0.030)		(0.041)	(0.066)
Term spread						0.095	0.003
						(0.059)	(0.164)
Tier 1 capital ratio				0.123	1.086	1.969	4.655*
				(1.036)	(1.001)	(1.544)	(2.427)
Equity / assets	-0.636	1.937	2.496				
	(4.435)	(4.274)	(3.543)				
(Equity /assets) ×		-0.951**	-0.839**				
Federal funds rate		(0.415)	(0.325)				
Tier 1 capital ratio ×				-0.465*	-0.533**	-0.810*	-1.153**
1-year Treasury yield				(0.265)	(0.245)	(0.425)	(0.489)
Tier 1 capital ratio ×						-0.547	-1.089
Term spread						(0.607)	(0.701)
Bank-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-year fixed effects	No	No	Yes	No	Yes	No	Yes
Observations	773,812	773,812	773,812	773,812	773,812	773,812	773,812
Number of banks	585	585	585	585	585	585	585
R^2	0.183	0.183	0.188	0.191	0.196	0.191	0.197

Table 8. Loan Risk Ratings, Taylor Rule Residuals, Economic Conditions, 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. The dependent variable is the internal risk rating assigned by the bank to a given loan, as reported in the Federal Reserve's STBL. Taylor rule residuals are obtained from rolling regressions of the target federal funds rate on the deviation of inflation from 2% and the difference between the median SPF-forecast of current-quarter GDP growth and potential GDP growth. Each rolling Taylor regression ends in the quarter previous to the current quarter in the loan-level regressions. The regression in column (4) includes an interaction 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 other variables are as defined in Table 4. Regressions control for all loan-, bank-, and regional-level explanatory variables included in Table 4 but their coefficients are not reported unless shown otherwise. All regressions exclude loans extended under commitment established prior to the current quarter from the sample. Columns (3) and (4) report results with quarter-fixed effects. All regressions include state- and bank-fixed effects. Regressions that exclude quarter fixed effects control for U.S. GDP growth and a dummy for NBER recession periods. Two-way clustered standard errors by bank and quarter are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	(1)	(2)	(3)	(4)
Taylor rule residual	-0.044***	-0.008		
	(0.015)	(0.028)		
Tier 1 capital ratio	-1.247	-2.091	-1.451	0.882
	(1.591)	(1.787)	(1.621)	(0.998)
Tier 1 capital ratio ×				-0.475**
Federal funds rate				(0.233)
Tier 1 capital ratio ×		-0.389*	-0.396**	
Taylor rule residual		(0.224)	(0.194)	
GDP growth	-0.004	-0.004		
	(0.004)	(0.004)		
GDP growth ×				0.005
Federal funds rate				(0.004)
NBER recession dummy	-0.093	-0.092		
	(0.064)	(0.064)		
NBER recession dummy ×				0.039
Federal funds rate				(0.034)
Bank-level controls	Yes	Yes	Yes	Yes
Loan-level controls	Yes	Yes	Yes	Yes
Regional controls	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes

State fixed effects	Yes	Yes	Yes	Yes
Quarter-year fixed effects	No	No	Yes	No
Observations	773,812	773,812	773,812	773,812
Number of banks	585	585	585	585
R^2	0.190	0.191	0.196	0.196

Table 9. Loan Risk Ratings, the Federal Funds Rate, and Bank Capital: Loans Securitized or Sold

This table reports panel regression estimates 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 to a given loan, as reported in the Federal Reserve's STBL. The ratio of C&I loans securitized to total C&I loans and leases is from Call Reports. All other variables are as defined in Table 4. Regressions control for all loan-, bank-, and regional-level explanatory variables included in Table 4 but their coefficients are not reported unless shown otherwise. 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 federal funds rate with quarter-fixed effects. All regressions include state- and bank-fixed effects. Regressions that exclude quarter fixed effects control for U.S. GDP growth and a dummy for NBER recession periods. Two-way clustered standard errors by bank and quarter are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	Full sample			Loans not under commitment		
	(1)	(2)	(3)	(4)	(5)	(6)
Federal funds rate	-0.020	0.001		-0.036*	-0.005	
	(0.013)	(0.018)		(0.019)	(0.027)	
Tier 1 capital ratio	-1.700**	-1.358*	0.256	-0.640	-0.134	1.283
	(0.815)	(0.704)	(1.045)	(0.990)	(0.884)	(1.170)
Tier 1 capital ratio ×		-0.247	-0.303*		-0.349*	-0.406**
Federal funds rate		(0.168)	(0.171)		(0.189)	(0.166)
Loans securitized / loans	-0.641**	-0.636**	-0.668**	-0.511**	-0.510**	-0.582**
	(0.278)	(0.276)	(0.281)	(0.244)	(0.233)	(0.244)
(Loans securitized / loans) ×		-0.002	-0.003		0.003	-0.012
Federal funds rate		(0.012)	(0.015)		(0.020)	(0.018)
Bank-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Loan-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Regional controls	Yes	Yes	Yes	Yes	Yes	Yes
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	967,873	967,873	967,873	393,131	393,131	393,131
Number of banks	472	472	472	468	468	468
R^2	0.196	0.196	0.199	0.231	0.231	0.236

Table 10. 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. In column (1), the sample is restricted to small banks, defined as those with assets below the top quintile. The 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) consists of loans by banks located in states where state income growth is not highly correlated with U.S. GDP growth (i.e., below median correlation). The sample in column (4) excludes financial crisis periods (2008 to 2010). The sample in column (5) excludes periods with many bank failures, defined as those with bank failure rates above the sample median, 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 4. Regressions control for all loan-, bank-, and regional-level explanatory variables included in Table 4 but their coefficients are not reported unless shown otherwise. All regressions include state-, bank-, and quarter-fixed effects. Two-way clustered standard errors by bank and quarter are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	Small banks	States without large banks	States with low correlation with U.S. GDP	Noncrisis years	Years with few bank failures
	(1)	(2)	(3)	(4)	(5)
Tier 1 capital ratio	-1.252	1.108	-0.492	0.621	0.976
	(1.346)	(0.910)	(1.419)	(1.257)	(0.993)
Tier 1 capital ratio ×	-0.387**	-0.492*	-0.683***	-0.436*	-0.508**
Federal funds rate	(0.192)	(0.252)	(0.220)	(0.239)	(0.225)
Bank-level controls	Yes	Yes	Yes	Yes	Yes
Loan-level controls	Yes	Yes	Yes	Yes	Yes
Regional controls	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes	Yes
Quarter-year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	269,989	555,579	282,207	715,170	714,483
Number of banks	519	545	240	572	547
R^2	0.303	0.203	0.177	0.197	0.190

Table 11. 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. The dependent variable is the internal risk rating assigned by the bank to a given loan, as reported in the Federal Reserve's 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 column (3) excludes loans with the highest risk rating of 5. Column (4) reports the results of estimating logit regressions of the probability that a loan is rated as very risky (i.e., an internal risk rating of 4 or 5) using loans from the second quarter of 1997 to the fourth quarter of 2011. All other variables are as defined in Table 4. Regressions control for all loan-, bank-, and regional-level explanatory variables included in Table 4 but their coefficients are not reported unless shown otherwise. Loans extended under commitment established prior to the current quarter are excluded from the sample. All equations except the logit regressions include state- and bank-fixed effects. Regressions that exclude quarter fixed effects control for U.S. GDP growth and a dummy for NBER recession periods. The logit regression reports a pseudo-R^2. Two-way clustered standard errors by bank and quarter are reported in parentheses for regressions (1) to (3). Standard errors clustered by bank are reported in parentheses for regression (4). *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	Capital ratios close to regulatory minimum	High state-level bank concentration	Excluding loans with risk rating of 5	Logit of very risky loan
	(1)	(2)	(3)	(4)
Federal funds rate				0.060**
				(0.031)
Tier 1 capital ratio	-8.189	-3.104**	-0.357	-4.755***
	(15.294)	(1.314)	(0.830)	(1.574)
Tier 1 capital ratio ×	-3.748	-0.430	-0.563***	-1.035***
Federal funds rate	(4.141)	(0.343)	(0.181)	(0.277)
Bank-level controls	Yes	Yes	Yes	Yes
Loan-level controls	Yes	Yes	Yes	Yes
Regional controls	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	No
State fixed effects	Yes	Yes	Yes	No
Quarter-year fixed effects	Yes	Yes	Yes	No
Observations	61,566	224,239	714,316	773,812
Number of banks	41	333	585	585
(Pseudo-)R^2	0.196	0.151	0.102	0.035

Table 12. Alternative Measures of Risk, the Federal Funds Rate, and Bank Capital: Change in C&I Loans and Holdings of Risky Securities

This table reports the results of estimating panel regressions of alternative measures of risk from the second quarter of 1997 to the fourth quarter of 2011. The dependent variable in columns (1) to (3) is the percentage change in commercial and industrial (C&I) loans for the bank, and the dependent variable in columns (4) to (6) is the ratio of securities held by the bank that are not guaranteed by the U.S. Treasury to total assets, both taken form Call Reports. All other variables are as defined in Table 4. Regressions control for all loan-, bank-, and regional-level explanatory variables included in Table 4 but their coefficients are not reported unless shown otherwise. All regressions include state- and bank-fixed effects. Regressions that exclude quarter fixed effects control for U.S. GDP growth and a dummy for NBER recession periods. Two-way clustered standard errors by bank and quarter are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	Change in C&I loans			Holdings of Risky Securities		
	(1)	(2)	(3)	(4)	(5)	(6)
Federal funds rate	0.000	0.004**		-0.002***	0.000	
	(0.000)	(0.002)		(0.000)	(0.001)	
Tier 1 capital ratio	0.587***	0.698***	0.681***	-0.016	-0.002	-0.002
	(0.100)	(0.108)	(0.107)	(0.012)	(0.003)	(0.003)
Tier 1 capital ratio ×		-0.023**	-0.022**		-0.012***	-0.011***
Federal funds rate		(0.010)	(0.010)		(0.004)	(0.004)
Bank-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Regional controls	Yes	Yes	Yes	Yes	Yes	Yes
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	444,081	444,081	444,081	444,081	444,081	444,081
Number of banks	11,798	11,798	11,798	11,798	11,798	11,798
R^2	0.261	0.262	0.263	0.825	0.828	0.830

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