# The Credit Channel of Unconventional Monetary Policy: Evidence from the United States

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**ABSTRACT**

We present new evidence of a credit channel of monetary policy for the U.S. banking system. We use confidential data on individual bank loans to businesses from 1997 to 2015 from the Federal Reserve's Survey of Terms of Business Lending. We find that banks tend to originate loans with lower spreads during periods of low short-term interest rates, especially banks with relatively weak balance sheets. Similarly, we find that, after the substantial expansion of its balance sheet in 2009, increases in Treasury holdings by the Federal Reserve are associated with a decline in loan spreads, especially for banks with relatively weak balance sheets. These results are consistent with a credit channel of unconventional monetary policy whereby monetary stimulus in the form of asset purchases strengthens the balance sheets of firms and banks, thus reducing intermediation costs and promoting bank lending.

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# I. Introduction

The recent crisis prompted the Federal Reserve to conduct unconventional monetary policy through a combination of forward guidance and large-scale asset purchases. With short-term interest rates at nearly zero by the end of 2008, the Federal Reserve announced that economic conditions were 'likely to warrant exceptionally low levels of the federal funds rate for an extended period.' This forward guidance on interest rates was complemented with three programs of large-scale asset purchases (LSAPs) between late 2008 and October 2014. These LSAPs included purchases of agency debt and agency-guaranteed mortgage-backed securities (MBS) and longer term Treasury securities.[1] Other major central banks have conducted similar policies since the crisis. These unprecedented interventions by central banks have reignited the interest in understanding how monetary policy affects bank lending to the real economy.

The period of very low interest rates has led to a debate on how low short-term rates influence bank risk taking (the so-called "risk-taking channel" of monetary policy). From a financial stability perspective, one concern is that an extended period of monetary stimulus through low interest rates could contribute to a build-up in financial risk taking (e.g., Rajan, 2010; Farhi and Tirole, 2012; Acharya et al., 2013; Jimenez et al. 2014; Dell'Ariccia et al. 2014, 2017).

[1] The first round of purchases ran from November 2008 to March 2010, at which point the Federal Reserve had accumulated US$1.25 trillion in MBS, US$175 billion in federal agency debt and US$300 billion in long-term Treasury securities. The second LSAP program lasted from November 2010 to the end of June 2011, and involved the purchase of $600 billion in longer term Treasuries and the reinvestment of securities attained under the previous program. In September 2011, Operation Twist was started which involved a shift towards a longer duration of its Treasury securities portfolio through the purchases of longer duration securities through the sale of shorter duration securities. Finally, in September 2012 a third round of asset purchases was initiated, initially amounting to US$40 billion in monthly agency MBS purchases and US$45 billion in monthly long-term Treasury securities purchases.

Similarly, the extensive use of LSAPs has received mixed support. Proponents point to sizeable announcement effects on asset prices (Krishnamurthy and Vissing-Jorgensen, 2011; Gagnon et al. 2011; Gertler and Karadi, 2011, 2013; D'Amico and King 2013) without jeopardizing financial stability (Chodorow-Reich, 2014). Opponents argue that these policies had little real effects (Stroebel and Taylor, 2012; Taylor, 2013) and come with undesirable side effects, such as the buildup of asset bubbles and increased risk taking (Brunnermeier and Sannikov, 2015; Becker and Ivashina, 2015; Di Maggio and Kacperczyk, 2017; Di Maggio, Kermani, and Palmer, 2016; Kurzman et al. 2017).

In theory, asset purchases affect term spreads and financial conditions through two main channels: the signaling channel and the portfolio rebalancing channel (Krishnamurthy and Vissing-Jorgensen, 2011). The signaling channel operates by influencing market expectations of future short-term interest rates. Asset purchases lower longer-term yields by signaling that the future path of short-term interest rates will be lower than expected. The portfolio rebalancing channel works through the effects of asset purchases on the marginal investor's valuation of those assets. Consistent with preferred habitat theories, this channel assumes that some investors have strong preferences for the securities targeted by the Federal Reserve and that arbitrage with other assets is limited. As a result, asset purchases drive up the prices and lower the associated term premiums of the targeted assets and similar assets.

When banks face financial frictions that drive a wedge between their external and internal cost of funds, asset purchases may involve credit channel effects, influencing the cost and availability of bank lending. With a credit channel present, the loosening of monetary policy through asset purchases leads to a loosening of financial constraints, which amplifies the overall effect of asset purchases on the cost of borrowing and the availability of credit (Bernanke and

Gertler 1995). Such credit channel effects operate through two related channels. First, according to the balance sheet channel, asset purchases increase the net worth of banks and their borrowers by boosting the value of their securities and other marketable collateral (Bernanke and Gertler 1989; Gertler and Karadi 2011). This channel should be particularly pronounced for banks with large holdings of MBS and U.S. Treasuries, and more generally for banks with weaker balance sheets (i.e., lower capital). Because this channel operates through boosting the equity values of banks it is also known as the capital relief or stealth recapitalization channel (Brunnermeier and Sannikov 2015). Second, according to the bank lending channel, asset purchases increase reserves and hence insured deposits in the banking system, thus expanding the amount of loanable funds. This channel should be particularly pronounced for banks with less liquid balance sheets and more generally for banks with weaker balance sheets (Bernanke and Blinder 1988; Kashyap and Stein 1994; Peek and Rosengren 1995; and Kashyap and Stein 2000). The common prediction of these theories is that the impact of asset purchases on lending should be stronger for banks with weaker balance sheets.

This paper is the first to study the impact of both short-term interest rates as well as large-scale asset purchases on the cost of bank lending to the corporate sector. Using a confidential loan-level dataset of commercial and industrial (C&I) loans from the Federal Reserve's Survey of Terms of Business Lending (STBL)[2] from 1997 to 2015, we analyze the impact of short-term interest rates and large-scale asset purchases on loan spreads. Our main hypothesis is that lower interest rates and substantial asset purchases are associated with lower loan spreads, especially

[2] STBL data have been used to study the impact of interest rate changes on risk-taking in bank loans and how risk-taking in bank loans varies over the cycle (see, for instance, Asea and Blomberg (1998), Carpenter, Whitesell, and Zakrajšek (2001), and Black and Hazelwood (2013), and Dell'Ariccia, Laeven and Suarez (2017)) but have not been used to study the impact of unconventional monetary policy on bank lending spreads.

for banks with weak balance sheets. Most of the literature on the credit (or bank lending) channel of monetary policy has focused on interest rate policy and has not considered asset purchases. Moreover this literature has exclusively focused on loan quantities rather than loan spreads (e.g., Kashyap, Stein and Wilcox 1993). The reason is that loan-level data are needed to isolate supply effects from demand effects but loan-level credit registers generally do not include information on loan interest rates (for instance, the Spanish credit register used by Jimenez et al. (2012) has information on loan quantities but not loan pricing). The advantage of the Federal Reserve's Survey of Terms of Business Lending (STBL) is that it has information not only on loan pricing but also on non-price terms of credit (collateral, size, maturity) and default risk (risk rating) that are needed to capture supply effects.

To study the relationship between short-term interest rates and loan spreads, we use the entire available sample. To study the relationship between unconventional monetary policy and loan spreads, we consider the period starting in 2009 and focus on the importance of Treasury securities held by the Federal Reserve relative to the economy. The use of loan level data allows the inclusion of bank fixed effects and the controlling for loan characteristics, greatly improving identification.[3] In particular, since 1997, the survey has asked respondents to report for each individual loan, their assessed risk rating, which provides a unique ex-ante measure of loan riskiness that we use to abstract from the effects of monetary policy on credit risk.

In terms of the relationship between bank lending and conventional monetary policy, we document that banks tend to lower loan spreads during periods of low interest rates. In

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

particular, for a given ex-ante internal risk-rating of the loan, banks tend to originate new business loans with lower spreads. Our empirical analysis indicates that, for the typical new loan, a one-standard deviation decrease in short-term interest rates is roughly associated with a decrease in loan spreads of 0.1 percentage points, which is a nontrivial effect, although it is somewhat modest when compared with the standard deviation of loan spreads in our sample (1.5 percentage points).

We also show that the negative relationship between short-term interest rates and bank lending terms, as measured by spreads, is more pronounced for banks that are more sensitive to short-term interest rates in their funding needs and for banks with weaker balance sheets, as measured by their capital ratios.

In terms of unconventional monetary policy, we find that Treasury holdings by the Federal Reserve are associated with lower loan spreads, especially for banks with relatively weak balance sheets in terms of capital, and for banks with higher security holdings in their portfolios. These results suggest that a credit channel of unconventional monetary policy through asset purchases exists and operates in the same direction as that of conventional monetary policy.

The economic effects of our results for unconventional monetary policy are significant. An interquartile range increase in Treasury holdings would lower spreads on loans with no commitment by roughly 0.2 percentage points which is about one-eighth of its interquartile range. Moreover, such an increase in Treasury holdings would lower loan spreads on loans with no commitment by about 0.3 percentage points more for a weakly capitalized bank (with common stock to assets ratio at its 25th percentile) than for a strongly capitalized bank (with common stock to assets ratio at its 75th percentile).

One may be concerned that our results are confounded by an endogenous relationship between asset purchases and bank lending conditions. Our focus on new loans should reduce concerns about endogeneity, since this subset of loans is less likely to inform FOMC decisions than a bank's entire portfolio. However, to further address these concerns, we take the following steps. First, we limit the sample to loans not under previous commitment (i.e., we exclude pre-committed loan agreements and withdrawals from credit lines), thereby focusing on truly new business loans reflecting more heavily loan-supply factors. Second, we control for state-level variation in economic conditions, so that financial stability considerations are accounted for as long as they affect monetary conditions only through their effect on macroeconomic conditions.

Existing work on the effectiveness of large-scale asset purchases has focused mostly on their impact on long-term rates and associated term premia. This literature has generally found large announcement effects of such policy changes, consistent with both signaling and portfolio rebalancing channels (Gagnon et al. 2011; Krishnamurthy and Vissing-Jorgenson 2011; D'Amico et al. 2012; D'Amico and King 2013). In terms of banks, Chodorow-Reich (2014) shows using event studies that unconventional monetary policy actions had strong positive impact on bond and equity values of banks.

In terms of methodology, our paper also differs from these studies that primarily rely on announcement effects using event studies. The advantage of using announcement effects that one can more precisely attribute findings to the announced policy changes. The disadvantage is that it does not lend itself well to study the effects on slow moving variables such as lending and financial conditions that tend to respond with some delay to monetary policy shocks. Moreover such methods only capture the impact of policy changes to the extent that they are not already incorporated in market expectations. Indeed available measures of monetary policy shocks

computed over short intervals around FOMC announcements (e.g. Gertler and Karadi, 2015) show a low correlation with actual changes in Federal funds rates.

The impact of asset purchases on bank lending has in comparison not received much attention in the literature. Rodnyanski and Darmouni (2017) study the impact of MBS purchases on real estate lending of US banks. Their focus is on their impact through banks' holdings of such MBS and they only have bank-level data. Similarly, Hancock and Passmore (2011) focus on MBS purchases to show that they lowered mortgage spreads.

Our paper also speaks more broadly to the literature on the credit channel of monetary policy which has focused on the impact of interest rate policy (Kashyap and Stein 2000; Jimenez et al. 2012). These papers generally find evidence in support of the existence of a credit channel although the relative importance of the bank lending and balance sheet channels remains in dispute. Contrary to the papers in this literature, we focus on loan pricing rather than quantities.

The paper proceeds as follows. Section II presents the methodology used to assess the link between conventional and unconventional monetary policy and bank lending spreads. Section III presents the data and descriptive statistics for the main variables used in the empirical analysis. Section IV presents and interprets the empirical results. Section V concludes.

## II. Empirical Methodology

We employ panel regression analysis to investigate the relationship between monetary policy and the interest rate spread of new loans issued by U.S. commercial banks. To study the relationship of lending terms with conventional monetary policy, we focus on the federal funds rate, and to study the relationship with unconventional monetary policy, we focus on Treasury

holdings in the Federal Reserve portfolio. Our basic regression model to study the effect of conventional monetary policy is as follows:

$$Spread_{kit} = \alpha_i + \lambda_j + \beta Fed\ funds\ rate_t + \theta X_{kit} + \mu Y_{it} + \rho Z_{jt} + \sigma M_t + \varepsilon_{kit},$$

(1)

where $Spread_{kit}$ is the interest rate spread of loan *k* extended by bank *i* during quarter *t*, which we use as a measure of borrowing costs, $Fed\ funds\ rate_t$ is the target federal funds rate, $X_{kit}$ is a set of loan-specific control variables (loan size and loan risk rating), $Y_{it}$ is a set of bank-specific control variables (log of total assets, capital ratio, liquid assets to total assets, C&I loans to total assets, deposits to total assets, loans to total assets, net income to total assets, short-term deposits to total assets), $Z_{jt}$ is a set of time-varying regional (either U.S. state or Census region) control variables, $M_t$ is a vector of macroeconomic variables (real GDP growth and a dummy for NBER recessions), $\alpha_i$ are bank-specific fixed effects, $\lambda_j$ are state-specific fixed effects, and $\varepsilon_{kit}$ is the error term.

Similarly, to study the relationship between unconventional monetary policy and bank spreads, we study the following specification:

$$Spread_{kit} = \alpha_i + \lambda_j + \beta Fed\ Treasury\ Holdings_t + \theta X_{kit} + \mu Y_{it} + \rho Z_{jt} + \sigma M_t + \varepsilon_{kit},$$

(2)

where $Fed\ Treasury\ Holdings_t$ correspond to the Treasury holdings of the Federal Reserve relative to nominal GDP at the beginning of quarter *t*, which we use as a measure of unconventional monetary policy.

We alleviate some concerns of endogeneity concerns by limiting the sample to truly new loans (i.e., those not made under prior commitment) and controlling for macroeconomic conditions, as well as by using beginning-of-period explanatory variables. The sample of loans

constitutes new C&I loans including loans extended under prior commitment. To mitigate concerns that monetary policy (i.e., asset purchases) responds endogenously to lending spreads we estimate each specification on the subsample of loans that are not made under prior commitment and therefore constitute truly new loans. Monetary policy should be less responsive to new loans as opposed to outstanding loans.

We control for changes in banking and economic conditions to mitigate concerns that our findings on the federal funds rate or asset purchases are driven by the business cycle or bank characteristics, either because bank capital varies with the economic cycle or across banks, or because the lending conditions vary endogenously with the state of the economy, potentially biasing the estimated coefficients. For instance, 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, in our analyses we control for changes in economic and banking conditions through the inclusion of economic and banking variables.

To control for dependence of observations within quarters, standard errors are clustered by quarter. We compute the loan spread as the interest rate on the loan minus the prime rate of the bank. In equations (1) and (2), our coefficient of interest is $\beta$. If conventional monetary policy stimulus through lower interest rates is associated with less stringent lending terms, we would expect the coefficient $\beta$ in equation (1) to be positive. Similarly, if unconventional monetary policy through increases in Treasury holdings by the central bank are associated with more accommodative lending terms, we would expect the coefficient $\beta$ in equation (2) to be negative.

In a recent paper, Drechsler, Savov and Schnabl (2017) show that banks' deposit flows are sensitive to interest rate changes, given rise to a deposit channel of monetary policy. When

the Federal funds rate rises, banks widen the spreads they charge on deposits, and deposits flow out of the banking system. To test whether the relationship between the federal funds rate and loan spreads is more pronounced for banks whose funding is more interest-rate sensitive, we expand equation (1) as follows:

$$Spread_{kit} =$$

$$\alpha_i + \lambda_j + \tau_t + \gamma Fed\ funds\ rate_t * Short\ term\ deposits_{it} + \theta X_{kit} + \mu Y_{it} + \rho Z_{jt} + \varepsilon_{kit}, \quad (3)$$

where $Short\ term\ deposits_{it}$ is the fraction of short-term deposits (those due within a year) to total deposits for bank $i$, and $\tau_t$ represents time fixed effects. The coefficient of interest in equation (3) is $\gamma$. If the relationship between spreads and monetary policy rates is stronger for banks that are more sensitive to fluctuations in borrowing costs in money markets, we expect the coefficient $\gamma$ in equation (3) to be positive.

Asset purchases by the Federal Reserve increased the value of assets on banks' balance sheets, indirectly increasing banks' capital ratios. The valuation effect of purchases of securities should be more pronounced for banks with a larger fraction of security holdings on their balance sheet (a similar argument is made by Rodnyansky and Darmouni (2017) for the case of mortgage-backed securities). To test whether the relationship between Treasury holdings by the Federal Reserve and bank lending terms is more pronounced for banks with larger security holdings in their portfolio, we expand equation (2) as follows:

$$Spread_{kit} =$$

$$\alpha_i + \lambda_j + \tau_t + \gamma Fed\ Treasury\ holdings_t * Bank\ Trading\ Securities_{it} + \theta X_{kit} + \mu Y_{it} + \rho Z_{jt} + \varepsilon_{kit}, \quad (4)$$

where $Bank\ Trading\ Securities_{it}$, is the ratio of bank holdings of Treasury securities and MBS in the trading account as a share of total assets, and $\tau_t$ represents time fixed effects. The

coefficient of interest in equation (4) is $\gamma$. If the relationship between spreads and monetary policy rates is stronger for banks that are more sensitive to fluctuations in the market price of long-term securities, we expect the coefficient $\gamma$ in equation (4) to be negative.

To test whether the relationship between loan spreads and the federal funds rate is stronger for banks with a weaker balance sheet, consistent with a credit channel of monetary policy as in Kashyap and Stein (2000), we expand equation (1) to include the interaction of the federal funds rate and bank capital, as measured by the bank leverage ratio. The resulting equation is as follows:

$$Spread_{kit} = \alpha_i + \lambda_j + \tau_t + \delta Fed\ funds\ rate_t * Bank\ capital\ _{it} + \theta X_{kit} + \mu Y_{it} + \rho Z_{jt} + \varepsilon_{kit}, \quad (5)$$

where bank capital is defined as in equation (1). The coefficient of interest is $\delta$. If the relationship between the federal funds rate and loan spreads is stronger for banks with weaker bank balance sheets, we expect $\delta$ to be negative.

Similar to the motivation for equation (5), to test how the relationship between loan spreads and Federal Reserve holdings of long-term securities varies with the strength of the balance sheet of the bank, we expand equation (2) to include the interaction of Federal Reserve holdings of Treasury securities with bank capital:

$$Spreads_{kit} = \alpha_i + \lambda_j + \tau_t + \delta Fed\ Treasury\ holdings_t * Bank\ capital_{it} + \theta X_{kit} + \mu Y_{it} + \rho Z_{jt} + \varepsilon_{kit}. \quad (6)$$

The focus of this specification is on the interaction term between asset purchases rates and bank capital, $\delta$. A positive coefficient $\delta$ on the interaction between measures of bank capital and asset holdings by the central bank would be expected if unconventional monetary policy

stimulates banks to ease loan terms for banks with weaker balance sheets, consistent with a credit channel, and specifically a bank balance sheet channel.

In an extension, we replace the monetary policy variable for unconventional monetary policy with the ratio of MBS holdings to nominal GDP. This allows to test whether the impact of purchases of mortgage-backed securities is qualitatively similar to that of Treasuries. In a recent paper, Rodnyansky and Darmouni (2017) show that banks with larger holdings of mortgage-backed securities increased their lending disproportionately more in response to Federal Reserve purchases of mortgage-backed securities.

## III. Data and Descriptive Statistics

### *A. Survey of Terms of Business Lending*

This paper uses confidential loan-level data over the period 1997 to 2015 from the Federal Reserve's Survey of Terms of Business Lending (STBL). 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.[4] 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

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

quarter (i.e., February, May, August, and November). As a result, we have information on each loan only for one week each quarter, not the whole quarter.

The STBL collects loan pricing information in the form of loan spreads, computed as the interest rate on the loan minus the prime lending rate. The loan spread variable is our main variable of interest. In addition to the loan spreads, the STBL collects loan information on the face value amount, compounding frequency, date on which the loan rate can be recalculated (if any), maturity date (if any), risk rating, commitment status, and whether the loan is secured by collateral. 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. Loan information is verified by the Federal Reserve, which should alleviate concerns of self-reported biases.[5] The publicly available release of this survey encompasses an aggregate version of the terms of business lending, reported by bank type. In this paper, we use the confidential data on individual loans with additional bank- and regional-level controls.

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 thus STBL micro-level data are 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 participate in the survey.

[5] The survey data are subject to validity and quality verification by Federal Reserve staff. Validity verification checks that answers are a feasible response to a given question, while quality verification checks the reasonableness of the responses. If a data item is judged 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 the quality verification, the respondent is asked to verify the record and is given an opportunity to provide an explanation.

Since its inception in February 1977, the STBL has been revised periodically to accommodate changes in lending practices. Loan risk ratings were added to the STBL in 1997. 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. This adjustment reflected price inflation over the intervening period and the increased use of business credit cards, developments that 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 interested in 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. For example, Friedman and Kuttner (1993) use STBL data to study credit conditions during the 1990 to 1991 economic recession and Asea and Blomberg (1998) focus on the behavior of lending standards over the cycle. Black and Rosen (2007) use STBL data to study monetary policy transmission. STBL data have also been

used to study how industry consolidation may affect the availability and pricing of small business loans (see Berger, Kashyap, and Scalise (1995)). Using STBL data, Carpenter, Whitesell, and Zakrajšek (2001) show that more closely linking capital requirements to the riskiness of individual business loans could allow banks to set aside noticeably less capital for those loans and without substantially changing the cyclical behavior of required capital levels, and Morgan and Ashcraft (2003) show that risk ratings on a bank's newly extended business loans can 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. Dell'Ariccia, Laeven and Suarez (2017) use STBL data to provide evidence of a risk-taking channel of interest rates during the period 1997Q2 to 2011Q4.

## *B. Data Sets 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*

A new loan's *Spread* is the interest rate on the loan minus the prime loan rate of the bank, as reported in the STBL. The loan spread is a measure of the cost of loan intermediation.[6]

*Risk rating* is the ex-ante internal risk rating assigned by the bank, as reported in the STBL. The internal risk rating is a discrete index that increases with perceived risk. On the

[6] Results are unaltered when we 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, or when we compute the loan spared as the interest rate on the loan minus the AA 30-day commercial paper rate. In all regressions with time-fixed effects, these base rates are absorbed by the time effects because they do not vary across banks.

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 respondents to report the rating from the STBL scale that corresponds most closely to their internal risk rating for each loan reported.[7] Importantly, these risk classifications take into account both the characteristics of the borrower and the protections provided in the loan contract. Loans in the Minimal Risk category have virtually no chance of resulting in a loss, while 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 the loan is secured by collateral, and whether 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. We exploit 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: *Treasury securities and MBS / assets* is the ratio of Treasury securities and MBS held in the trading account to total

[7] For detailed survey instructions, including those applicable to loan risk ratings, see http://www.federalreserve.gov/reportforms/forms/FR_2028a--s20150803_i.pdf.

assets; *Equity / assets* is the ratio of common stock to total assets; *KS liquidity* is the ratio of securities (excluding trading accounts) plus federal funds sold to total assets; *Bank size* is the log of bank total assets (in US$ millions); *C&I loans / loans* is the ratio of commercial and industrial loans to total loans; *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; *Loans / assets* is the ratio of total loans to total assets; *Net income / assets* is the ratio of net income to total assets.

Bank location is based on the bank's 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-level variables, or region-level variables where state-level variables are unavailable, to account for the possibility that local conditions such as employment, inflation, house prices, and economic activity affect bank lending. At the state level, we employ 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 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 change in the consumer price index (CPI) (quarter over quarter, annualized rate) taken from BLS.

### *B.4. Nationwide Variables*

Our main measures of asset holdings by the Federal Reserve are *Fed Treasury holdings / nominal GDP*, which is the ratio of U.S. Treasury holdings by the Federal Reserve to nominal U.S. GDP, and *Fed MBS holdings / nominal GDP*, which is the ratio of MBS holdings by the Federal Reserve to nominal U.S. GDP. Data on the Federal Reserve's asset holdings are from the Federal Reserve H.4.1 statistical release.

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 that allows it to implement monetary policy. The effective federal funds rate is a volume-weighted median of rates on transactions by domestic banks and U.S. branches and agencies of foreign banks that is calculated daily by the Federal Reserve Bank of New York.

Other nationwide variables include real GDP growth (quarter over quarter, annual rate) taken from the BEA, and dummy for recession periods following the definition of the NBER.

*C. Descriptive Statistics for Main Variables*

Figure 1 shows the evolution of U.S. short- and medium-term interest rates, as measured by the Federal funds rate and the 2-year Treasury rate, over the sample period. Both series track each other closely and the Federal funds rate reached its zero lower bound in early 2009. The spread between the 2-year Treasury rate and the Federal funds rate narrowed over the period 2009 to 2012 as the Federal Reserve embarked on large-scale purchases of U.S. Treasuries.

Figure 2 shows the evolution of asset purchases by the Federal Reserve over time, broken down between purchases of Treasury securities and MBS. The data show a stepwise increase in the holdings of both asset classes, as the Federal Reserve added to its previous purchases in each of the three programs, with the purchases of Treasury securities overtaking those of MBS

purchases during the first quarter of 2011. Over the sample period, Federal Reserve holdings of U.S. Treasury securities increased from about 5% of GDP in 2009 to 14% of GDP in 2015, and holdings of MBS increased from 4% of GDP in 2009 to 10% of GDP in 2015.

Figure 3 shows the evolution of bank loan rates and spreads, computed as averages across banks weighted by loan amount. Spreads are computed over either prime rates (our baseline) or AA-rated nonfinancial commercial paper rates. Both spreads track each other closely and the loan rate matches closely the spread over CP rates in the post-2009 period when short-term interest rates are near zero.

Figure 4 shows the evolution of bank capitalization ratios, as measured by the weighted average Tier-1 capital ratio across banks. Bank capital increased substantially following the financial crisis.

Table 1 reports summary statistics for our main regression variables. Descriptive statistics are reported separately for the sample of loans from 1997:Q2 to 2015:Q4, which is used for the regressions measuring (conventional) monetary policy through the federal funds rate (in Panel A), and for the subsample of loans extended from 2009:Q2 to 2015:Q4, which is used for the regressions measuring (unconventional) monetary policy through Federal Reserve Treasury holdings. We exclude from our samples those loans that are extended under commitment prior that was established at least 30 days prior to the time the loan was issued, which do not represent truly new loans. The reason for excluding loans made under commitment is twofold. First, unlike "discretionary loans", these loans are likely to be less responsive to current macro conditions, including the monetary policy environment. Including loans made under commitment in the sample might therefore underestimate the effect of interest. Second, loans

not made under commitment represent discretionary new loans and therefore better capture the marginal impact on the terms of new loans.

In the full sample (1997:Q2 to 2015:Q4) reported in Panel A of Table 1, the average loan spread is about 0.6 percentage points, with a large standard deviation of 1.5 percentage points, indicating a high degree of variation across loans and over time reflecting in part differences in credit risk. The average loan risk rating in the sample is 3.3, with a standard deviation of 0.8, 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$477,770 but the variation is very large, reflecting the fact that the STBL covers business loans to firms of all sizes. The banks in the sample have a leverage capital ratio (common stock to total assets) of 0.6% on average but the dispersion is significant, with a standard deviation of 1.2%. Banks also vary significantly in size, averaging US$25 billion in total assets but with a large difference between small and large banks. Indeed, the bank at the 25$^{th}$ percentile of total assets has just about US$380 million in assets. Banks on average are profitable (with average net income representing 0.6% of total assets) but the variation in net income is substantial. 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 business loans is a reasonable proxy for developments in the overall loan portfolio of the average bank.

The federal funds rate also displays substantial variation over the sample period, averaging about 2.4% in nominal terms but with a standard deviation of 2.3%. Finally, about one-tenth of quarters in the sample are recession periods.

In the subsample we used to study unconventional monetary policy (2009:Q2 to 2015:Q4) reported in Panel B of Table 1, loan spreads, face values, and risk ratings all tend to be a bit lower compared with those in the full sample period, while the probability that a loan is collateralized by real estate is higher. In the 2009:Q2 to 2015:Q4 subsample, banks were a bit larger by assets but relied less on short-term deposits for funding relatively to the full sample. In contrast with Panel A, Panel B reports summary statistics for the fraction of Treasury and MBS securities held by the bank in its trading account as a fraction of total assets, which averages roughly 14% with a standard deviation of 8.9%. Other bank-level variables are fairly similar across Panels A and B of Table 1. Compared with the full sample, the 2009:Q2 to 2015:Q4 sample exhibits, on average, higher state unemployment rates, but lower state personal income growth, CPI growth, and housing price growth.

A key variable reported in Panel B (but not in Panel A) is the Federal Reserve holdings of Treasury securities and MBS scaled by nominal GDP. During the 2009:Q2 to 2015:Q4 period, Federal Reserve asset holdings averaged about 10% of nominal GDP with a standard deviation of 3.4%, and MBS holdings averaged 7.1% of GDP with a standard deviation of 2%. Both assets expanded markedly over the sample period. The annualized growth rate averaged 22.4% for Treasury holdings and 23.3% for MBS holdings. Over the subsample period corresponding to the unconventional monetary policy, the target federal funds rate essentially remained at its effective lower bound of 0.125 percentage points. This allows us to assess the impact of asset purchases while abstracting from the influence of changes in the target federal funds rate and therefore facilitates identification.

## IV. Empirical Results

In this section we present our main results on the relationship between monetary policy and loan spreads.

### *A. Relationship between Interest Rates and Bank Lending Terms*

We exclude from the sample used in our baseline regressions those loans that banks made under a commitment (e.g., drawn from a line of credit) established 30 days prior to the loan. 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. Regressions are estimated at the loan level and standard errors are clustered by time period.

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/or the general environment in which the bank operates (including GDP growth, inflation, and unemployment).

Our results on the relationship between short-term interest rates and the pricing of business loans are reported in Table 2. The dependent variable is the loan spread. Column (1) reports estimates of equation (1) in Section II. The statistically significant positive coefficient on the federal funds rate suggests that, controlling for the riskiness of the loan at origination, banks tend to charge relatively narrower spreads when short-term interest rates are lower. These results suggest some easing of loan terms in low-interest rate environments. An interquartile range decrease in the federal funds rate would lower spreads about 6 basis points, which is about 5% of the interquartile range of spreads in the 1997Q2 to 2015Q4 sample, suggesting that the effect of

conventional monetary policy while statistically significant is not particularly large in terms of its economic magnitude. We also find, as expected, that spreads tend to be higher for riskier and smaller loans.

Next 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). We then expand the previous regression model by including the interaction between short-term interest rates and bank reliance on short-term funding. This expanded model, which also includes time-fixed effects, corresponds to equation (3) in Section II. The results reported in column (2) of Table 2 suggest that banks that ex-ante appear more sensitive to interest rates, decrease their spreads by more during periods of low interest rates.

Next we study whether the health of the balance sheet of the bank matters for the relationship between bank lending terms and interest rates. In particular, in column (3) of Table 2 we estimate equation (5) for spreads including an interaction of bank capital with the federal funds rate and time-fixed effects. We proxy bank capital using the ratio of common equity to total assets (leverage ratio).[8] The estimates reported in column (3) suggest that the positive relationship between loan spreads and the federal funds rate reported in column (1) is stronger for banks with weaker balance sheets, as measured by the capital ratios. These results are consistent with the presence of a credit channel of monetary policy.

[8] Results are qualitatively similar when using the regulatory Tier-1 capital ratio as measure of bank capitalization instead. We prefer to use the leverage ratio because it is less determined by banking regulation.

The effect is also economically significant. The results imply that a decrease in the Federal Funds rate from its 75th percentile of 4.9% to its 25th percentile of 0.1% is associated with a change in loan spreads that is 3 basis points lower (more negative) for weekly capitalized banks than for strongly capitalized banks.[9] The differential effect between strongly and weakly capitalized banks is statistically significant but modest in magnitude compared with the standard deviation of loan spreads of 1.6 percentage points in the 2009Q2 to 2015Q4 sample.

*B. Relationship between Federal Reserve Asset Holdings and Lending Terms*

Table 3 reports results from OLS regressions of bank lending spreads on Federal Reserve asset holdings (U.S. Treasuries or MBS) relative to nominal GDP from 2009Q2 to 2015Q4. Obviously, loan spreads depend on loan characteristics such as loan size and risk rating, so not controlling for these factors could confound the analysis on the relationship between Federal Reserve asset holdings and loan terms. Similarly, bank characteristics (such as capitalization, profitability, and liquidity) and socioeconomic characteristics (such as GDP growth, inflation, and unemployment) may impact loan spreads at any given time. We therefore include a large set of loan-, bank-, and region-specific control variables with the aim to purge any confounding demand effects. We do not include short-term rates because these were virtually constant and close to zero over the sample period as monetary policy hit the zero lower bound. Any effects from asset purchases are therefore not confounded by changes in short-term interest rates.

We first estimate equation (2) in Section II on the link between loan spreads and asset purchases. The results point to a significantly negative relationship between Federal Reserve Treasury holdings and loan spreads (column (1)), consistent with the hypothesis that

[9] This effect is evaluated by using the 75th percentile of leverage to define strongly capitalized banks, by using the 25th percentile of leverage to define weakly capitalized banks, and by assigning mean values to other variables.

expansionary monetary policy through asset purchases is related with lower lending spreads by banks. The economic magnitude of this finding is significant. An interquartile increase in Federal Reserve Treasury holdings from 5.9% of nominal GDP to 13.6% of nominal GDP would suggest a decrease in loan spreads of roughly 40 basis points, or one-quarter of the interquartile range for the spreads in the regression sample. This suggests that the overall impact of asset purchases on loans spreads is nontrivial.

Next, we consider whether the strength of the relationship between lending spreads and Federal Reserve holdings of Treasury securities depends on the direct sensitivity of banks to fluctuations in the price of Treasury securities, corresponding to equation (4) in the Section II. We proxy this sensitivity by the fraction of Treasury and MBS securities in the trading account to total assets, and interact this measured sensitivity with the ratio of Federal Reserve holdings of Treasury securities to nominal GDP. The estimates from this regression are reported in column (2) of Table 3. The negative and statistically significant coefficient for the interaction term indicates banks that are more sensitive to fluctuations in the price of Treasury securities reduce their spreads by more compared with other banks.

Next, we consider the differential effect of bank capital on the link between asset purchases and loan spreads to gauge the importance of leverage in the transmission of unconventional monetary policy. Column (3) of Table 3 presents results when we estimate equation (5) for spreads, which includes an interaction term between the Federal Reserve asset holdings variable and bank capital.

Consistent with a bank balance sheet channel, we obtain a statistically significant and positive coefficient on the interaction term between bank capital and Federal Reserve Treasury holdings. The effect is also economically significant. The results imply that an increase in U.S.

Treasury holdings by the Federal Reserve from its 25th percentile of 5.9% to its 75th percentile of 13.6% of nominal GDP is associated with a change in loan spreads that is 7 basis points lower (more negative) for weekly capitalized banks than for strongly capitalized banks.[10] The differential effect between strongly and weakly capitalized banks is statistically significant but modest in magnitude compared with the standard deviation of loan spreads of 1.6 percentage points in the 2009Q2 to 2015Q4 sample. The differential effect for Treasury purchases is also comparable in magnitude to that obtained for Federal funds rates.

We check the robustness of our results to using different measures of unconventional monetary policy. In particular, we replace the Federal Reserve holdings of Treasury securities with Federal Reserve holdings scaled by nominal GDP. The results using MBS holdings by the central bank reported in Table 4 are fairly similar to those obtained when using holdings of Treasury securities.

## V. Conclusions

This paper provides evidence of a credit channel of conventional and unconventional monetary policy whereby both decreases in policy interest rates and asset purchases lower the cost of bank loans for a given credit risk rating of the loan, especially for weakly capitalized banks. These results suggest that both conventional and unconventional monetary policy can impact the quality of credit extended by the banking sector. We find that the relationship between lending spreads and policy interest rates is stronger for banks that are more sensitive to fluctuations in short-term interest rates through their liabilities. Similarly, we find that the

[10] This effect is evaluated by assigning mean values to other variables.

relationship between lending spreads and Federal Reserve asset holdings is stronger for banks that are more sensitive to short-term fluctuations in the prices of Treasury securities.

Our empirical analysis shows that an interquartile decrease in the federal funds rate would decrease loans spreads by 6 basis points (which is about 5% of its own interquartile range). Meanwhile, an interquartile range increase in Federal Reserve Treasury asset holdings would lower spreads on loans with no commitment by 40 basis points (which is about one-quarter of the interquartile range of spreads in the corresponding sample). Moreover, consistent with a credit channel of asset purchases and of conventional monetary policy, we find that the relationship between spreads and measures of monetary policy depends on the degree of bank capitalization: the effect of asset purchases on loan spreads is more pronounced for highly leveraged banks.

We obtain these results using loan-level data on newly issued loans, which is critical to assessing the marginal impact of asset purchases on lending conditions. By restricting our attention to the terms of new loans, we can focus on the ex-ante, marginal impact on loan pricing. Finally, by conditioning on bank capital, our analysis links to theoretical literatures on the credit channel of monetary policy.

While our results are statistically significant, their economic magnitude is for the most part relatively small. This is not surprising given that the impact of asset purchases may impact real estate loans and securities holdings more than C&I loans. At the same time, some of the estimated relationships are not trivial, also given that we provide evidence that banks respond by adjusting margins that are not directly affected by asset purchases. Our results should therefore be seen as broadly supportive of unconventional monetary policies having an effect on bank lending terms.

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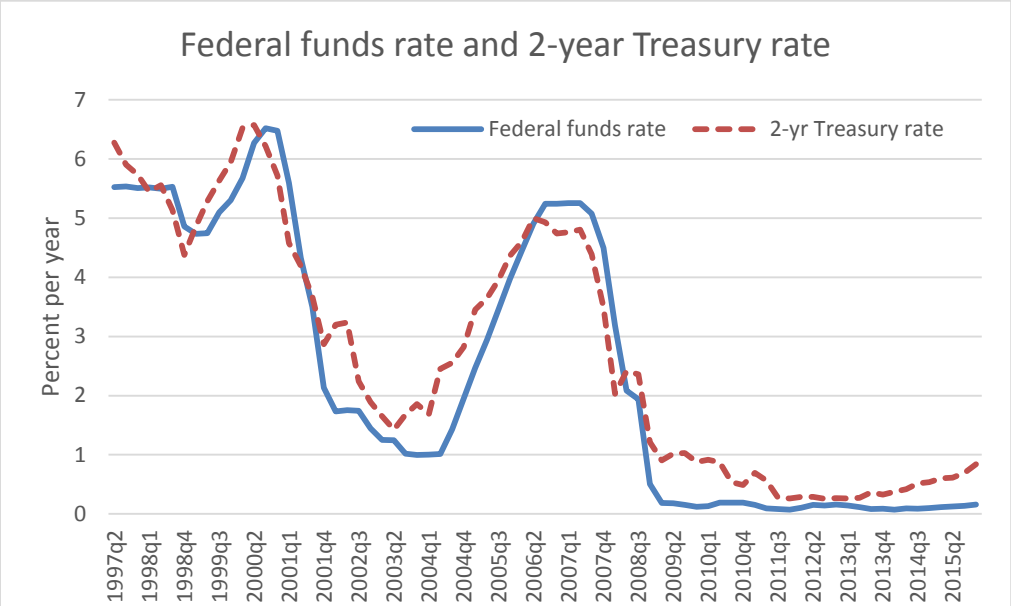
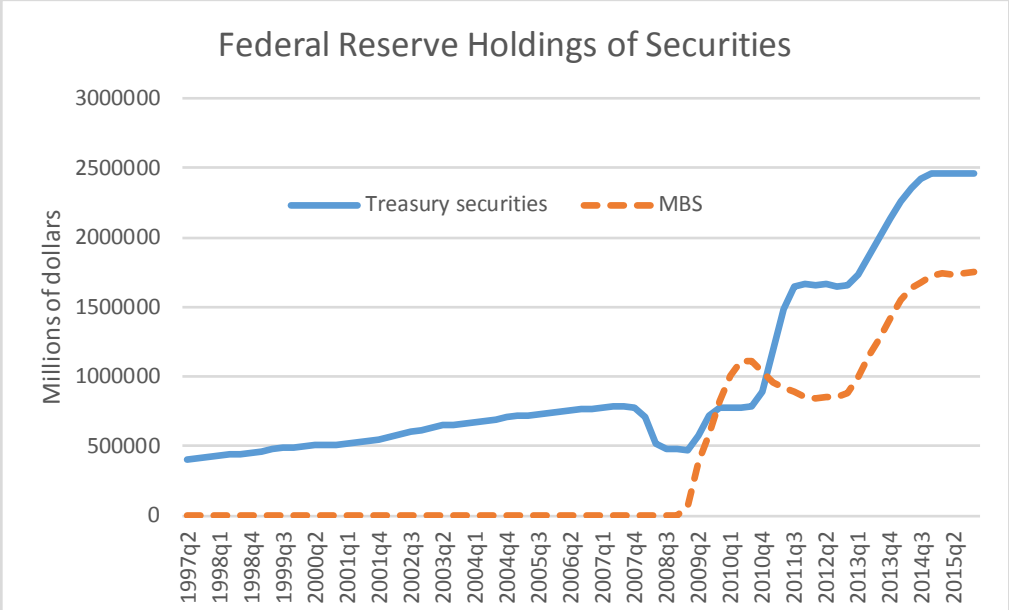
**Figure 1. U.S. interest rates, 1997-2015**



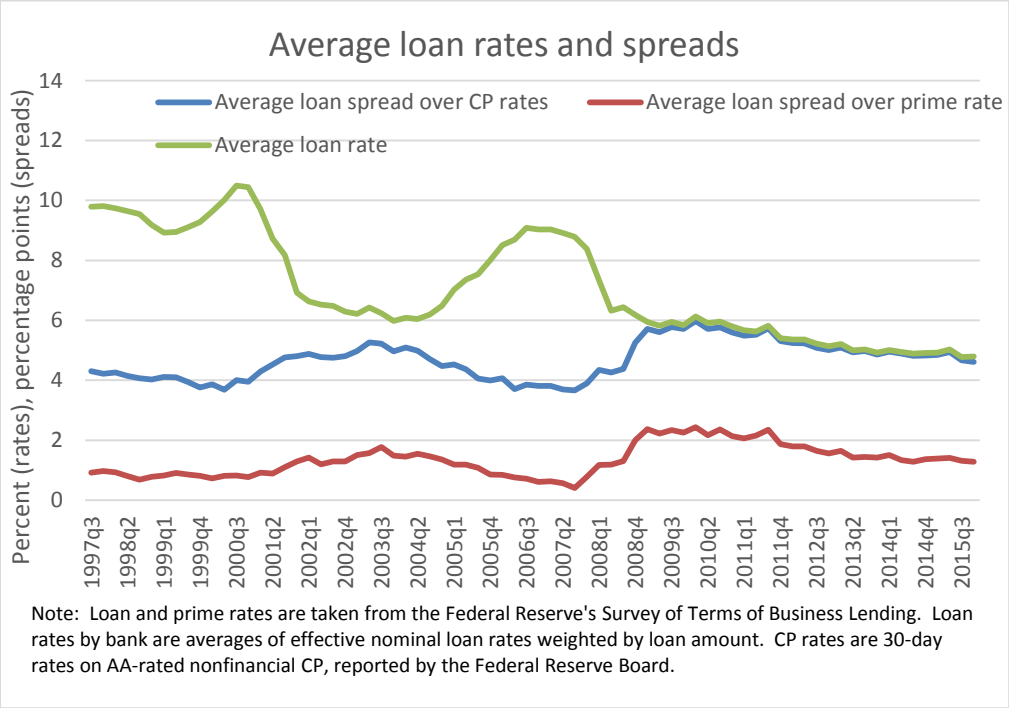

Source: Board of Governors of the Federal Reserve System (US), H.15 Selected Interest Rates statistical release, Effective Federal Funds Rate [FEDFUNDS] and 2-Year Treasury Constant Maturity Rate [DGS2], retrieved from FRED, Federal Reserve Bank of St. Louis.

**Figure 2. MBS and Treasuries purchases by the Federal Reserve, 1997-2015**



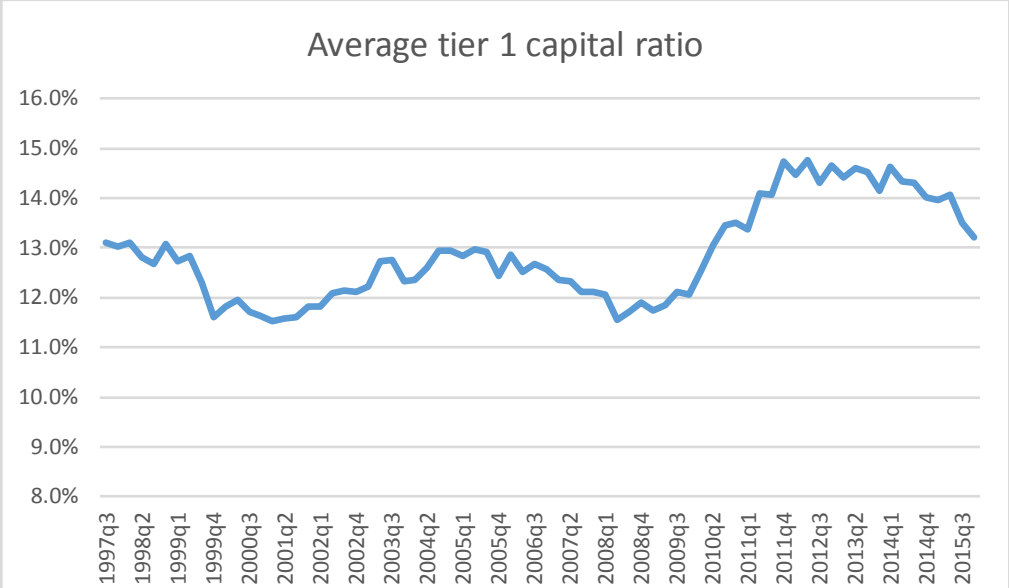

Source: Federal Reserve H.4.1. Factors Affecting Reserve Balances statistical release. The series for Treasury securties reports U.S. Treasury securities held outright from 2002 and U.S. government securities bought outright prior to 2002.

**Figure 3. Loan rates and loan spreads, 1997-2015**




Note: Loan and prime rates are taken from the Federal Reserve's Survey of Terms of Business Lending. Loan rates by bank are averages of effective nominal loan rates weighted by loan amount. CP rates are 30-day rates on AA-rated nonfinancial CP, reported by the Federal Reserve Board.

**Figure 4. Bank capitalization, 1997-2015**




Note: Tier 1 capital ratio is total tier 1 capital over risk-weighted. Data are taken from the Consolidated Report of Condition and Income (Call Reports), for banks that respond the Surveyof Terms of Business Lending.

## Table 1. Summary Statistics

This table reports descriptive statistics of the variables used in our baseline regressions. The sample described in Panel A includes loans reported to the Federal Reserve's STBL from the second quarter of 1997 to the fourth quarter of 2015, and the sample in Panel B covers from the second quarter of 2009 to the fourth quarter of 2015. 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 indexes 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.

**Panel A**

| | Observations | Average | 25$^{th}$ percentile | 75$^{th}$ percentile | Standard deviation |
|---|---|---|---|---|---|
| *Loan-level variables* | | | | | |
| Loan spread (in percentage points) | 1,438,832 | 0.648 | -0.161 | 1.391 | 1.525 |
| Dummy for loans secured by collateral | 1,438,830 | 0.828 | 1 | 1 | 0.378 |
| Risk rating | 1,438,832 | 3.279 | 3 | 4 | 0.849 |
| Loan size (dollars) | 1,438,832 | 477,770 | 17,845 | 140,000 | 5,244,079 |
| *Bank-level variables* | | | | | |
| Bank total assets ($ millions) | 15,006 | 25,385 | 381 | 6180 | 130,100 |
| Leverage ratio | 15,006 | 0.006 | 0.001 | 0.007 | 0.012 |
| Net income / assets | 15,006 | 0.006 | 0.003 | 0.009 | 0.008 |
| Liquid assets / assets | 15,006 | 0.024 | 0.012 | 0.032 | 0.018 |
| Deposits / assets | 15,006 | 0.788 | 0.738 | 0.860 | 0.097 |
| Short-term deposits / deposits | 15,006 | 0.015 | 0 | 0 | 0.064 |
| Non-retail deposits / deposits | 15,006 | 0.337 | 0.169 | 0.369 | 0.666 |
| Loans / assets | 15,006 | 0.638 | 0.566 | 0.733 | 0.142 |
| C&I loans / loans | 15,006 | 0.215 | 0.129 | 0.273 | 0.124 |
| *Regional variables* | | | | | |
| State personal income growth (%) | 3291 | 4.247 | 2.161 | 6.581 | 4.964 |
| Change in region CPI (%) | 300 | 2.131 | 1.040 | 3.480 | 2.126 |
| State unemployment rate (%) | 3,291 | 5.621 | 4.200 | 6.600 | 2.028 |
| Change in state housing prices (%) | 3291 | 3.292 | 0.246 | 6.940 | 7.095 |
| *Nationwide variables* | | | | | |
| Target federal funds rate (%) | 75 | 2.398 | 0.125 | 4.916 | 2.283 |
| Real GDP growth (%) | 75 | 4.112 | 3.067 | 5.797 | 2.826 |

| | | | | | |
|---|---|---|---|---|---|
| NBER recession | 75 | 0.107 | 0 | 0 | 0.311 |

**Panel B**

| | Observations | Average | 25th percentile | 75th percentile | Standard deviation |
|---|---|---|---|---|---|
| *Loan-level variables* | | | | | |
| Loan spread (in percentage points) | 472,034 | 0.482 | -0.301 | 1.116 | 1.634 |
| Dummy for loans secured by collateral | 474,711 | 0.908 | 1 | 1 | 0.289 |
| Risk rating | 474,711 | 3.139 | 3 | 4 | 0.862 |
| Loan size (dollars) | 474,711 | 317,081 | 27,118 | 128,997 | 6,000,118 |
| *Bank-level variables* | | | | | |
| Bank total assets ($ millions) | 5,501 | 36,936 | 559 | 6,213 | 182,697 |
| Treasury and MBS holdings / assets | 5501 | 0.142 | 0.084 | 0.184 | 0.089 |
| Leverage ratio | 5,501 | 0.005 | 0.001 | 0.004 | 0.012 |
| Net income / assets | 5,501 | 0.005 | 0.002 | 0.008 | 0.008 |
| Liquid assets / assets | 5,501 | 0.014 | 0.008 | 0.017 | 0.012 |
| Deposits / assets | 5,501 | 0.812 | 0.774 | 0.864 | 0.071 |
| Short-term deposits / deposits | 5,501 | 0.005 | 0 | 0 | 0.024 |
| Non-retail deposits / deposits | 5,501 | 0.317 | 0.155 | 0.340 | 0.618 |
| Loans / assets | 5,501 | 0.635 | 0.575 | 0.726 | 0.140 |
| C&I loans / loans | 5,501 | 0.192 | 0.116 | 0.242 | 0.107 |
| *Regional variables* | | | | | |
| State personal income growth (%) | 1,172 | 3.609 | 1.619 | 5.699 | 4.848 |
| Change in region CPI (%) | 108 | 1.642 | 0.488 | 2.735 | 1.720 |
| State unemployment rate (%) | 1,172 | 7.211 | 5.600 | 8.600 | 2.207 |
| Change in state housing prices (%) | 1,172 | 1.666 | -2.266 | 5.971 | 7.202 |
| *Nationwide variables* | | | | | |
| Treasury holdings / nominal GDP | 27 | 0.101 | 0.059 | 0.136 | 0.0338 |
| MBS holdings / nominal GDP | 27 | 0.071 | 0.054 | 0.095 | 0.020 |
| Target federal funds rate (%) | 27 | 0.126 | 0.125 | 0.125 | 0.008 |
| Real GDP growth (%) | 27 | 3.457 | 2.089 | 5.054 | 2.044 |
| NBER recession | 27 | 0.037 | 0 | 0 | 0.192 |

## Table 2. Loan Spread, Federal Funds Rate, and Bank Characteristics

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 2015 by banks reporting to the Federal Reserve's STBL, which correspond to equations (1) and (2) in the text. The dependent is the loan spread. Bank size (as measured by the log of total assets), leverage capital ratio, net income, liquid assets, deposits, short-term deposits, non-retail deposits, loans, and C&I loans are measured at the bank level 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 region CPI and state unemployment rate are from the BLS, and the change in housing prices is based on indexes 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. Regressions (2) and (3) also include time fixed effects. Standard errors clustered by quarter are reported in brackets. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

| Dependent variable:<br>Loan Spread | (1) | (2) | (3) |
|---|---|---|---|
| Target federal funds rate | 0.037** | | |
| | [0.016] | | |
| Target federal funds rate × Short-term deposits / deposits | | 0.546*** | |
| | | (0.103) | |
| Target federal funds rate × Leverage ratio | | | -3.782*** |
| | | | [0.996] |
| Loan risk rating | 0.355*** | 0.363*** | 0.362*** |
| | [0.012] | (0.011) | [0.011] |
| Loan size | -0.269*** | -0.270*** | -0.270*** |
| | [0.007] | (0.007) | [0.007] |
| Bank size | -0.273*** | -0.121*** | -0.152*** |
| | [0.038] | (0.043) | [0.044] |
| Bank leverage ratio | 2.624*** | 53.128*** | 55.496*** |
| | [0.717] | (14.746) | [14.555] |
| Bank net income / assets | -5.883*** | -6.230*** | -6.221*** |
| | [1.690] | (1.771) | [1.932] |
| Bank liquid assets / assets | 2.406** | 1.973* | 2.382** |
| | [1.127] | (1.088) | [1.163] |
| Bank deposits / assets | -0.348 | 0.024 | 0.103 |
| | [0.215] | (0.201) | [0.185] |
| Short-term deposits / deposits | -1.026*** | -3.317*** | -0.764*** |
| | [0.245] | (0.578) | [0.232] |
| Non-retail deposits / deposits | -0.086** | 0.050 | 0.008 |
| | [0.042] | (0.046) | [0.040] |
| Bank loans / assets | 1.155*** | 0.669*** | 0.855*** |
| | [0.191] | (0.133) | [0.150] |
| Bank C&I loans / loans | -0.447** | -0.855*** | -0.618*** |
| | [0.206] | (0.188) | [0.179] |
| State personal income growth | 0.005** | 0.001 | 0.001 |
| | [0.003] | (0.003) | [0.003] |

| | | | |
|---|---|---|---|
| Change in region CPI | -0.011 | -0.020 | -0.026* |
| | [0.007] | (0.015) | [0.015] |
| State unemployment rate | 0.124*** | -0.017 | -0.011 |
| | [0.014] | (0.014) | [0.014] |
| Change in state housing prices | 0.001 | 0.002 | 0.000 |
| | [0.002] | (0.002) | [0.002] |
| GDP growth | 0.004 | | |
| | [0.007] | | |
| NBER recession dummy | 0.031 | | |
| | [0.038] | | |
| Constant | 5.568*** | 4.268*** | 4.641*** |
| | [0.808] | (0.781) | (0.762) |
| Bank fixed effects | Yes | Yes | Yes |
| State fixed effects | Yes | Yes | Yes |
| Time fixed effects | No | Yes | Yes |
| Observations | 1,438,826 | 1,438,826 | 1,438,826 |
| Number of banks | 612 | 612 | 612 |
| $R^2$ | 0.321 | 0.337 | 0.337 |

## Table 3. Loan Spread, Federal Reserve Treasury Holdings, and Bank Characteristics

This table reports panel regression estimates of terms of individual new business loans originated from the second quarter of 2009 to the fourth quarter of 2015 by banks reporting to the Federal Reserve's STBL, which correspond to equation (2) in the text. The dependent variable is loan spread as reported to the STBL. Explanatory variables are defined as in Table 2 with the inclusion of Federal Reserve Treasury holdings based off the H.4.1 release reports published by the Federal Reserve Board. The sample excludes loans extended under commitment established prior to the current quarter from the sample. All regressions include state- and bank-fixed effects. Regressions (2) and (3) also include time fixed effects. Standard errors clustered by quarter are reported in brackets. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

| Dependent variable:<br>Loan Spread | (1) | (2) | (3) |
|---|---|---|---|
| Federal Reserve treasury holdings | -2.703** | | |
| | (1.059) | | |
| Federal Reserve treasury holdings × Bank Securities | | -10.392*** | |
| | | (3.458) | |
| Federal Reserve treasury holdings × Leverage ratio | | | 312.147*** |
| | | | (87.982) |
| Loan risk rating | 0.370*** | 0.374*** | 0.374*** |
| | (0.025) | (0.024) | (0.024) |
| Loan size | -0.220*** | -0.218*** | -0.218*** |
| | (0.009) | (0.009) | (0.009) |
| Bank size | -0.172 | 0.100 | 0.112 |
| | (0.184) | (0.207) | (0.206) |
| Bank leverage ratio | 121.529*** | 121.222*** | 57.014 |
| | (33.299) | (33.041) | (35.802) |
| Bank net income / assets | -3.261* | -2.062 | -3.377* |
| | (1.735) | (2.326) | (1.902) |
| Bank liquid assets / assets | -22.070*** | -19.991** | -22.169*** |
| | (7.213) | (8.007) | (7.528) |
| Bank deposits / assets | -3.055*** | -1.522** | -0.982 |
| | (0.551) | (0.735) | (0.644) |
| Short-term deposits / deposits | -4.000*** | -2.448 | -3.168** |
| | (1.336) | (1.449) | (1.276) |
| Bank loans / assets | 1.244*** | -2.118*** | 1.516*** |
| | (0.190) | (0.348) | (0.209) |
| Bank C&I loans / loans | -2.003*** | -0.005 | -1.646*** |
| | (0.305) | (0.005) | (0.285) |
| State personal income growth | -0.000 | -0.056** | -0.006 |
| | (0.003) | (0.020) | (0.005) |
| Change in region CPI | -0.000 | -0.070*** | -0.060*** |
| | (0.007) | (0.025) | (0.020) |
| State unemployment rate | 0.055** | 0.003 | -0.059** |
| | (0.021) | (0.003) | (0.024) |
| Change in state housing prices | 0.004* | 1.777 | 0.001 |
| | (0.002) | (3.511) | (0.003) |
| GDP growth | -0.006 | | |

| | | | |
|---|---|---|---|
| | (0.009) | | |
| NBER recession dummy | -0.255*** | | |
| | (0.057) | | |
| Constant | 6.618** | -10.392*** | 0.689 |
| | (3.061) | (3.458) | (3.478) |
| Bank fixed effects | Yes | Yes | Yes |
| State fixed effects | Yes | Yes | Yes |
| Time fixed effects | No | Yes | Yes |
| Observations | 472,034 | 472,034 | 472,034 |
| Number of banks | 318 | 318 | 318 |
| $R^2$ | 0.374 | 0.377 | 0.380 |

## Table 4. Loan Spread and Federal Reserve MBS Holdings

This table reports panel regression estimates of terms of individual new business loans originated from the second quarter of 2009 to the fourth quarter of 2015 by banks reporting to the Federal Reserve's STBL, which correspond to equation (2) in the text. The dependent variable is loan spread. Explanatory variables are defined as in Table 2 with the inclusion of Federal Reserve MBS holdings based off the H.4.1 release reports published by the Federal Reserve Board. 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 clustered by quarter are reported in brackets. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

| Dependent variable:<br>Loan spread | (1) |
|---|---|
| Federal Reserve MBS holdings | -3.742*** |
| | (1.181) |
| Loan risk rating | 0.372*** |
| | (0.025) |
| Loan size | -0.219*** |
| | (0.009) |
| Bank size | -0.210 |
| | (0.180) |
| Bank leverage ratio | 123.032*** |
| | (33.422) |
| Bank net income / assets | -3.989** |
| | (1.560) |
| Bank liquid assets / assets | -21.679*** |
| | (7.422) |
| Bank deposits / assets | -2.752*** |
| | (0.613) |
| Short-term deposits / deposits | -3.399** |
| | (1.354) |
| Bank loans / assets | 1.241*** |
| | (0.182) |
| Bank C&I loans / loans | -2.026*** |
| | (0.323) |
| State personal income growth | 0.002 |
| | (0.003) |
| Change in region CPI | -0.013 |
| | (0.009) |
| State unemployment rate | 0.061*** |
| | (0.016) |
| Change in state housing prices | -0.000 |
| | (0.003) |
| GDP growth | -0.002 |
| | (0.009) |
| NBER recession dummy | -0.301*** |
| | (0.052) |
| Constant | 7.064** |
| | (3.050) |

| | |
|---|---|
| Bank fixed effects | Yes |
| State fixed effects | Yes |
| Time fixed effects | No |
| Observations | 472,034 |
| Number of banks | 318 |
| $R^2$ | 0.374 |