

SHORT-TERM INTEREST RATES AND BANK LENDING TERMS: EVIDENCE FROM A SURVEY OF U.S. LOANS

Giovanni Dell’Ariccia
International Monetary Fund

Luc Laeven
European Central Bank

Gustavo Suarez
United States Federal Reserve Board

The long period of low interest rates that followed the global financial crisis has rekindled interest in how short-term interest rates affect bank behavior. In particular, it has led to a debate on how low policy rates influence bank risk-taking. This risk-taking channel of monetary policy corresponds to the view that interest rate policy affects the quality and not just the quantity of bank credit. From a financial stability perspective, one concern is that a protracted period of low interest rates and monetary stimulus could contribute to an increase in financial risk-taking (Rajan, 2010; Farhi and Tirole, 2012; Acharya, Pagano, and Volpin, 2013; Chodorow-Reich, 2014). Concerns about the risk-taking effects of monetary policy have motivated a lively debate about the extent to which financial stability considerations should be an integral part of the monetary policy framework (Woodford, 2012; Stein, 2014).

Despite the obvious policy interest, the empirical evidence on this topic is scant for the United States. The existing empirical papers on the link between monetary policy and risk-taking are mostly focused

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on Europe (for example, Jimenez and others, 2014; Ioannidou, Ongena, and Peydro, 2015; Altunbas, Gambacorta, and Marques-Ibañez, 2010).

In this paper, we study the link between short-term interest rates and bank risk-taking using confidential data on individual U.S. bank loans from the Federal Reserve's Survey of Terms of Business Lending (STBL). Since 1997, the survey has asked respondents to report their assessed risk rating for each individual loan, which provides a unique *ex ante* measure of loan riskiness.

We document that banks tend to ease their lending terms during periods of low interest rates. In particular, for a given *ex ante* internal risk rating of the loan, banks tend to originate new business loans with lower spreads and that are less likely to be collateralized. Our empirical analysis indicates that for the typical new loan, a one-standard-deviation decrease in short-term interest rates is associated with a decrease in loan spreads of roughly 0.1 percentage points. This is a nontrivial effect, although it is somewhat modest when compared with the standard deviation of loan spreads in our sample (1.4 percentage points).

We also show that the negative relationship between short-term interest rates and bank lending terms, as measured by spreads and collateralization, is more pronounced for riskier loans and for banks that are more sensitive to short-term interest rates in their funding needs. Finally, using residuals from Taylor-rule regressions, we show that the less restrictive standards prevailing during periods of low interest rates are explained by the rate component that is orthogonal to cyclical effects captured by the output gap and inflation. We also consider a modified Taylor rule that incorporates financial stability considerations and find similar results. These findings alleviate some concerns that short-term interest rates set by monetary policy are endogenous to bank lending behavior.

Our statistical results are not well suited to answer whether or not the additional risk banks take by easing their standards when facing more accommodative monetary policy is excessive, because we do not model the optimal degree of financial risk-taking. In other words, our results can inform the conduct of monetary policy through an improved understanding of the effects of monetary policy on the financial system, but by themselves they cannot help answer the question of whether a given policy (past or present) is optimal.

The rest of the paper proceeds as follows. Section 1 highlights our contribution to the existing empirical literature. Section 2 presents the methodology used to assess the link between bank lending terms and short-term interest rates and describes the survey of terms of

business lending and other data used in our empirical analysis. Section 3 presents and interprets the empirical results, and section 4 concludes.

1. RELATION WITH EXISTING LITERATURE

Different theoretical approaches deliver different predictions on the relationship between the monetary policy rate (or more precisely the interest rate on safe assets) and bank risk-taking.¹ On one hand, most portfolio allocation models will predict that an exogenous decrease in the yield on safe assets will lead to greater risk-taking (for example, Fishburn and Porter, 1976). On the other hand, corporate finance models focusing on the effects of limited liability predict that a decrease in the interest rate that banks have to pay on deposits will reduce risk-taking: this is the classical risk-shifting effect. Due to these offsetting forces, the relationship between short-term interest rates and bank risk-taking is an empirical question (see Dell’Ariccia, Laeven, and Marquez, 2014).

Given the debate on the financial stability concerns of maintaining low interest rates, it is not surprising that the empirical literature on the relationship between interest rates and bank risk-taking has grown notably in recent years. This paper adds to our understanding of this relationship by (1) studying changes in lending along different loan terms, (2) measuring loan risk at origination from an *ex ante* perspective, and (3) focusing on the United States using a detailed loan-level database.

Exploiting loan-level information from the Federal Reserve’s STBL, we study the relationship between monetary policy rates and different terms of business lending, maintaining constant the *ex ante* risk profile of the loan. In particular, we study the effect of monetary policy on loan spreads and the collateralization of new loans. In this context, we define bank lending terms as easier if, controlling for the riskiness of the loan, banks charge lower spreads or are less likely to require collateral.

One of the contributions of our work consists of controlling for the perceived riskiness of loans at origination. By contrast, most measures of bank risk in the literature are measured *ex post*, which makes it hard to disentangle whether any realized risk was truly an *ex ante* decision by the bank or an *ex post* effect of deterioration in

1. For a discussion, see Altunbas, Gambacorta, and Marques-Ibañez (2010); Chodorow-Reich (2014); Dell’Ariccia and Marquez (2013).

economic activity over the business cycle. Other papers measure bank risk using information on changes in lending standards observed in lending surveys (see Lown and Morgan, 2006, for the United States; and Maddaloni and Peydro, 2011, for the euro area) or rating agency estimates (Altunbas, Gambacorta, and Marques-Ibañez, 2010), but they do not control for loan riskiness. Finally, papers based on credit registries generally use borrower-level measures of risk based on preexisting default history or ex post loan default rates (Jimenez and others, 2014; Ioannidou, Ongena, and Peydro, 2015), rather than what the bank perceived at origination.

Another novelty of the present paper is that it employs U.S. loan-level data. Most recent studies focus on Europe. The few papers focusing on the United States use syndicated loans or aggregate data (Paligorova and Santos, 2012; Delis, Hasan, and Mylonidis, 2011; Buch, Eickmeier, and Prieto, 2011). Syndicated lending mostly reflects borrowing by relatively large corporations and thus may not be representative of broader credit markets. A significant advantage of using U.S. data is that it offers a relatively long time series (contrary to, say, euro area surveys), which helps researchers encompass more monetary policy easing and tightening cycles. In a closely related paper, Dell'Ariccia, Laeven, and Suarez (2016) document how a bank's balance sheet structure (leverage and liquidity) affects the relationship between monetary policy and bank risk-taking.

Our paper is most closely related to Jimenez and others (2014) and Ioannidou, Ongena, and Peydro (2015), who use detailed information on borrower quality from credit registry databases for Spain and Bolivia. Consistent with our results, they find a positive association between low interest rates at loan origination and the probability of extending loans to borrowers with bad credit history or no history at all.

2. METHODOLOGY AND DATA

To investigate the relationship between short-term interest rates and the terms on newly issued loans, we employ standard panel regression analysis. Our basic regression model is as follows:

$$y_{kit} = \alpha_i + \lambda_j + \beta r_t + \theta \mathbf{X}_{kit} + \mu \mathbf{W}_{it} + \rho \mathbf{Z}_{jt} + \gamma \mathbf{M}_t + \varepsilon_{kit} \quad (1)$$

where y_{kit} is a characteristic of loan k extended by bank i in quarter t , α_i bank-specific fixed effects, λ_j are state-specific fixed effects, r_t is the federal funds rate at the beginning of quarter t , \mathbf{X}_{kit} are loan

characteristics (loan risk rating and loan amount), \mathbf{W}_{it} is a set of bank-specific control variables measured at the beginning of quarter t , \mathbf{Z}_{jt} is a set of time-varying regional (either U.S. state or Census region) control variables, \mathbf{M}_t is a set of macroeconomic controls (GDP growth and an indicator of NBER recessions), and ε_{kit} is the error term. To control for the potential dependence of observations within banks and within quarters, standard errors are two-way clustered by bank and quarter. Our coefficient of interest in equation (1) is β . Under the hypothesis that lending terms are easier during periods of low interest rates, we expect β to be positive for a regression explaining loan spreads and the probability of collateralization.

To study how the relationship of short-term interest rates on bank lending standards changes with loan or bank characteristics, we expand equation (1) by including interactions between short-term interest rates and those characteristics. In these specifications, we drop the macroeconomic variables in the vector \mathbf{M}_t and the level of short-term interest rates and introduce time-fixed effects instead. More formally, when considering the interaction of the bank-specific variable v_{it} (part of the vector \mathbf{W}_{it}) with the short-term interest rate, we estimate the following equation:

$$y_{kit} = \alpha_i + \lambda_j + \tau_t + \delta r_t * v_{it} + \theta \mathbf{X}_{kit} + \mu \mathbf{W}_{it} + \rho \mathbf{Z}_{jt} + \varepsilon_{kit} . \quad (2)$$

where τ_t represents a time fixed effect, and all other variables are defined as in equation (1). The coefficients of interest in these specifications are δ .

2.1 The Federal Reserve's Survey of Terms of Business Lending

We use loan-level data from the confidential Survey of Terms of Business Lending (STBL) from 1997 to 2011. The STBL is a quarterly survey on lending to businesses originated by a stratified sample of about 400 banks conducted by the Federal Reserve since 1977. The banks surveyed cover a large share of the U.S. banking sector's assets. The survey asks participating banks about the terms of all commercial and industrial loans originated during the first full business week of the middle month in every quarter (February, May, August, and November). Banks report various loan characteristics, including the bank's internal assessment of the risk of the loan using a scale from one (low risk) to five (highest risk). The risk-rating measure roughly maps to the banks' internal loan risk ratings and has been reported in the survey since 1997.

The STBL is the Federal Reserve's main source of data on marginal returns on business loans for a representative set of banking institutions nationwide and a wide range of loan sizes. As a result, the STBL provides valuable insights into shifts in the composition of banks' business loan portfolios and the implications of those shifts for bank profitability (Carpenter, Whitesell, and Zakrajšek, 2001; Black and Rosen, 2007; Black and Hazelwood, 2013).

2.2 Variable Definitions

Our analysis combines 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 and macroeconomic variables.

2.2.1 Loan-level variables

For each loan in the sample, the STBL reports the name of the bank extending the loan, the size (in dollars), whether or not the loan is secured by collateral, the effective interest rate charged by the bank for the loan, and the prime rate used by the bank. In addition, banks report their own *ex ante* assessment of the riskiness of the loan using a risk-rating index designed by the survey, which increases with risk: 1 = Minimal risk; 2 = Low risk; 3 = Moderate risk; 4 = Acceptable risk; and 5 = Special mention or classified asset.

2.2.2 Bank variables

We compile information about the balance sheet of the banks responding to the STBL from the quarterly Consolidated Reports of Condition and Income (FFIEC 031 and 041) (call reports) for commercial banks. In particular, in our empirical analysis, *Tier 1 capital* is the ratio of Tier 1 regulatory capital to total risk-weighted assets; *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 (that is, up to one year) deposits to total deposits; *Nonretail deposits / deposits* is the ratio of nonretail deposits to total deposits; *Loans / assets* is the ratio of total loans to total assets; and *C&I loans / loans* is the ratio of commercial and industrial loans to total loans.

We locate banks using their headquarters as reported in the National Information Center (NIC) database. We use information on bank location to match bank-specific data with regional (state-specific) data to control for loan demand conditions.

2.2.3 Regional variables

Our regressions include state- or region-level factors (where state-level factors are unavailable) to allow for the possibility that local conditions such as employment, inflation, and house prices 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 annualized quarter-over-quarter rate of change in the house price index published by the Office of Federal Housing Enterprise Oversight/Federal Housing Finance Agency (OFHEO/FHFA). We consider the annualized quarter-over-quarter rate of change in the consumer price index (CPI) by U.S. Census Bureau region, as reported by the BLS.

2.2.4 Nationwide variables

The short-term interest rate is measured using the three-month average of the nominal target federal funds rate. By adjusting reserves, the Federal Reserve controls the market-determined effective federal funds rate to implement monetary policy. At the macroeconomic level, we also control for the U.S. real GDP growth (quarter over quarter, annual rate), reported by the BEA, and for an indicator variable for recessions dated by the National Bureau of Economic Research (NBER).

2.3 Descriptive Statistics of Main Variables

Table 1 reports summary statistics on our main regression variables. We restrict our sample to loans that are not made under a commitment established prior to the quarter of the survey. In contrast with the more discretionary loans that constitute our sample, the terms of loans originated under a commitment (for example, a line of credit) do not necessarily reflect the bank's own assessment of the riskiness of the loan at the time the loan was extended.

Table 1. Summary Statistics

	<i>Obs.</i>	<i>Average</i>	<i>25th pctl.</i>	<i>75th pctl.</i>	<i>Standard deviation</i>
<i>Loan-level variables</i>					
Loan spread (in percentage points)	1,121,510	0.754	0.074	1.425	1.444
Dummy for loans secured by collateral	1,121,508	0.807	1	1	0.395
Risk rating	1,112,510	3.306	3	4	0.837
Loan size (dollars)	1,121,510	520,529	14,800	142,285	4,703,035
<i>Bank-level variables</i>					
Bank total assets (\$million)	11,854	21,072	318	5,884	104,353
Tier 1 capital ratio	11,854	0.122	0.095	0.135	0.049
Net income / assets	11,854	0.006	0.003	0.010	0.009
Liquid assets / assets	11,854	0.027	0.014	0.035	0.019
Deposits / assets	11,854	0.779	0.724	0.858	0.103
Short-term deposits / deposits	11,854	0.018	0	0	0.071
Nonretail deposits / deposits	11,854	0.362	0.190	0.461	0.267
Loans / assets	11,854	0.641	0.566	0.737	0.141
C&I loans / loans	11,854	0.219	0.131	0.277	0.127
<i>Regional variables</i>					
State personal income growth (%)	2,604	2.114	-0.549	4.794	4.824
Change in regional CPI (%)	236	2.386	1.112	3.985	2.908
State unemployment rate (%)	2,604	5.434	4.000	6.233	2.079
Change in state housing prices (%)	2,604	3.104	-0.523	7.739	8.356
<i>Nationwide variables</i>					
Target federal funds rate (%)	59	3.012	1.000	5.250	2.203
Real GDP growth (%)	59	2.257	1.318	3.600	2.837
NBER recession	59	0.186	0	0	0.393

a. 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. Loan spread is the difference between the interest rate on the loan minus the rate the prime rate reported by the bank. Risk rating is the internal risk rating assigned by the bank to a given loan, as reported in STBL, with 1=Minimal Risk, 2=Low Risk, 3=Moderate Risk, 4=Acceptable Risk, and 5=Special Mention or Classified Asset. Loan spread, loan size, and the dummy for loans secured by collateral are all taken from the STBL. Bank location is based on its headquarters, as reported in the NIC database. Bank total assets, capital, profitability, liquidity, deposit, and loan ratios are based on 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 indices published by OFHEO/FHFA. Growth rates are reported as annual rates. Recession dates are from the NBER. We exclude from the sample loans extended under commitment established prior to the current quarter from the sample.

The average loan spread over the bank's prime rate is about 0.75 percentage point, although there is considerable dispersion, with a standard deviation of 1.44 percentage points. The majority of loans in the sample are collateralized. The mean risk rating in the sample is 3.31, with a standard deviation of 0.84, indicating that the average loan over the sample period as reported by banks is between moderate risk (rating 3) and acceptable risk (rating 4). The average loan amount is US\$520,529, but the variation is quite large, reflecting the fact that the survey includes business loans to firms of all sizes.

Banks in our sample vary significantly in size, averaging US\$21 billion in total assets but with a standard deviation of over US\$104 billion, indicating that the sample includes both small and large banks. Loans constitute about two-thirds of the banks' balance sheets, on average, which suggests that our focus on risk-taking through lending is an important part of the risk profile of banks in our sample. On average, about one-fifth of the lending activity of banks in our sample is commercial and industrial (C&I) loans, and the typical bank in our sample is mostly funded by deposits.

The federal funds rate also displays substantial variation over the sample period, averaging about 3 percent in nominal terms with a standard deviation of 2.2 percent. Finally, about one-fifth of quarters in the sample are recession periods.

3. RESULTS

In this section, we present our main results concerning the effect of monetary policy conditions on lending terms. We also present some robustness checks that suggest that our baseline results are not likely driven by the response of monetary policy to the economic cycle or financial stability concerns.

We exclude from the sample those loans that banks made under a commitment (for example, drawn from a line of credit) established prior to the quarter of the survey. Instead, we focus on loans originated entirely at the discretion of the lender, which are more likely to capture risk-taking attitudes for the bank.

We study the effect of short-term interest rates on the terms of bank loans to businesses, controlling for the risk of the loan. In particular, we control for the bank's own assessment of the riskiness of the loan as reported to the STBL in the loan risk rating. We also control for other factors that could affect the risk profile of new loans at the bank level (including the originating bank's capitalization, profitability, and liquidity) and the general environment in which the bank operates (including GDP growth, inflation, and unemployment).

Table 2. Terms of Business Lending and the Federal Funds Rate^a

<i>Explanatory variable</i>	<i>Dependent variable</i>	
	<i>Loan spread</i>	<i>Dummy for secured loan</i>
	<i>(1)</i>	<i>(2)</i>
Target federal funds rate	0.037*** (0.012)	0.008*** (0.002)
Loan risk rating	0.346*** (0.010)	0.056*** (0.004)
Loan size	-0.275*** (0.007)	-0.006*** (0.001)
Bank size	-0.088*** (0.032)	-0.030*** (0.006)
Bank tier 1 capital ratio	3.754*** (0.571)	-0.106 (0.152)
Bank net income / assets	-6.641*** (1.495)	0.277 (0.248)
Bank liquid assets / assets	-2.158** (0.975)	-0.126 (0.286)
Bank deposits / assets	1.104*** (0.224)	0.068 (0.052)
Short-term deposits / deposits	-0.548*** (0.193)	-0.102* (0.053)
Nonretail deposits / deposits	-0.08 (0.073)	-0.014 (0.015)
Bank loans / assets	0.799*** (0.115)	0.107** (0.046)
Bank C&I loans / loans	0.476** (0.184)	0.197*** (0.039)
State personal income growth	-0.000*** (0.000)	0.000*** (0.000)
Change in regional CPI	-0.002 (0.006)	0.000 (0.001)
State unemployment rate	0.099*** (0.011)	0.019*** (0.002)
Change in state housing prices	-0.002 (0.001)	0.000 (0.000)
GDP growth	0.008 (0.006)	0.001 (0.001)
NBER recession dummy	0.012 (0.039)	-0.003 (0.005)

Table 2. (continued)

<i>Explanatory variable</i>	<i>Dependent variable</i>	
	<i>Loan spread</i>	<i>Dummy for secured loan</i>
	<i>(1)</i>	<i>(2)</i>
Constant	2.043*** (0.690)	0.809*** (0.113)
<i>Summary statistic</i>		
Bank fixed effects	Yes	Yes
State fixed effects	Yes	Yes
Time fixed effects	No	No
No. observations	1,121,510	1,121,508
No. banks	590	590
R^2	0.331	0.183

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

*** Statistically significant at the 1 percent level.

a. This table reports panel regression estimates of terms of individual new business loans originated from the second quarter of 1997 to the fourth quarter of 2011 by banks reporting to the Federal Reserve's STBL, which correspond to equation (1) in the text. The dependent variables in columns (1) and (2) are, respectively, loan spread and an indicator variable for collateralization as reported to the STBL. Bank size (as measured by the log of total assets), Tier 1 capital ratio, net income, liquid assets, deposits, short-term deposits, nonretail deposits, loans, and C&I loans are measured at the bank level and are all taken from call reports. Risk rating 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 regional CPI and state unemployment rate are from the BLS; and the change in housing prices is based on indices published by OFHEO/FHFA. The sample excludes loans extended under commitment established prior to the current quarter from the sample. All regressions include state and bank fixed effects. Standard errors two-way clustered by quarter and bank are reported in parentheses.

Our results on the relationship between short-term interest rates and the terms of business lending are reported in table 2. The dependent variable in column (1) is the loan spread. The statistically significant positive coefficient on the federal funds rate suggests that, controlling for the riskiness of the loan as assessed by the bank itself at origination, banks tend to charge relatively narrower spreads when short-term interest rates are lower, suggesting some easing of loan terms in low-interest rate environments.

Beyond the pricing of loans, banks appear to adjust risk-taking through some other terms of their lending. In column (2) of table 2, we report the results of estimating equation (1) with an indicator for loans collateralized by real estate as the dependent variable. The positive coefficient on the federal funds rate in the regression suggests that, conditional on their assessment of loan riskiness, banks are less likely to originate business loans secured by collateral in low-interest-rate environments.

Table 3. Terms of Business Lending and the Federal Funds Rate by Loan Risk Rating^a

<i>Explanatory variable</i>	<i>Dependent variable</i>	
	<i>Loan spread</i>	<i>Dummy for secured loan</i>
	<i>(1)</i>	<i>(2)</i>
Target federal funds rate × Loan risk rating	0.022*** (0.003)	0.008*** (0.001)
Loan risk rating	0.319*** (0.014)	0.028*** (0.003)
Loan size	-0.265*** (0.007)	-0.005*** (0.001)
Bank size	-0.142*** (0.030)	0.006 (0.009)
Bank tier 1 capital ratio	1.888** (0.712)	-0.008 (0.156)
Bank net income / assets	-8.708*** (1.586)	0.465 (0.367)
Bank liquid assets / assets	0.635 (0.932)	-0.683** (0.266)
Bank deposits / assets	1.140*** (0.263)	0.117* (0.058)
Short-term deposits / deposits	-1.063*** (0.188)	-0.088 (0.055)
Nonretail deposits / deposits	0.166* (0.091)	-0.005 (0.017)
Bank loans / assets	0.609*** (0.151)	0.075 (0.048)
Bank C&I loans / loans	-0.059 (0.180)	0.191*** (0.042)
State personal income growth	-0.000** (0.000)	0.000*** (0.000)
Change in regional CPI	0.006 (0.015)	-0.002 (0.003)
State unemployment rate	-0.028** (0.012)	0.028*** (0.003)
Change in state housing prices	0.002 (0.002)	-0.001 (0.001)
Constant	4.176*** (0.607)	0.053 (0.184)

Table 3. (continued)

<i>Explanatory variable</i>	<i>Dependent variable</i>	
	<i>Loan spread</i> (1)	<i>Dummy for secured loan</i> (2)
<i>Summary statistic</i>		
Bank fixed effects	Yes	Yes
State fixed effects	Yes	Yes
Time fixed effects	Yes	Yes
No. observations	1,121,510	1,121,508
No. banks	590	590
R^2	0.338	0.186

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

*** Statistically significant at the 1 percent level.

a. This table reports panel regression estimates of terms of individual new business loans originated from the second quarter of 1997 to the fourth quarter of 2011 by banks reporting to the Federal Reserve's STBL, which correspond to equation (2) in the text. The dependent variables in columns (1) and (2) are, respectively, loan spread and an indicator variable for collateralization as reported to the STBL. Explanatory variables are defined as in table 2. The sample excludes loans extended under commitment established prior to the current quarter from the sample. All regressions include time, state, and bank fixed effects. Standard errors two-way clustered by quarter and bank are reported in parentheses.

In table 3, we report the results of expanding the regressions reported in table 2 by interacting the effect of the federal funds rate with the risk rating of the loan. Analogous to table 2, the dependent variable in column (1) is the loan spread. The positive coefficient on the interaction between the federal funds rate and the loan risk rating indicates that in periods with low interest rates, banks lower their spreads relatively more for riskier loans. The results for the regression using an indicator for loans secured by real estate in column (2) suggest that the additional easing of non-pricing loan terms during periods of low interest rates is also more pronounced for riskier loans.

In table 4 we study whether banks that are more interest-rate sensitive change their loan terms more aggressively during periods of lower interest rates. Banks with higher short-term funding needs tend to be more exposed to changes in interest rates. Thus, we proxy reliance on short-term funding using the fraction of short-term deposits (maturing in less than one year). Table 4 reports the results of expanding the regressions in table 2 by including the interaction between short-term interest rates and bank reliance on short-term funding.

Table 4. Terms of Business Lending and the Federal Funds Rate by Bank Sensitivity to Interest Rates^a

<i>Explanatory variable</i>	<i>Dependent variable</i>	
	<i>Loan spread</i>	<i>Dummy for secured loan</i>
	(1)	(2)
Target federal funds rate × Short term deposits / deposits	0.201*** (0.063)	0.034* (0.020)
Loan risk rating	0.353*** (0.009)	0.056*** (0.004)
Loan size	-0.279*** (0.007)	-0.006*** (0.001)
Bank size	-0.074** (0.028)	0.005 (0.009)
Bank tier 1 capital ratio	2.984*** (0.504)	-0.053 (0.157)
Bank net income / assets	-6.054*** (1.539)	0.652* (0.356)
Bank liquid assets / assets	-0.009 (0.798)	-0.719*** (0.265)
Bank deposits / assets	1.090*** (0.228)	0.099* (0.057)
Short-term deposits / deposits	-1.677*** (0.416)	-0.263** (0.113)
Nonretail deposits / deposits	0.096 (0.079)	-0.014 (0.016)
Bank loans / assets	0.581*** (0.102)	0.085* (0.047)
Bank C&I loans / loans	-0.114 (0.147)	0.168*** (0.045)
State personal income growth	-0.000*** (0.000)	0.000*** (0.000)
Change in regional CPI	0.012 (0.012)	-0.002 (0.003)
State unemployment rate	-0.01 (0.011)	0.028*** (0.003)
Change in state housing prices	0.002 (0.001)	-0.001 (0.001)
Constant	2.719*** (0.673)	0.002 (0.181)

Table 4. (continued)

<i>Explanatory variable</i>	<i>Dependent variable</i>	
	<i>Loan spread</i> (1)	<i>Dummy for secured loan</i> (2)
<i>Summary statistic</i>		
Bank fixed effects	Yes	Yes
State fixed effects	Yes	Yes
Time fixed effects	No	No
No. observations	1,121,510	1,121,508
No. banks	590	590
R^2	0.338	0.185

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

*** Statistically significant at the 1 percent level.

a. This table reports panel regression estimates of terms of individual new business loans originated from the second quarter of 1997 to the fourth quarter of 2011 by banks reporting to the Federal Reserve's STBL, which correspond to equation (2) in the text. The dependent variables in columns (1) and (2) are, respectively, loan spread and an indicator variable for collateralization as reported to the STBL. Explanatory variables are defined as in table 2. The sample excludes loans extended under commitment established prior to the current quarter from the sample. All regressions include time, state, and bank fixed effects. Standard errors two-way clustered by quarter and bank are reported in parentheses.

The results reported in column (1) suggest that banks that ex ante appear more sensitive to interest rates decrease their spreads by more during periods of low interest rates. Similarly, the results in column (2) are consistent with the hypothesis that rate-sensitive banks are also less likely to collateralize their loans when interest rates are lower compared with banks that are less rate sensitive.

Even though our regressions control for a large set of factors correlated with the risk profile of loans, our ability to identify an exogenous effect of monetary policy on bank lending terms is limited, in part because monetary policy typically responds to macroeconomic conditions. To alleviate this type of endogeneity concern, we explicitly replace the federal funds rate as the dependent variable in our regressions with a Taylor rule residual, which represents the monetary policy surprise. We obtain the Taylor rule residuals from rolling regressions of the target federal funds rate on the deviation of CPI inflation from 2 percent and the difference between actual and potential GDP growth.

Table 5. Terms of Business Lending and the Taylor Rule Residuals^a

<i>Explanatory variable</i>	<i>Dependent variable</i>	
	<i>Loan spread</i>	<i>Dummy for secured loan</i>
	<i>(1)</i>	<i>(2)</i>
Taylor rule residual	0.034*** (0.013)	0.005*** (0.002)
Loan risk rating	0.346*** (0.010)	0.056*** (0.004)
Loan size	-0.275*** (0.007)	-0.006*** (0.001)
Bank size	-0.098*** (0.031)	-0.033*** (0.006)
Bank tier 1 capital ratio	3.818*** (0.552)	-0.095 (0.153)
Bank net income / assets	-7.305*** (1.513)	0.152 (0.232)
Bank liquid assets / assets	-2.214** (0.970)	-0.136 (0.285)
Bank deposits / assets	1.060*** (0.227)	0.069 (0.052)
Short-term deposits / deposits	-0.549*** (0.194)	-0.101* (0.053)
Nonretail deposits / deposits	-0.086 (0.073)	-0.013 (0.015)
Bank loans / assets	0.815*** (0.115)	0.114** (0.046)
Bank C&I loans / loans	0.508*** (0.183)	0.207*** (0.039)
State personal income growth	-0.000*** (0.000)	0.000*** (0.000)
Change in regional CPI	0.013* (0.008)	0.002** (0.001)
State unemployment rate	0.093*** (0.010)	0.015*** (0.002)
Change in state housing prices	-0.002 (0.001)	0.000 (0.000)
GDP growth	0.012* (0.007)	0.002** (0.001)
NBER recession dummy	0.015 (0.041)	-0.003 (0.005)

Table 5. (continued)

<i>Explanatory variable</i>	<i>Dependent variable</i>	
	<i>Loan spread</i>	<i>Dummy for secured loan</i>
	(1)	(2)
Constant	2.719*** (0.673)	-1.407*** (0.413)
<i>Summary statistic</i>		
Bank fixed effects	Yes	Yes
State fixed effects	Yes	Yes
Time fixed effects	No	No
No. observations	1,121,510	1,121,508
No. banks	590	590
R^2	0.330	0.183

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

*** Statistically significant at the 1 percent level.

a. This table reports panel regression estimates of terms of individual new business loans originated from the second quarter of 1997 to the fourth quarter of 2011 by banks reporting to the Federal Reserve's STBL, which correspond to equation (2) in the text. The dependent variables in columns (1) and (2) are, respectively, loan spread and an indicator variable for collateralization as reported to the STBL. Taylor rule residuals are obtained from rolling regressions of the target federal funds rate on deviations of median SPF projections for GDP growth from potential output growth and deviations of CPI inflation from 2 percent. All other explanatory variables are defined as in table 2. The sample excludes loans extended under commitment established prior to the current quarter from the sample. All regressions include state and bank fixed effects. Standard errors two-way clustered by quarter and bank are reported in parentheses.

Table 5 reports the results of reestimating equation (1) replacing the federal funds rate with the Taylor rule residual. We find that the results reported in table 2 are robust to using a measure of monetary policy conditions that is orthogonal to the degree of slack in economic activity and deviations of inflation from target. In other words, we find that the component of interest rates that reflects economic activity is likely not the main driver for our baseline results reported in table 2.

An additional endogeneity concern is that short-term interest rates set by monetary policy could respond directly to financial stability considerations. To alleviate this concern, we also report our results replacing the federal funds rate with the residual from a Taylor rule expanded to include financial risk. In particular, we reestimate the Taylor rule used in table 5 with a rule that also includes the option-implied volatility on the S&P 500 index one month out (that is, the VIX), in addition to measures of the output gap and deviations of inflation from its target. We report the results of this new estimation in table 6.

Table 6. Terms of Business Lending and Modified Taylor Rule Residuals^a

<i>Explanatory variable</i>	<i>Dependent variable</i>	
	<i>Loan spread</i>	<i>Dummy for secured loan</i>
	<i>(1)</i>	<i>(2)</i>
Modified Taylor rule residual	0.019*	0.003**
	(0.011)	(0.001)
Loan risk rating	0.333***	0.050***
	(0.010)	(0.004)
Loan size	-0.261***	-0.004***
	(0.007)	(0.001)
Bank size	-0.105***	-0.040***
	(0.035)	(0.008)
Bank tier 1 capital ratio	4.241***	-0.196
	(0.643)	(0.164)
Bank net income / assets	-7.458***	0.222
	(1.696)	(0.250)
Bank liquid assets / assets	-1.181	-0.286
	(1.115)	(0.358)
Bank deposits / assets	1.391***	0.114**
	(0.264)	(0.056)
Short-term deposits / deposits	-0.767***	-0.116*
	(0.200)	(0.060)
Nonretail deposits / deposits	0.019	-0.011
	(0.081)	(0.017)
Bank loans / assets	0.940***	0.052
	(0.131)	(0.045)
Bank C&I loans / loans	0.790***	0.244***
	(0.209)	(0.040)
State personal income growth	-0.000***	0.000***
	(0.000)	(0.000)
Change in regional CPI	0.002	0.001
	(0.007)	(0.001)
State unemployment rate	0.087***	0.013***
	(0.012)	(0.002)
Change in state housing prices	-0.003**	0.000
	(0.001)	(0.000)
GDP growth	0.006	0.000
	(0.008)	(0.001)
NBER recession dummy	0.012	-0.005
	(0.048)	(0.004)

Table 6. (continued)

<i>Explanatory variable</i>	<i>Dependent variable</i>	
	<i>Loan spread</i>	<i>Dummy for secured loan</i>
	(1)	(2)
<i>Constant</i>	1.815** (0.690)	1.116*** (0.126)
<i>Summary statistic</i>		
Bank fixed effects	Yes	Yes
State fixed effects	Yes	Yes
Time fixed effects	No	No
Observations	941,063	941,062
Number of banks	543	543
R^2	0.318	0.185

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

*** Statistically significant at the 1 percent level.

a. This table reports panel regression estimates of terms of individual new business loans originated from the second quarter of 1997 to the fourth quarter of 2011 by banks reporting to the Federal Reserve's STBL, which correspond to equation (2) in the text. The dependent variables in columns (1) and (2) are, respectively, loan spread and an indicator variable for collateralization as reported to the STBL. Modified Taylor rule residuals are obtained from rolling regressions of the target federal funds rate on deviations of median SPF projections for GDP growth from potential output growth, deviations of CPI inflation from 2 percent, and the VIX. All other explanatory variables are defined as in table 2. The sample excludes loans extended under commitment established prior to the current quarter from the sample. All regressions include state and bank fixed effects. Standard errors two-way clustered by quarter and bank are reported in parentheses.

The results in table 6 are fairly similar to those reported in table 5, suggesting that the component of short-term interest rates that reflects financial stability considerations is likely not responsible for explaining the results in table 2, which alleviates some endogeneity concerns².

4. CONCLUSIONS

This paper provides evidence that banks tend to ease lending terms for new loans in an environment of low short-term interest rates, controlling for the ex ante assessment of loan riskiness. For

2. Dell'Arccia, Laeven, and Suarez (2016), who find that bank loans tend to be assessed as being more risky at origination during periods of low interest rates, document that the interest-rate effects tend to be stronger in times of lower financial stress (for example, periods with few bank failures), when financial stability considerations are less likely to weigh on short-term interest rates.

example, our empirical analysis shows that a one-standard-deviation decrease in short-term interest rates would result in a decrease in loan spreads for new loans of about 0.1 percentage point (compared with its standard deviation of 1.4 percentage points). Moreover, we also find evidence that banks are less likely to require collateral for new loans originated during low-interest rate periods.

We obtain these results using loan-level data on newly issued loans, which is critical for assessing the impact on general credit conditions and on the riskiness of U.S. bank loans. This contrasts with most existing studies, which largely rely 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 changes in lending terms, while controlling for *ex ante* perceptions of loan risk. Most existing studies analyze *ex post* loan performance, which could be affected by subsequent events.

We also find that the link between lower short-term interest rates and easier loan terms (as measured by spreads and collateral requirements) is more pronounced for banks that are more sensitive to short-term interest rates, as measured by the fraction of short-term deposits in their total deposit base and for riskier loans. These findings suggest that the negative relationship between interest rates and lending terms in our baseline results likely operates through decisions made by the bank in response to changes in interest rates and not through an omitted variable.

We also find similar results when replacing short-term interest rates with Taylor rule residuals that control for the degree of economic slack (as captured by the output gap and deviations of inflation from its target level) and for overall financial risk (as captured by the VIX), suggesting that our results are not explained by endogenous and predictable responses of interest rates to economic and financial conditions.

This paper has focused on a very specific margin of risk-taking: the terms of business lending. The effect on the overall asset portfolio of banks could be different. In fact, Dell'Ariccia, Laeven, and Suarez (2016) find that banks increase their holding of riskier securities during periods of low interest rates. In addition, there are several other channels through which interest rate policy can affect bank stability, including leverage, liquidity, and maturity mismatches (Adrian and Shin, 2009).

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