Changes in Bank Lending Standards and the Macroeconomy

William F. Bassett Mary Beth Chosak John C. Driscoll Egon Zakrajšek*

May 1, 2012

Abstract

Identifying the macroeconomic effects of credit supply disruptions is difficult because many of the same factors that influence the supply of bank loans can also affect the demand for credit. Using bank-level responses to the Federal Reserve's Senior Loan Officer Opinion Survey, we decompose the reported changes in lending standards—a commonly-used indicator of changes in credit supply conditions—into two parts: (*i*) a component capturing the change in banks' lending posture in response to bank-specific and macroeconomic factors that also affect loan demand; and (*ii*) a residual component, which provides a cleaner measure of fluctuations in the effective supply of bank-intermediated credit. When included in a VAR framework, shocks to our credit supply measure are associated with substantial declines in output and in the capacity of businesses and households to borrow from the banking sector, as well as with a sharp widening of credit spreads and a significant easing of monetary policy. We corroborate the interpretation of our series as representing movements in the supply of bank loans using a detailed loan-level data set: A regression of individual loan amounts on the corresponding interest rate spreads—where the latter is instrumented with our bank-level loan-supply shifter—yields the semi-elasticity of loan demand between −1.0 and −1.5.

JEL Classification: E32, E44
Keywords: credit supply shocks, bank credit policies, financial accelerator

We thank Bob Avery, Katrin Assenmacher-Wesche, Joseph Haubrich, Daniel Paravisini, and seminar participants at the European Central Bank, the Federal Reserve System's 2011 "Day-Ahead" conference on Financial Market and Institutions, and the Winter 2011 North American Econometric Society meetings for helpful comments. Thomas Spiller provided outstanding research assistance. The views expressed in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or of anyone else associated with the Federal Reserve System. (This paper is a substantially revised version of the paper circulated previously under the title "Identifying the Macroeconomic Effects of Bank Lending Supply Shocks.")

*All authors are affiliated with the Division of Monetary Affairs, Federal Reserve Board. E-mails: william.f.bassett@frb.gov; mary.e.chosak@frb.gov; john.c.driscoll@frb.gov; and egon.zakrajsek@frb.gov.

1 Introduction

Economists have long hypothesized that the commercial banking sector—or a financial system more generally—may serve as a propagation mechanism for, or a source of, economic shocks. In the 1960s, for example, Brunner and Meltzer [1963] criticized small-scale macroeconomic models for not including multiple measures of credit prices and quantities, including those of bank loans. In his seminal work on the Great Depression, Bernanke [1983] argued that the widespread bank failures during the early 1930s helped exacerbate the depth and length of the ensuing economic contraction. Spurred by the extraordinary events of the 2007–09 financial crisis, an emergent theoretical literature emphasizes the implications of the capital position of financial intermediaries for asset prices and macroeconomic dynamics; see, for example, Brunnermeier and Sannikov [2011] and He and Krishnamurthy [2012].

A large body of related research has also focused on whether monetary policy might have effects on real economic activity through the market for bank-intermediated credit: If banks were not able to readily substitute other sources of funding for deposits, then changes in the federal funds rate—which affects banks' opportunity cost of issuing certain kinds of deposits—would influence the price and supply of bank loans. In turn, this change in credit market conditions would affect investment and consumption decisions of bank-dependent borrowers.[1]

Theoretical work of Bernanke and Gertler [1989], Kiyotaki and Moore [1997], and Bernanke et al. [1999] broadened this "bank lending channel" view of monetary policy transmission to a "broad credit channel" or a "financial accelerator" mechanism, arguing that a tightening of monetary policy would lead to a worsening of the quality of borrowers' balance sheets that would reduce the net present value of their available collateral. In the presence of imperfect financial markets, a deterioration in the condition of borrowers' balance sheets would exacerbate the agency costs associated with external finance and cause an increase in the cost of all forms of borrowing, including, but not limited to, bank-intermediated credit. The higher cost of credit would in turn have real economic consequences, such as depressing business investment, output, and cash flows, thereby further impairing borrowers' financial position. Those adverse developments would push up the cost of borrowing even more, thus multiplying the impact of the original increase in short-term interest rates.

At least two difficult endogeneity problems complicate empirical investigations of the roles that banks and other financial institutions play in business cycle fluctuations. First, many economic disturbances that may affect the supply of bank loans likely have independent effects on real variables as well. For example, an unanticipated change in the stance of monetary policy may change the interest rate on, or quantity of, bank loans, but at the same time, that change likely

[1] See, for example, Bernanke and Blinder [1988], Romer and Romer [1990], Bernanke and Lown [1991], Gertler and Gilchrist [1993], Ramey [1993], Kashyap and Stein [1994, 2000], Peek and Rosengren [1995a,b, 2000], Ashcraft [2005], and Gilchrist and Zakrajšek [1995, 2011a].

also affects spending and production through its influence on expectations and interest rates in other markets. Thus, parsing the marginal effect of monetary policy shocks on real economic activity through the market for bank loans requires additional identifying assumptions, which may be difficult to obtain.

Second, even apparently exogenous credit supply shocks originating within the banking sector may have their origins in disturbances that also separately affect other macroeconomic variables. For example, the steep and unexpected decline in home prices in the United States that materialized in latter part of 2006 was a key driver of the losses on home mortgages and related credit instruments that nearly crippled the global financial system and resulted in a significant tightening of credit conditions for many borrowers. This shock, however, also left many households with mortgage balances that substantially exceeded the value of their homes, a reduction in wealth that sapped consumer spending, impaired household credit quality, and depressed demand for credit.

As problems in the housing sector spread to other parts of the economy, severe turmoil roiled many financial markets, economic activity slowed sharply, and an official recession was declared to have have started in October 2007. During the so-called "Great Recession," credit conditions tightened significantly, bank loans outstanding contracted sharply, and bank lending continued to decline steadily even after the resumption in economic growth; see, for example, Bassett et al. [2011]. As with monetary policy shocks, disentangling the marginal effect of the shock to banks' lending standards as a result of the financial crisis from effects of changes in loan demand and other factors that contributed to the decline in bank lending requires additional identifying assumptions.

In this paper, we use the changes in bank lending standards for businesses and households as reported on the Federal Reserve Board's quarterly Senior Loan Officer Opinion Survey on Bank Lending Practices (SLOOS), to develop a new measure of changes in the supply of bank loans—namely a change in bank lending standards that is uncorrelated with the key bank-specific and macroeconomic factors that can simultaneously affect the demand for credit. Compared with previous empirical research that employs survey data on changes in bank lending standards, our paper is the first to employ *bank-level* responses—as opposed to the aggregated series—to study the role of credit supply factors in U.S. economic fluctuations.[2] In addition, we systematically incorporate responses to questions on changes in lending standards on loans to both businesses and households when constructing our indicator of movements in the effective supply of bank loans; earlier research, in contrast, primarily relied on the aggregated changes in lending standards on commercial and industrial (C&I) loans to identify credit supply shocks.

The use of bank-level survey responses allows us to better account for an endogenous component of the reported change in lending standards, a component that reflects fluctuations in bank-specific

[2]See, for example, Schreft and Owens [1991], Lown et al. [2000], Lown and Morgan [2002, 2006], Cunningham [2006], Bayoumi and Melander [2008], and Swiston [2008]. A closely related research effort using the Bank Lending Survey conducted by the European Central Bank includes the recent work of De Bondt et al. [2010], Ciccarelli et al. [2010], and Cappiello et al. [2010].

and macroeconomic factors that can also affect—either explicitly or implicitly—the demand for bank-intermediated credit. We argue that the portion of the reported change in bank lending standards that cannot be explained by those factors provides a cleaner measure of movements in the supply of bank loans available to potential borrowers. Such exogenous shifts in the effective supply of bank-intermediated credit could arise, for example, from banks' internal reassessments of the inherent riskiness of their business lines, changes in regulations or the supervisory environment, or changes in industry strategies; see, for example, Bassett and Zakrajšek [2003].

At the macroeconomic level, our measure of fluctuations in the supply of bank-intermediated credit corresponds to the cross-sectional average of the "unexplained" changes in banks' reported lending standards. This series accords quite well with narrative accounts of changes in credit market conditions during the 1992–2011 period. For example, it points to a sharp and sudden reduction in the availability of credit right around the time of the Long-Term Capital Management (LTCM) crisis in the early autumn of 1998. A similar pull-pack in the supply of bank loans occurred immediately before the economic downturn in 2001 and before and during the early phases of the 2007–09 financial crisis. In contrast, "easy" credit conditions mark the 2004–06 period, which has been characterized by many observers, at least in retrospect, as having had lax underwriting standards and significant underpricing of risk, factors that fueled the last surge of credit growth and asset price appreciation in the housing sector before the spectacular bursting of the bubble at the end of 2006.

As noted above, our indicator of movements in the supply of bank loans utilizes changes in lending standards on loans to both businesses and households. Consequently, we are able to provide a more comprehensive accounting of the role of credit supply shocks in U.S. cyclical fluctuation over the past two decades, compared with studies that employ only the survey results for changes in C&I lending policies. Specifically, to evaluate systematically the macroeconomic effects of shocks to the supply of bank-intermediated credit, we include our measure of unexplained changes in lending standards into a standard monetary vector autoregression (VAR). This multivariate framework serves as a convenient way to trace out the effect of a loan supply shock on key macroeconomic aggregates.

The results from this analysis indicate that innovations in our measure of loan supply have economically large and statistically significant effects on output and core lending capacity of U.S. commercial banks.[3] According to our estimates, an adverse loan supply shock of one standard deviation is associated with a decline in the level of real GDP of about 0.75 percent two years after the shock, while the capacity of businesses and households to borrow from the banking sector

[3]Core loans are the sum of C&I loans, loans secured by real estate, and consumer loans; these business lines correspond to the loan categories covered by the SLOOS. Core lending capacity is the sum of core loans outstanding and the amount of unused commitments to make such loans. Our focus on this broader measure of credit intermediation by commercial banks is motivated by the fact that the banking system provides credit to businesses and households in two important ways: By originating new loans (on balance sheet) and by providing lines of credit (off balance sheet); see Bassett et al. [2011] for discussion and details.

falls almost 4 percent over the same period. This shock also leads to a substantial rise in private credit spreads and elicits a significant easing of monetary policy, macroeconomic dynamics typically associated with an adverse credit supply shock.

The gist of our empirical approach attempts to purge the reported changes in lending standards of the factors associated with changes in the economic outlook and risk tolerance that could also affect loan demand. To test whether our methodology captures shifts in the supply of loans, we use the bank-level version of our series as an instrument in a regression of loan quantities on loan prices (i.e., loan-rate spreads). Put differently, if our series of unexplained changes in bank lending standards is an accurate indicator of movements in loan supply, using it in this way should help trace out the slope of the loan demand curve.

Specifically, we again exploit the micro-level aspect of the data to construct an analog of our bank-specific unexplained changes in overall lending standards for the reported changes in standards on C&I loans. We match these bank-level shifts in supply of C&I loans with data from the Federal Reserve's quarterly Survey of Terms of Business Lending (STBL), a source of detailed loan-level information on C&I loan originations. We find that while a simple OLS regression of (log) loan amounts on the corresponding interest rate spreads results in an estimate of semi-elasticity of loan demand of about -0.5, an IV regression—using the bank-specific unexplained changes in lending standards as instruments for loan-level interest rate spreads—yields an estimate of semi-elasticity between -1.0 and -1.5, depending on the functional form. The large decrease in the estimated coefficient is consistent with the interpretation that the unexplained shifts in banks' lending standards largely represent movements in loan supply, rather than in loan demand.

The remainder of the paper is organized as follows. Section 2 describes the data from which our measure of movements in loan supply is constructed. In Section 3, we outline the empirical strategy used to estimate the unexplained changes in bank lending standards. Section 4 analyzes the macroeconomic implication of credit supply shocks. In Section 5, we use the bank-specific loan-supply shifters to estimate the slope of the demand curve curve for C&I loans. Section 6 concludes.

2 Data Sources and Methods

This paper proposes a new measure of changes in the effective supply of bank loans to businesses and households by combining survey information on the reported changes in bank lending standards with other bank-specific and macroeconomic variables. We control for possibly endogenous changes in banks' credit policies by conditioning on bank-specific and macroeconomic variables that might affect–either explicitly or implicitly—loan demand, guided in part by the reasons banks report on the survey.

Our choice of the conditioning variables is also informed by both theoretical models and empirical research on the cyclical behavior of banks' lending standards. For example, theoretical

work of Rajan [1994] and Ruckes [2004] suggests that banks soften their lending standards in response to competitive pressures in order to grow their loan books during economic expansions. Berger and Udell [2004] present empirical evidence showing that banks tend to tighten lending standards in response to rising loan loss reserves and associated reductions in profitability. A related literature studies the relationship between banks' access to stable funding sources, such as core deposits, and their willingness to extend loan commitments; see, for example, Kashyap et al. [2002], Pennacchi [2006], and Gatev and Strahan [2006].

2.1 Senior Loan Officer Opinion Survey

The Federal Reserve's Senior Loan Officer Opinion Survey of Bank Lending Practices (SLOOS) has queried banks about changes in their lending standards for major categories of loans to households and businesses since 1990:Q2 and about changes in demand for those loan categories since 1991:Q4. The survey is usually conducted four times per year by the Federal Reserve Board, and up to 60 U.S. commercial banks participate in each survey. (See Appendix A for additional information about the SLOOS.)

Specifically, banks are asked to report whether they have changed their standards during the survey period (i.e., over the previous three months) on the following seven categories of core loans: C&I, commercial real estate, residential mortgages to purchase homes, home equity lines of credit, credit cards, auto, and consumer loans other than credit cards or auto loans.

Questions about changes in standards follow the general pattern of

> "Over the past three months, how have your bank's credit standards for approving loans of type X changed?"

On the demand side, the prototypical question is

> "Over the past three months, how has the demand for loans of type X at your bank changed?"

Banks are asked to answer both questions using a qualitative scale ranging from 1 to 5. More formally, letting $I^S_{it}[k]$ denote an indicator variable for bank i's reported change in credit standards for loan category k in quarter t and $I^D_{it}[k]$ the corresponding change in demand, the possible answers are as follows:

$$I^S_{it}[k] = \begin{cases} 1 &= \text{eased considerably} \\ 2 &= \text{eased somewhat} \\ 3 &= \text{about unchanged} \\ 4 &= \text{tightened somewhat} \\ 5 &= \text{tightened considerably} \end{cases} \quad \text{and} \quad I^D_{it}[k] = \begin{cases} 1 &= \text{increased considerably} \\ 2 &= \text{increased somewhat} \\ 3 &= \text{about unchanged} \\ 4 &= \text{decreased somewhat} \\ 5 &= \text{decreased considerably} \end{cases}$$

However, banks historically have been extremely unlikely to characterize their changes in standards or demand as having changed "considerably," and so we use only three classifications for those variables, rather than the five possible answers available to survey respondents.[4] Accordingly, the original categorical variables $I_{it}^{S}[k]$ and $I_{it}^{D}[k]$ are recoded as follows:

$$I_{it}^{S}[k] = \begin{cases} -1 & \text{if bank } i \text{ reported } \textit{easing} \text{ standards on loan category } k \text{ in quarter } t \\ 0 & \text{if bank } i \text{ reported no change in standards on loan category } k \text{ in quarter } t \\ 1 & \text{if bank } i \text{ reported } \textit{tightening} \text{ standards on loan category } k \text{ in quarter } t \end{cases}$$

and

$$I_{it}^{D}[k] = \begin{cases} -1 & \text{if bank } i \text{ reported } \textit{decreased} \text{ demand for loan category } k \text{ in quarter } t \\ 0 & \text{if bank } i \text{ reported no change in demand for loan category } k \text{ in quarter } t \\ 1 & \text{if bank } i \text{ reported } \textit{increased} \text{ demand for loan category } k \text{ in quarter } t \end{cases}$$

The extent to which changes in a given bank's lending standards or demand conditions affect lending volumes more generally will likely depend on how active that bank is in a particular lending category. Therefore, we use the responses to the questions about each lending category, together with data from the Reports of Condition and Income (Call Reports) on the amount of outstanding loans the bank has in that category, to construct a composite index of changes in lending standards and loan demand for each bank in our panel.

The two indexes are calculated as the following weighted averages:

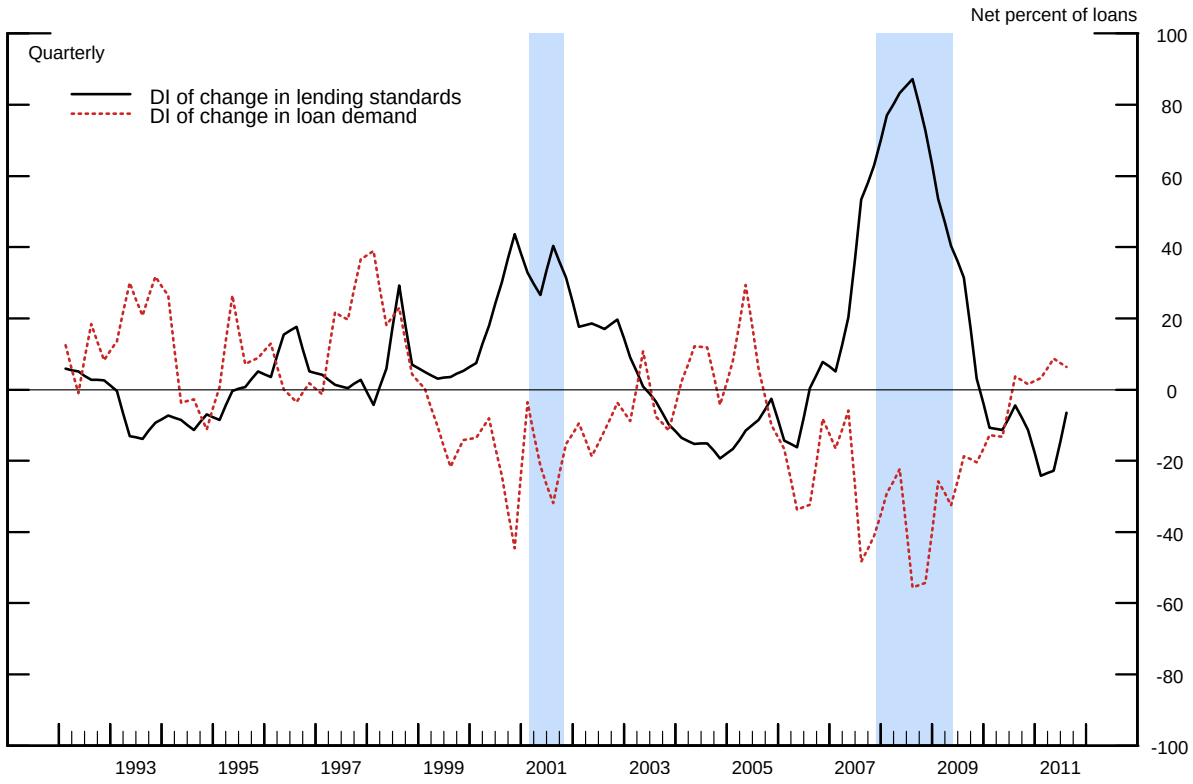
$$\Delta S_{it} = \sum_{k} \omega_{it}[k] \times I_{it}^{S}[k] \quad \text{and} \quad \Delta D_{it} = \sum_{k} \omega_{it}[k] \times I_{it}^{D}[k] \tag{1}$$

where $0 \leq \omega_{it}[k] \leq 1$ denotes the fraction of bank i's core loan portfolio that is accounted for by loans in category k, as reported on bank i's Call Report in quarter t.[5] The two composite indexes of changes in lending standards and loan demand—ΔS_{it} and ΔD_{it}, respectively—are diffusion indexes (DIs) that take on continuous values between -1 and 1. The bank-specific index ΔS_{it} can be interpreted as the net fraction of loans on bank i's balance sheet that were in categories for which the bank reported changing lending standards over the survey period; similarly, the diffusion index ΔD_{it} represents the net fraction of loans that were in categories for which the respondent bank reportedly experienced a change in demand over the same period.

[4] The results in this paper are robust to using all five categories, with weights ranging from -2 to $+2$.

[5] For multi-bank holding companies, we sum the amount of outstanding loans across all banks within the same holding company. Interbank loans among such affiliates, which would be subject to double counting by this method, are reported separately on the Call Report. We do not use the values for the entire holding company because responses are asked of loan officers at commercial bank subsidiaries and, therefore, may not be representative of lending standards used by nonbank subsidiaries of the holding company.

Figure 1: Changes in Bank Lending Standards and Loan Demand



NOTE: Sample period: 1992:Q1–2011:Q3. The solid line depicts the diffusion index (DI) of the change in overall bank lending standards; the dotted line depicts the diffusion index of the change in overall loan demand. Positive values of the DIs indicate a net tightening/increase in standards/demand, while negative values indicate a net easing/decrease in standards/demand (see text for details). The shaded vertical bars represent NBER-dated recessions.

The bank-specific DIs in equation (1) can be aggregated across banks according to:

$$\Delta S_t = \sum_i w_{it} \times \Delta S_{it} \quad \text{and} \quad \Delta D_t = \sum_i w_{it} \times \Delta D_{it}, \tag{2}$$

where $0 \leq w_{it} \leq 1$ denotes the fraction of total core loans on SLOOS respondents' balance sheets that are held by bank i in quarter t. Constructed in this way, the two aggregate DIs account for the heterogeneity of loan portfolios at the level of an individual bank, as well as for each bank's relative share of outstanding loans, and thus they likely capture the cyclical variation in credit supply conditions and loan demand at the economy-wide level.

Figure 1 shows the aggregate DIs (expressed in percent), indicating changes in lending standards and loan demand over the past two decades.[6] Note that the cyclical pattern of both series

[6]Although completely arbitrary, positive values of the two DIs indicate a net tightening/increase in stan-

qualitatively matches narrative accounts of changes in credit market conditions during this period. Lending standards tightened substantially in response to the financial turmoil associated with the "Ruble crisis" and the collapse of the LTCM hedge fund in the early autumn of 1998. A pronounced tightening of credit conditions also occurred during periods surrounding the 2001 and 2007–09 economic downturns. Banks reported that loan demand was strengthening during much of the mid-1990s and during the mid-2000s, two periods of strong and sustained economic growth. On the other hand, the two NBER recessions are characterized by a substantial weakening in loan demand. In fact, the strong negative comovement between the two series seems to confirm that changes in credit availability and loan demand over the course of a business cycle are often driven to some extent by common shocks.

A considerable insight into the possible sources of such common shocks can be gleaned from the survey itself. In particular, a portion of the SLOOS devoted to questions on C&I lending also asks banks to rate the relative importance of several possible reasons that may have led them to change their lending policies on such loans.[7] The possible reasons include macroeconomic factors, such as a less favorable or more uncertain economic outlook; bank-specific factors, such as a deterioration in the bank's current or expected capital position; or borrower-specific factors, such as an increase in industry-specific problems.

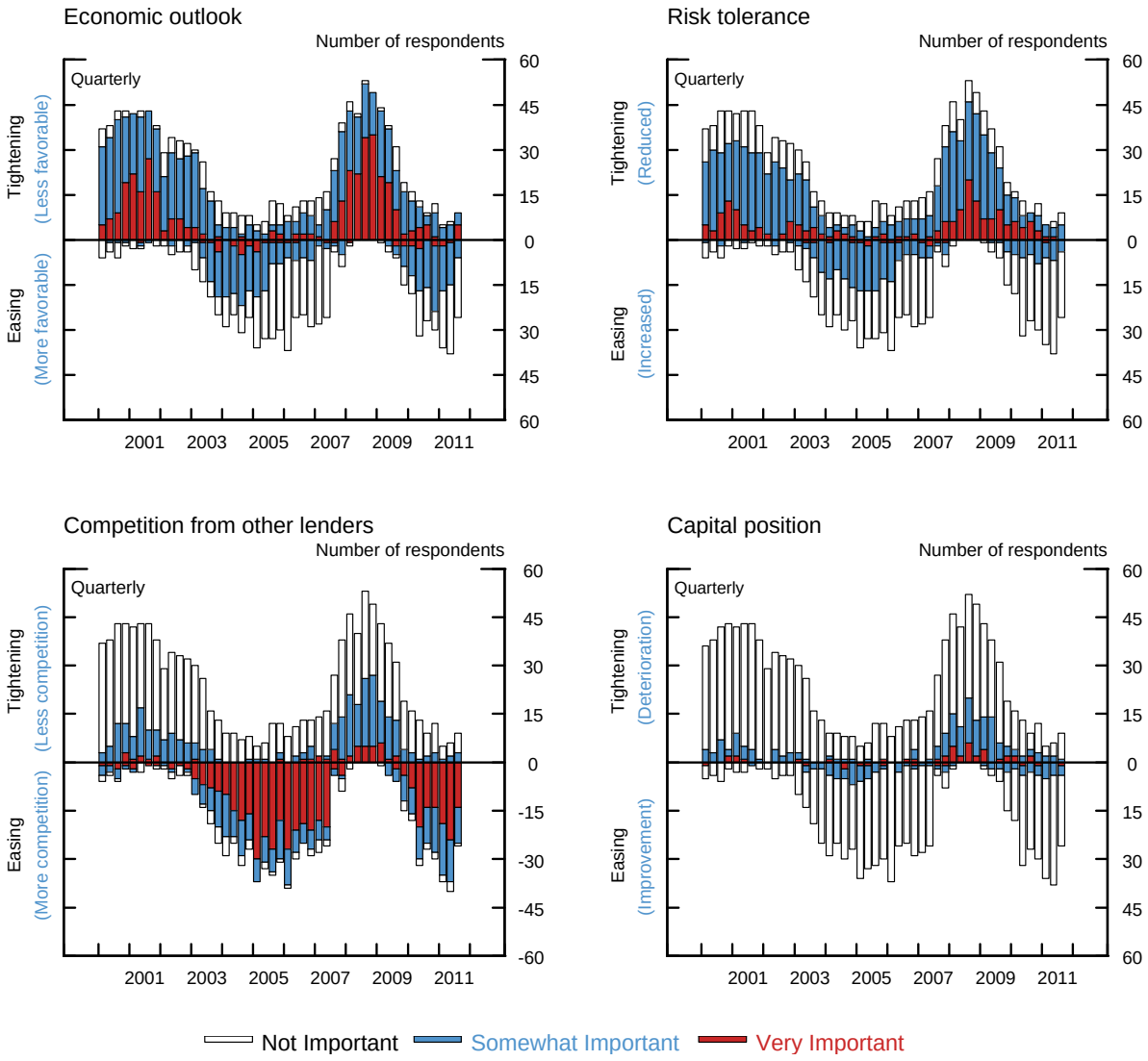
The bars in the panels of Figure 2 show the number of respondents offering four commonly cited reasons (of the eight possible choices) for tightening or easing of C&I lending policies: Changes in the economic outlook (upper left); changes in risk tolerance (upper right); changes in competitive pressures from other banks or nonbank sources of funding (lower left); and changes in the bank's current or expected capital position (lower right). In each panel, the height of the positive bars represents the number of respondents citing that reason as not important (white portion), somewhat important (blue portion) or very important (red portion) for tightening, while the negative bars give the number citing that reason as not, somewhat, or very important for easing.

The top two panels show that changes in the economic outlook and shifts in risk tolerance—factors that likely have an independent effect of loan demand—tend to be the most commonly-cited reasons for changes in bank lending standards and terms on C&I loans. Both of those reasons were cited as particularly important factors by banks that tightened lending policies during the 2001 and 2007–09 recessions. By contrast, the lower left panel indicates that banks that ease lending standards or terms are more likely to point to competition from other lenders as the reason for doing so, rather than an increase in risk tolerance or an improvement in the economic outlook. The lower right panel shows that prior to the 2007–09 financial crisis, changes in banks' capital

dards/demand, while negative values indicate a net easing/decrease in standards/demand, directions that are consistent with the SLOOS.

[7] Respondents are also asked to characterize changes in several different terms on C&I loans, such as spreads over their cost of funds and loan covenants. The reasons that banks give for changes in their lending policies can apply to changes in either standards or terms. For this reason, in any given survey, the number of banks responding to the reasons question can exceed the number of banks that changed lending standards.

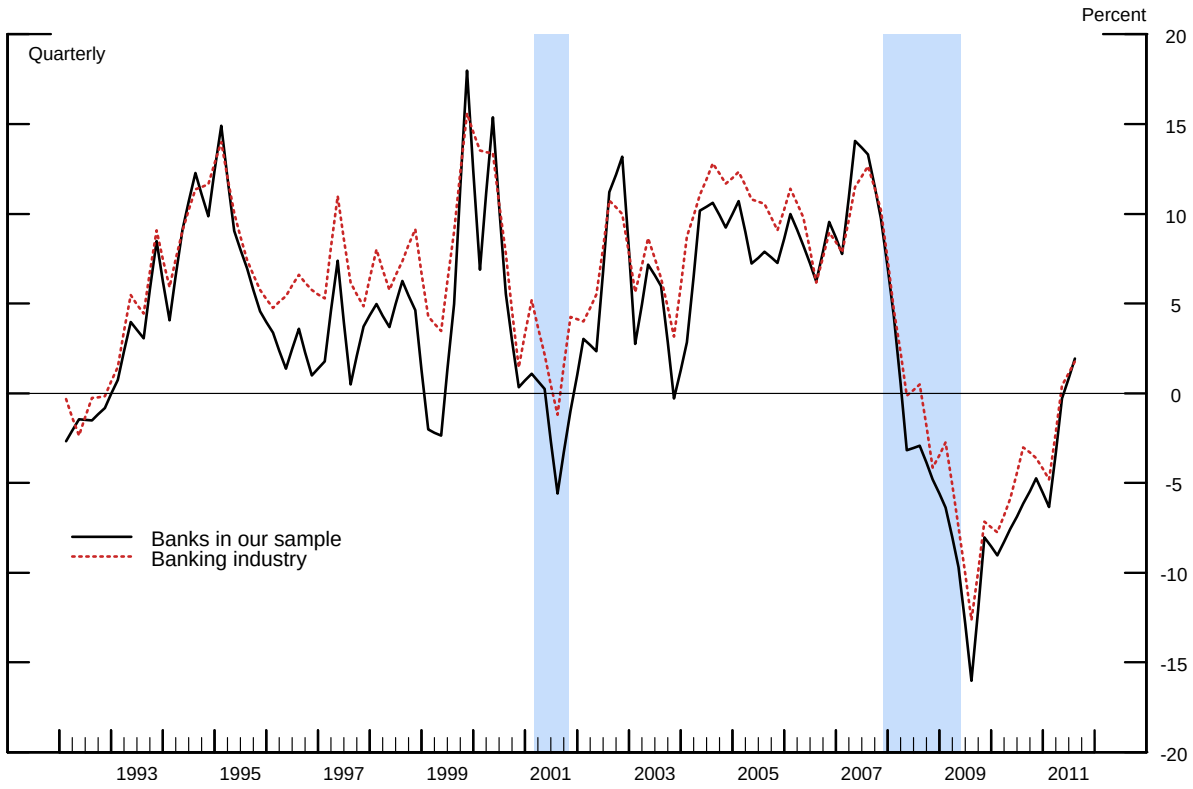
Figure 2: Selected Reasons for Tightening or Easing Standards on C&I Loans



NOTE: Sample period: 2000:Q1–2011:Q3. The bars show the number of banks responding to the SLOOS that pointed to the following reasons for tightening or easing their lending standards on C&I loans: (1) more or less favorable economic outlook; (2) increased or reduced risk tolerance; (3) increased or decreased competition from other lenders; and (4) improvement or deterioration in their capital position. Unshaded portions of the bars indicate that those banks reported the reason as not being important; blue shaded portions that the reason was somewhat important; and red shaded portions that the reason was very important.

position—very much a supply factor—generally were not given as an important reason for changes in C&I credit policies; interestingly, even during the "Great Recession," capital concerns were cited by only a modest number of respondents as a reason for moving to a more-stringent lending posture.

Figure 3: Growth of Core Loans at Commercial Banks
(*Sample vs. Industry*)



NOTE: Sample period: 1992:Q1–2011:Q3 The solid line depicts the (annualized) quarterly growth rate of core loans for the 68 banks that responded to the SLOOS during our sample period; the dotted line depicts the corresponding series for the entire U.S. commercial banking sector. The data are seasonally adjusted. The shaded vertical bars denote the NBER-dated recessions.

Over the 1992:Q1–2011:Q3 period, the sample covered by our analysis, about 140 different banks participated in the survey.[8] However, in conjunction with bank-level survey responses, our analysis also employs market data on banks' equity valuations. Accordingly, we eliminated from the SLOOS respondent panel institutions that were not part of a publicly-traded bank holding company (BHC). In addition, we included only those respondents that remained in the survey for at least 20 quarters.

Applying those selection criteria to the respondent panel yielded a sample of 68 banks. Though only about half of the original SLOOS respondent panel, banks in our data set still accounted, on average, for about 55 percent of industry-wide assets over the sample period. Moreover, as shown in Figure 3, the growth of total core loans for our sample of 68 banks closely matches the growth rate

[8]The diffusion indexes characterizing changes in loan demand begin in 1991:Q3. We start the analysis in 1992:Q1 because that is when the full set of explanatory variables is available.

of core loans for the entire U.S. commercial banking sector. Combined, these results indicate that our sample of banks likely reflects trends in credit availability and loan demand for the banking industry as a whole.

2.2 Bank-Specific Factors Affecting Changes in Lending Standards

In this section, we describe the construction of the other key bank-specific variables used in our empirical analysis. Specifically, we use the Call Reports to construct measures of bank profitability, asset quality, and balance sheet composition for each bank, factors that may exert an independent influence of the propensity of banks to change their credit policies.[9] The change in the bank's net interest margin from the previous quarter is used as an indicator of the return on the bank's newly originated loans. The quarterly change in loan loss provisions captures the current trend in credit quality of the bank's loan portfolio; because deterioration in asset quality may be an indication that lending policies may be too loose and that the quality of the bank's borrowers has declined, we expect banks to tighten lending standards in response to rising loan loss provisions.

The fraction of assets funded with core deposits is an indicator of the bank's liquidity position and the sensitivity of its asset-liability management structure to changes in market interest rates. Banks with higher core deposit funding ratios may be better able to absorb shocks to the pricing of other liabilities and therefore tighten lending standards less frequently or more gradually during economic downturns. We use the ratio of core loans to total assets to control for both liquidity and for the importance of lending operations in the bank's business model. In either case, a bank that is more heavily engaged in traditional lending activities should be more conservative in its lending policies and so the expected sign on this variable is positive.

We also consider the effects of bank-specific market indicators on the changes in bank lending standards. Using daily stock prices from the Center for Research in Securities Prices (CRSP) database, we calculate quarterly stock returns for the parent bank holding companies (BHCs). We expect high stock returns, which represent prospects for growth and ease with which the bank could raise additional capital to support new lending, to be associated with a greater propensity to ease lending standards. For each BHC, we also construct Tobin's Q, a common proxy for charter value; see for example, Keeley [1990].[10] A higher charter value should tend to make bank management more conservative, in order to reduce the likelihood of more-stringent supervision or failure that could result in the loss of some or all of the charter value.

[9] Bank balance sheet variables are adjusted for mergers between commercial banks by comparing balance sheet values at the end of the quarter with those at the beginning of the quarter, accounting for amounts acquired or lost during the period because of mergers. For information on the merger-adjustment procedure for income sheet items, see the appendix in English and Nelson [1998].

[10] Tobin's Q is constructed by assuming the market value of each BHC to be equal to its market capitalization plus the book value of its total liabilities as reported in the quarterly Consolidated Financial Statements for Bank Holding Companies (the FR Y-9C form); the book value of assets is the firm's total assets reported in the FR Y-9C.

Table 1: Summary Statistics of Selected Bank Characteristics

Variable	Mean	StdDev
Net interest margin	3.84	0.86
Loan loss provisions	0.74	1.00
Core loans[a]	53.7	16.3
C&I loans[b]	26.2	10.3
CRE loans[b]	16.5	12.9
RRE loans[b]	31.9	15.7
Credit card loans[b]	3.8	5.6
Other consumer loans[b]	10.0	5.0
Core deposits[c]	51.4	13.2
Total assets[d]	127.8	241.3
Tobins's Q	1.08	0.08
Stock returns	7.6	62.2

NOTE: Sample period: 1992:Q1–2011:Q3; Obs. = 3,062; No. of banks = 68. Net interest margin = annualized net interest income as a percent of average interest-earning assets; loan loss provisions = annualized provisions for loan and lease losses as a percent of average total loans and leases; core loans = sum of residential real estate (RRE), commercial real estate (CRE), C&I, credit card, and other consumer loans; core deposits = sum of transaction accounts, demand deposits, savings deposits, and small time deposits; Tobin's Q = ratio of the market value of equity plus the book value of liabilities to the book value of total assets of the parent BHC; and stock return = annualized quarterly stock return (in percent) of the parent BHC.
[a] As a percent of total assets.
[b] As a percent of total loans and leases.
[c] As a percent of total liabilities.
[d] In billions of chain-weighted dollars (2005 = 100).

Key characteristics of our sample of 68 banks are summarized in Table 1.[11] With almost 128 billion of assets, the average bank in our sample is quite large. Nevertheless, the size of banks in the sample runs from about $2.5 billion to more than $1 trillion, a range that covers large community and regional banks, as well as institutions with nationwide and international operations. Moreover, the sample primarily contains banks that have material exposures to each of the loan categories routinely queried by the SLOOS—core loans account, on average, for more than one half of total assets. Our sample also includes some banks that have business models concentrated in specific asset classes. Because of the relatively long sample period covering multiple business cycles, we benefit from significant variation in net interest margins, loan loss provisions, and banks' equity valuations.

[11] To protect the confidentiality of the SLOOS respondents, summary statistics associated with an individual institution, such as minimum, maximum, and median, are not reported.

2.3 Macroeconomic Factors Affecting Changes in Lending Standards

Most of the respondents to the SLOOS that change their lending standards during the survey period indicate that changes in the economic outlook, or in the degree of certainty about the outlook, are the most important reasons for the change in their lending policies. At the same time, however, these factors are very likely to affect loan demand as well. To control for these macroeconomic effects, we employ data from the Survey of Professional Forecasters (SPF). Specifically, the economic outlook in any given quarter t is summarized by the following four macroeconomic indicators: (1) the expected year-ahead growth in real GDP; (2) the expected year-ahead change in the unemployment rate; (3) the expected year-ahead change in the 3-month Treasury bill rate; and (4) the expected year-ahead change in the 10-year Treasury yield. The controls capturing the current state of the economy include the change in real GDP and in the unemployment rate from four quarters earlier, as well as the quarterly change in the real federal funds rate, an indicator of the shift in the stance of monetary policy.[12]

Another commonly-offered reason for the change in bank lending standards is the change in risk tolerance. As a proxy for changes in banks' risk attitudes, we use quarterly changes in the excess bond premium (EBP), an indicator of shifts in the effective risk aversion of the financial sector developed recently by Gilchrist and Zakrajšek [2011b].[13] Another popular measure of risk aversion in financial markets is the VIX (i.e., the "fear" index) , the option-implied volatility on the S&P 500 stock price index. In principle, movements in the VIX should also capture fluctuations in economic uncertainty (e.g., Bloom [2009]), another factor that is frequently cited by the SLOOS respondents as a reason for the change in their lending standards.[14] Accordingly, we also include the quarterly change in the VIX index among the set of macroeconomic factors that could be driving changes in banks' credit policies.

[12]The real federal funds rate is calculated as the nominal effective funds rate less average CPI inflation over the next ten years, as reported by the SPF.

[13]Gilchrist and Zakrajšek [2011b] employ a large panel of unsecured corporate bonds issued by U.S. nonfinancial firms to decompose the associated credit spreads into two components: a default-risk component capturing the usual countercyclical movements in expected defaults, and a non-default-risk component that captures the cyclical fluctuations in the relationship between default risk and credit spreads, the so-called excess bond premium. Importantly, they show that fluctuations in the EBP are closely related to the financial condition of broker-dealers, highly leveraged financial intermediaries that play a key role in most financial markets, according to Adrian and Shin [2010]. Taken together, this evidence is consistent with the notion that deviations in the pricing of long-term corporate bonds relative to the expected default risk of the underlying issuer reflect shifts in the effective risk aversion of the financial sector. Increases in risk aversion, in turn, lead to a contraction in the supply of credit, both through the corporate bond market and the broader commercial banking sector.

[14]As discussed by Bekaert et al. [2010], volatility indexes such as the VIX can be decomposed into an uncertainty component that captures the actual expected stock market volatility and the so-called variance risk premium, a component reflecting risk aversion and other non-linear pricing effects.

3 An Econometric Model of Changes in Bank Lending Standards

When gauging the supply-side implications of changes in bank lending policies, it is important to keep in mind that even the changes in lending standards reported in the SLOOS reflect the confluence of demand and supply factors. Recognizing this endogeneity problem, other researchers using aggregate indexes of changes in bank lending standards have relied on VAR-based identification strategies to try to identify the component of the change in standards that is orthogonal to other determinants of loan supply and demand; see, for example, Lown and Morgan [2002, 2006], Ciccarelli et al. [2010], and Cappiello et al. [2010].

This paper, by contrast, outlines an alternative approach that relies on bank-level responses to SLOOS questions about changes in lending standards. The advantage of our micro-based approach is that it allows us to better control for three potential sources of endogeneity. First, we are able to use the bank-specific SLOOS responses to questions about changes in loan demand to partial out changes in standards that are related to the reported changes in loan demand. Second, we can control for the effects of other bank-specific income, balance-sheet, and market indicators that might affect changes in standards—such variables may respond in part to other economic shocks that in turn affect loan demand and real activity, and are thus at least partly endogenous.[15] And lastly, we use survey information—as opposed to VAR-based expectations—on the economic outlook to control for the effects of expected future macroeconomic variables that might plausibly also affect current loan demand and economic activity.

Formally, we consider the following dynamic fixed effects specification to model changes in banks' lending standards:

$$\Delta S_{it} = \beta_1 \Delta S_{i,t-1} + \beta_2 \Delta D_{it} + \boldsymbol{\lambda}_1' E_{t-1}[\mathbf{m}_{t+4} - \mathbf{m}_t] + \boldsymbol{\lambda}_2' \mathbf{f}_t + \boldsymbol{\theta}' \mathbf{Z}_{i,t-1} + \eta_i + \epsilon_{it}, \tag{3}$$

where ΔS_{it} is the diffusion index of the change in lending standards at bank i in quarter t; ΔD_{it} is the corresponding diffusion index of the change in loan demand; $\mathbf{m}_t$ is a vector of macroeconomic variables characterizing the economic outlook; $\mathbf{f}_t$ is a vector of indicators capturing changes in risk attitudes of the financial sector and macroeconomic uncertainty, as well as changes in the current state of the economy; and $\mathbf{Z}_{it}$ is a vector of bank-specific control variables. Because banks typically change their lending standards only gradually, the regression equation (3) includes one lag of the dependent variable, whereas the bank fixed effect η_i controls for any unobservable (time-invariant) bank characteristics that could influence the way banks report changes in their credit policies on the SLOOS.[16]

[15] These bank-specific variables also move in part for purely exogenous reasons. Thus, by partialing out their effects on changes in lending standards, we are potentially removing some purely exogenous changes in standards. Hence our indicator of changes in the supply of bank loans likely understates the degree of exogenous shifts in banks' credit policies.

[16] For example, the time-series mean of the diffusion index of the change in aggregate lending standards (the solid line in Figure 1) is positive, suggesting a gradual tightening of standards over the sample period. It is possible that

As discussed above, the vector $\mathbf{m}_t$ characterizing the economic outlook consists of the log of real GDP (y_t), the unemployment rate (u_t), the 3-month Treasury bill rate (r_t^{3m}), and the 10-year Treasury yield (r_t^{10y}). The conditional expectations operator $E_{t-1}[\cdot]$—which uses the values of $\mathbf{m}_{t+4}$ and $\mathbf{m}_t$ that would have been available to the respondent banks at the time of the survey in quarter t—corresponds to SPF expectations of these variables and captures the fact banks reportedly change lending policies in response to changes in the economic outlook.[17] Common factors $\mathbf{f}_t$ control for changes in the current state of the economy; these are summarized by a four-quarter change in the log of real GDP ($y_t - y_{t-4}$), a four-quarter change in the unemployment rate ($u_t - u_{t-4}$), and the quarterly change in the real federal funds rate (Δrff_t). The quarterly change in the excess bond premium (ΔEBP_t) and the VIX (ΔVIX_t), on the other hand, capture changes in the risk attitudes of the financial sector and fluctuations in macroeconomic uncertainty.

The bank-specific factors—the vector $\mathbf{Z}_{i,t-1}$—that potentially play a role in the banks' setting of credit policies include recent trends in profitability, asset quality, and balance sheet composition, as well as stock market performance of the parent BHC and its franchise value as measured by the Tobin's Q; all of these bank-specific factors are measured as of the end of the previous period and thus are pre-determined.[18] Given the relatively long time-series dimension of our panel—an average bank is in our panel for 34 quarters—we estimate equation (3) by OLS. The results of this exercise for three variants of equation (3) are shown in Table 2.

The first specification reported in Table 2 includes only the lagged change in lending standards and the bank-specific diffusion index of changes in loan demand. As might be expected, having tightened standards in the current quarter has an economically large and statistically significant effect on tightening standards further in the subsequent quarter. The high degree of persistence in bank lending policies suggests that banks are either unwilling to reverse recent changes in lending standards or to materially change lending policies from period to period.[19] Specifically, an increase of one standard deviation in the fraction of loans on which banks tightened standards—about 33 percent—leads to an increase of almost 20 percent in the fraction of loans subject to tightening in the subsequent quarter. In contrast, an increase in loan demand reported over the survey period is associated with a modest softening of standards in that period. According to our estimates, a one standard deviation increase in the fraction of loans for which greater demand is reported (about 45 percent) is associated with a decrease in the fraction of loans subject to tightening of about

this reflects bias towards reporting a tightening by at least some survey respondents, who may not wish to appear lax in their lending standards. To the extent there is a consistent bias at some respondents, fixed effects should pick it up.

[17] As a robustness check, we also included the log of the GDP price deflator in the vector $\mathbf{m}_t$; controlling for expected year-ahead inflation had virtually no effect on any results reported in the paper.

[18] Our results are robust to the inclusion of changes in accounting measures of capital adequacy (i.e., the leverage and risk-based capital ratios used in current regulations), but these variables are statistically and economically insignificant and thus omitted.

[19] The apparent stickiness of lending standards might be due to the importance of banking relationships (such as opportunities to cross-sell products), which would be adversely affected if a bank significantly changed its lending policies from quarter to quarter.

Table 2: Factors Affecting Changes in Lending Standards at Commercial Banks

	Regression Specification					
Explanatory Variable	*Est.*	*S.E.*	*Est.*	*S.E.*	*Est.*	*S.E.*
Lagged change in standards: $\Delta S_{i,t-1}$	0.543	0.021	0.388	0.024	0.363	0.024
Change in DI of loan demand: ΔD_{it}	-0.101	0.015	-0.078	0.013	-0.071	0.014
Economic outlook: $E_{t-1}[y_{t+4} - y_t]$	-	-	-0.144	1.500	-0.185	1.710
Economic outlook: $E_{t-1}[u_{t+4} - u_t]$	-	-	13.56	2.467	5.377	3.671
Economic outlook: $E_{t-1}[r^{3m}_{t+4} - r^{3m}_t]$	-	-	-2.640	1.408	-2.586	1.425
Economic outlook: $E_{t-1}[r^{10y}_{t+4} - r^{10y}_t]$	-	-	-1.116	2.770	-6.489	3.179
Change in real GDP: $[y_t - y_{t-4}]$	-	-	-0.191	0.402	-0.625	0.538
Change in unemployment: $[u_t - u_{t-4}]$	-	-	2.624	0.677	2.588	0.0695
Change in real FF rate: Δrff_t	-	-	-8.554	1.169	-9.284	1.167
Change in EBP: ΔEBP_t	-	-	11.58	1.749	10.65	1.796
Change in VIX: ΔVIX_t	-	-	0.236	0.124	0.385	0.118
Change in net interest margin: $\Delta NIM_{i,t-1}$	-	-	-	-	-1.236	1.350
Change in loan loss provisions: $\Delta LLP_{i,t-1}$	-	-	-	-	2.043	0.939
Share of core loans: $CoreLns_{i,t-1}$	-	-	-	-	0.336	0.133
Share of core deposits: $CoreDep_{i,t-1}$	-	-	-	-	-0.272	0.082
Bank size: $\ln A_{i,t-1}$	-	-	-	-	0.025	0.013
Tobin's Q: $Q_{i,t-1}$	-	-	-	-	0.104	0.108
Stock returns: $R_{i,t-1}$	-	-	-	-	-0.056	0.008
$\Pr > W_1$ [a]	-		0.000		0.000	
$\Pr > W_2$ [b]	-		-		0.000	
R^2 (within)	0.348		0.417		0.434	

NOTE: Sample period: 1992:Q1–2011:Q3; Obs. = 3,062; No. of banks = 68. Dependent variable is ΔS_{it}, the diffusion index (DI) of the change lending standards at bank i in quarter t. Entries under the column headings "*Est.*" denote OLS estimates of the parameters associated with the explanatory variables: ΔD_{it} = diffusion index of change in loan demand at bank i in quarter t; $E_{t-1}[y_{t+4} - y_t]$ = SPF expectations of the year-ahead growth in real GDP; $E_{t-1}[u_{t+4} - u_t]$ = SPF expectations of the year-ahead change in the unemployment rate; $E_{t-1}[r^{3m}_{t+4} - r^{3m}_t]$ = SPF expectations of the year-ahead change in the 3-month Treasury bill rate; $E_{t-1}[r^{10y}_{t+4} - r^{10y}_t]$ = SPF expectations of the year-ahead change in the 10-year Treasury yield; $[y_t - y_{t-4}]$ = four-quarter growth in real GDP; $[u_t - u_{t-4}]$ =four-quarter change in the unemployment rate; Δrff_t = quarterly change in the real federal funds rate; ΔEBP_t = quarterly change in the excess bond premium; ΔVIX_t = quarterly change in the option-implied volatility on the S&P 500 stock market index. For definitions of the bank-specific variables see the notes to Table 1. Robust asymptotic standard errors are clustered at the bank level and are reported under the column headings "*S.E.*" All specifications include bank fixed effects (not reported).

[a] p-value for the (robust) exclusion test of macroeconomic and financial indicators.

[b] p-value for the (robust) exclusion test of bank-specific indicators.

5 percent.

The second specification includes our set of macroeconomic and financial indicators. The addition of these variables reduces the magnitude of the coefficients on lagged changes in standards and the diffusion index of changes in loan demand somewhat, though both variables remain economically and statistically highly significant. Expected increases in both the short- and longer-term

nominal interest rates—a likely signal of expected strengthening in economic activity over the forecast horizon—are associated with easings in lending standards, as is an expected rise in real GDP; although they have intuitively correct signs, none of the coefficients on those variables is statistically significant at conventional levels.

In contrast, a worsening of both current and expected labor market conditions is associated with a shift to a materially more stringent bank lending posture. According to our estimates, an expected rise in the unemployment rate of one percentage point over the subsequent year leads to an immediate increase of 13 percentage points in the diffusion index of changes in bank lending standards, a result consistent with the fact that loan officers responding to the SLOOS view the prospective economic outlook as an important factor when setting their bank's current lending policy. An increase in the unemployment rate over the past year is also associated with a statistically significant tightening of lending standards, though the effect is only one-fifth the magnitude of a similarly-sized increase in the expected unemployment rate.

An effective tightening of monetary policy during the survey period—as evidenced by an increase in the real federal funds rate—is associated with an economically large easing of lending standards. The direction of this effect confirms the forward-looking nature of SLOOS respondents when setting current lending policies, as the real funds rate typically increases in response to an improvement in the economic outlook.[20] Consistent with the banks' responses to the survey, an increase in the excess bond premium—an indication of reduced risk appetite in the financial sector—is associated with a significant tightening of lending standards: An increase of one percentage point in the excess bond premium leads to an immediate increase of about 12 percent in the fraction of loans subject to more stringent lending policies. In contrast, movements in the VIX—a proxy for changes in economic uncertainty—have an economically negligible effect on the diffusion index of changes in bank lending standards.

Parameter estimates and the associated standard errors of our preferred specification, which also includes the bank-specific control variables, are shown in the last two columns of the table. Most of the bank-level variables have statistically significant, economically intuitive, but fairly modest effects on changes in lending standards. For example, a jump of one percentage point in the rate of loan loss provisioning—a forward-looking indicator of asset quality—leads to an increase in the diffusion index of changes in bank lending standards of about 2 percentage points in the subsequent quarter, a result consistent with that of Berger and Udell [2004], who find that banks tend to impose more stringent lending standards and terms in response to a deterioration in the quality of their loan portfolios.

The negative coefficient on the core deposit ratio indicates that banks that rely more heavily on such deposits to fund lending activities are less likely to tighten lending standards. Though the

[20]The negative coefficient on the changes in real funds rate stands in contrast to results of Maddaloni and Peydró [2012], who present evidence—based on the Euro area Bank Lending Standards Survey—that low monetary policy rates may induce banks to make riskier loans by adopting softer lending standards.

size of this effect is small in economic terms, the negative relationship between the tightening of lending standards and the share of assets funded by core deposits comports with the hypothesis that a stable source of funding allows banks to adjust credit policies more gradually in response to an adverse economic shock. Note that having experienced higher stock returns in the past quarter is also associated with slightly easier subsequent lending policies, a move that may reflect a more robust capital base from which to lend.

Most importantly, however, the inclusion of the bank-specific variables does not appreciably change the statistical or economic significance of the variables controlling for the current macroeconomic environment or for the changes in the risk appetite of the financial sector. It does, however, noticeably affect the size of the coefficients associated with variables capturing the economic outlook. In particular, the effect of an expected change in the 10-year Treasury yield on lending standards is now substantially more negative and statistically significant. The combined effect of expected changes in both the short- and longer-term interest rates indicates that an expected steepening of the yield curve is associated with an immediate softening of the banks' lending posture, a move that is consistent with the well-documented predictive content of the term spread for future economic activity.[21] At same time, the economic impact of expected changes in the unemployment rate has been appreciably diminished.

We use this specification to purge the reported changes in bank lending standards of the key macroeconomic and bank-specific factors that may also affect loan demand. Specifically, our measure of changes in the supply conditions of bank-intermediated credit—denoted by ΔS_t^u—is given by the standardized sequence of cross-sectional (weighted) averages of the OLS residuals $\hat{\epsilon}_{it}$ from our preferred specification:

$$\Delta S_t^u = \sum_{i=1}^{N_t} w_{it} \hat{\epsilon}_{it},$$

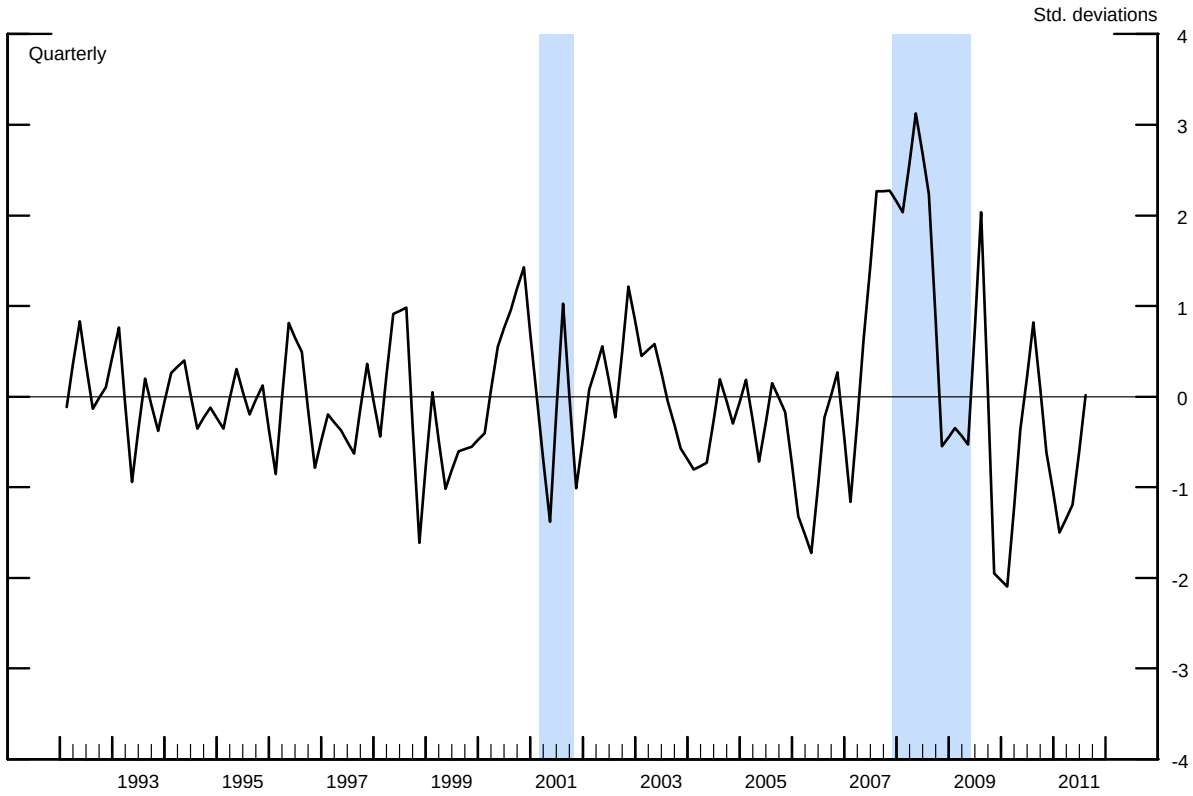
where N_t denotes the number of banks that are in our sample in quarter t, and w_{it} is the ratio of core loans at bank i to total core loans held by banks in the sample during that same period.[22]

As constructed, the series ΔS_t^u, $t = 1, 2, \ldots, T$, captures changes in lending standards that are orthogonal to the macroeconomic and bank-specific factors that are also likely correlated with changes in loan demand. Compared with the diffusion index of changes in lending standards, our series should provide a cleaner indicator of shifts in the effective supply of bank loans to businesses and households—such unanticipated tightenings in lending standards should cause banks to reduce lending and impose more stringent loan terms on their borrowers, while unanticipated easings

[21] See, for example, Harvey [1988]; Estrella and Hardouvelis [1991]; Estrella and Mishkin [1998]; Hamilton and Kim [2002]; and Ang et al. [2006].

[22] We standardize the series for the ease of interpretation. As a robustness check, we have also computed an unweighted estimate of shifts in the effective supply of bank loans, and the unweighted series closely resembles the weighted one. All the results in the paper are robust to using an unweighted estimate of the exogenous changes in bank lending standards.

Figure 4: Changes in the Supply of Bank Loans to Businesses and Households



NOTE: Sample period: 1992:Q1–2011:Q3. The solid line depicts the estimated exogenous change in bank lending standards, an indicator of shifts in the effective supply of bank-intermediated credit; the series has been standardized (see text for details). The shaded vertical bars denote NBER-dated recessions.

should be followed by increased lending and easier loan terms.[23] Given the large number of bank-specific and macroeconomic conditioning variables and the fact that these unanticipated changes in lending standards reflect simultaneous decisions of many banks, fluctuations in our loan supply measure are mostly plausibly accounted for by fundamental reassessments of the riskiness of certain types of bank lending, changes in business strategies, or in response to changes in the structure or intensity of bank supervision and regulation.

Figure 4 shows our indicator of changes in the effective supply of bank loans to businesses and households. The series exhibits many of the same qualitative patterns as the aggregate diffusion index of the change in bank lending standards shown in Figure 1—in fact, the correlation between the two series is about 0.60. Nevertheless, there are a number of important differences. Although lending standards tightened unexpectedly in the latter half of 1999—several quarters before the

[23] In keeping with the directionality of the diffusion index of the change in bank lending standards ΔS_t in Figure 1, *positive* values of ΔS_t^u should indicate a *decrease* in loan supply and vice versa.

bursting of the "dot-com" bubble—changes in lending standards during the subsequent recession appear to be, on average, about in line with those predicted by our model. In contrast, the aggregate diffusion index of changes in bank lending standards indicates a cumulative tightening of credit conditions that lasted well past the official end of the recession in November 2001. An unanticipated shift towards a more stringent lending posture also occurred in late 2002, a move that lasted several quarters and likely reflected banks' reassessment of corporate credit risk in response to a slew of high-profile accounting scandals that significantly undermined investor confidence during that period.

The aggregate diffusion index of the change in lending standards points to a marked and persistent softening of standards beginning in 2003. Our measure, in contrast, suggests that this apparent easing of credit conditions was about in line with the macroeconomic and bank-specific factors included in our model. In fact, according to our estimates, changes in bank lending standards did not materially deviate from those predicted by the model until early 2006, definitely a period of easy credit. Both series, however, point to a substantial tightening of credit conditions beginning in early 2007. Our estimates also indicate that the massive tightening of standards at the apex of the financial crisis at the end of 2008 was largely consistent with the severe coincident deterioration in broad macroeconomic conditions and an extraordinarily heightened level of risk aversion in financial markets, the two most important factors driving changes in banks' credit policy during that period.

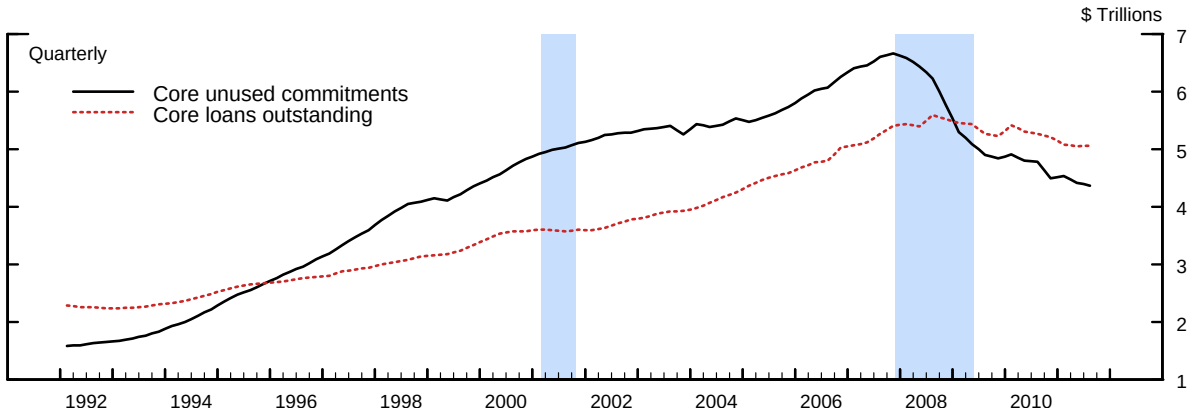
4 Macroeconomic Implications

In this section, we examine the macroeconomic implications of credit supply shocks by including our series of unanticipated changes in bank lending standards into a fairly standard monetary VAR framework. In addition to our indicator of shifts in the effective supply of bank loans, which is ordered first, the VAR specification includes the following five endogenous variables: (1) log-difference of real GDP; (2) inflation, as measured by the log-difference of the GDP deflator; (3) log-difference of banks' core lending capacity; (4) the "GZ credit spread," a corporate bond credit spread index with high information content for future economic activity constructed by Gilchrist and Zakrajšek [2011b]; and (5) the effective federal funds rate. The GZ spread is included to capture financial disturbances that may originate outside the banking system, while the federal funds rate controls for the stance of monetary policy.

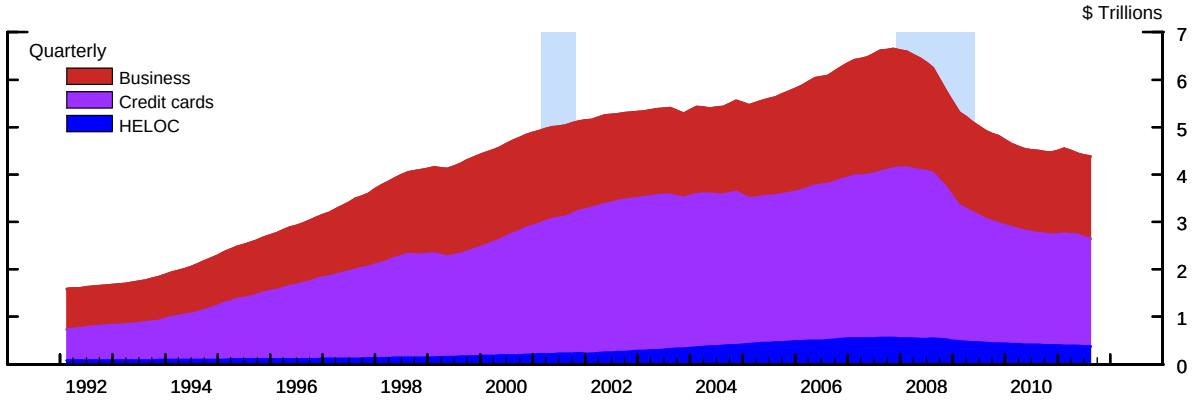
An important issue in such analysis is the extent to which firms and households are financing their expenditures by borrowing through newly originated loans, as opposed to drawing on their existing lines of credit.[24] At the same time, banks may curtail their credit exposures in the initial

[24] As shown by Gilchrist and Zakrajšek [2011a], this distinction is crucial for understanding the cyclical dynamics of bank lending because unused loan commitments, which represent a significant source of off-balance-sheet credit risk to banks and as liquidity insurance for businesses, started to contract immediately with the onset of the crisis

Figure 5: Core Loans and Unused Commitments at U.S. Commercial Banks



(a) Core Loans Outstanding and Unused Commitments



(b) Composition of Unused Commitments

NOTE: Sample period: 1992:Q1–2011:Q3. The black line in the top panel depicts the dollar amount of core unused commitments, and the dotted red line depicts the dollar amount of core loans outstanding at U.S. commercial banks. The bottom panel depicts the composition of unused commitments; HELOC is home equity lines of credit. All series are from Call Reports and are deflated by the GDP price deflator (2005 = 100). Shaded vertical bars denote NBER-dated recessions.

phases of an economic downturn primarily by reducing the amount of unused commitments.[25] Figure 5 illustrates the banking sector's unique role in the provision of credit in the form credit lines. According to the top panel, core loans outstanding exceeded the corresponding unused

in mid-2007, while loans outstanding on banks' balance sheet expanded briskly during the first year of the recession. Another possibility for borrowers facing an adverse credit supply shock is to rely on internal liquidity. Indeed, at least in the business sector, firms with greater exposure to aggregate risk find it more costly to obtain credit lines from banks and, as a result, tend to rely more heavily on cash reserves to manage their future liquidity needs (see Acharya et al. [2009]).

[25]This hypothesis is in fact consistent with the evidence presented by Morgan [1998], who shows that changes in C&I loans outstanding not made under commitment are more sensitive to changes in the stance of monetary policy than changes in such loans made under a previous commitment.

commitments by an appreciable margin during the early 1990s. Over time, however, banks' off-balance-sheet credit exposures have expanded rapidly, and by the most recent business cycle peak at the end of 2007, core unused commitments totaled close to seven trillion dollars, substantially more than about five trillion dollars of core loans outstanding. As shown in the bottom panel, credit card commitments accounted for the majority of this off-balance-sheet exposure, followed closely by business credit lines.[26]

In the latter half of 2007, this enormous off-balance-sheet credit exposure presented banks with a major risk in light of falling home prices, escalating strains in the interbank funding markets, and an emerging slowdown in economic activity. Given the importance of banks' commitments to fund business and consumer loans, our VAR specification includes the growth in core lending capacity (i.e., the sum of core loans outstanding and the corresponding unused commitments), a broad measure of credit intermediation by commercial banks, which attempts to capture the full potential of businesses and households to borrow from the banking sector.

The identifying assumption implicit in the recursive ordering of the VAR implies that credit supply shocks have an immediate impact on output growth, inflation, and the growth of core lending capacity; such shocks can also elicit an immediate response of monetary policy, as well as a reaction in credit spreads, movements in which have been shown to be especially informative about the evolution of the real economy and risks to the economic outlook.[27] The identification of credit supply shocks in this context is buttressed further by the fact that our indicator of shifts in the effective supply of bank loans has already been purged—at the micro level—of the macroeconomic and bank-specific factors that can also affect loan demand.[28] We estimate the VAR over the 1992:Q1–2011:Q3 period using two lags of the endogenous variables.

Figure 6 shows the impulse responses of the key endogenous macroeconomic variables—core lending capacity, real GDP, the credit spread index, and the federal funds rate—to a one-time, one standard deviation orthogonalized shock to our measure of changes in the effective supply of bank-intermediated credit. The effects on output and core lending capacity are accumulated, so that the plotted responses reflect the effects of the adverse credit supply shock on the levels of those variables. To conserve on space, we do not show the effects of the shock on inflation, which are statistically and economically insignificant.

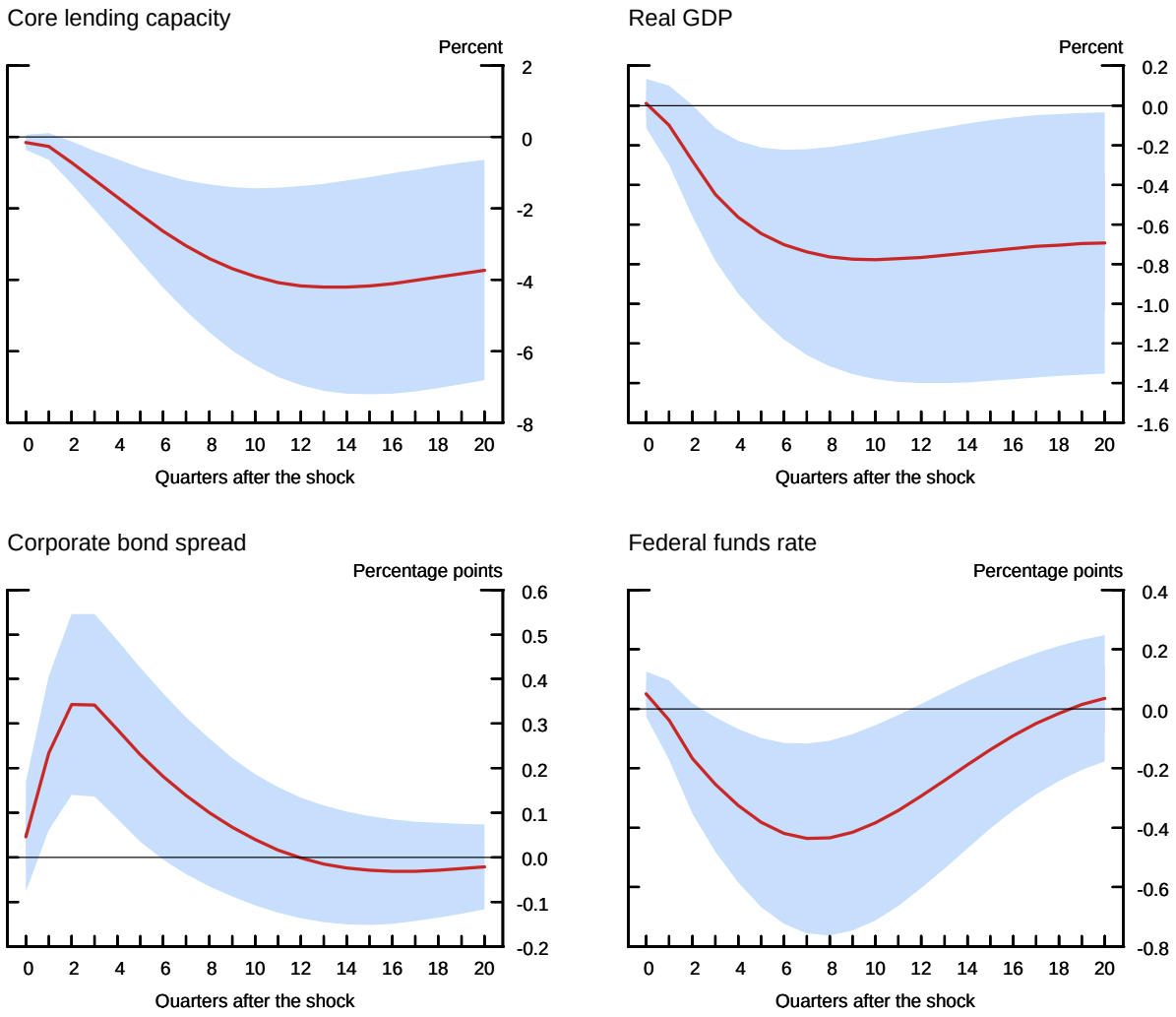
According to our results, such adverse credit supply shocks have significant macroeconomic consequences. The capacity of businesses and households to borrow from the banking sector begins

[26]It is important to note that what we label as "business lines" is recorded in Call Reports prior to 2010 as "other" unused commitments. More detailed data available since 2010 suggest that credit lines to businesses—both financial and nonfinancial—account for the vast majority of this category.

[27]The predictive content of corporate bond credit spreads for future economic activity has been analyzed by Gertler and Lown [1999], Mody and Taylor [2004], King et al. [2007], Mueller [2009], Gilchrist et al. [2009], Gilchrist and Zakrajšek [2011b], and Faust et al. [2011].

[28]It is worth noting that all the VAR results reported in the paper are robust to ordering our measure of changes in loan supply variable before the GZ spread and the federal funds rate, an identification scheme that implies that credit supply shocks affect the real economy and banks' core lending capacity with a lag.

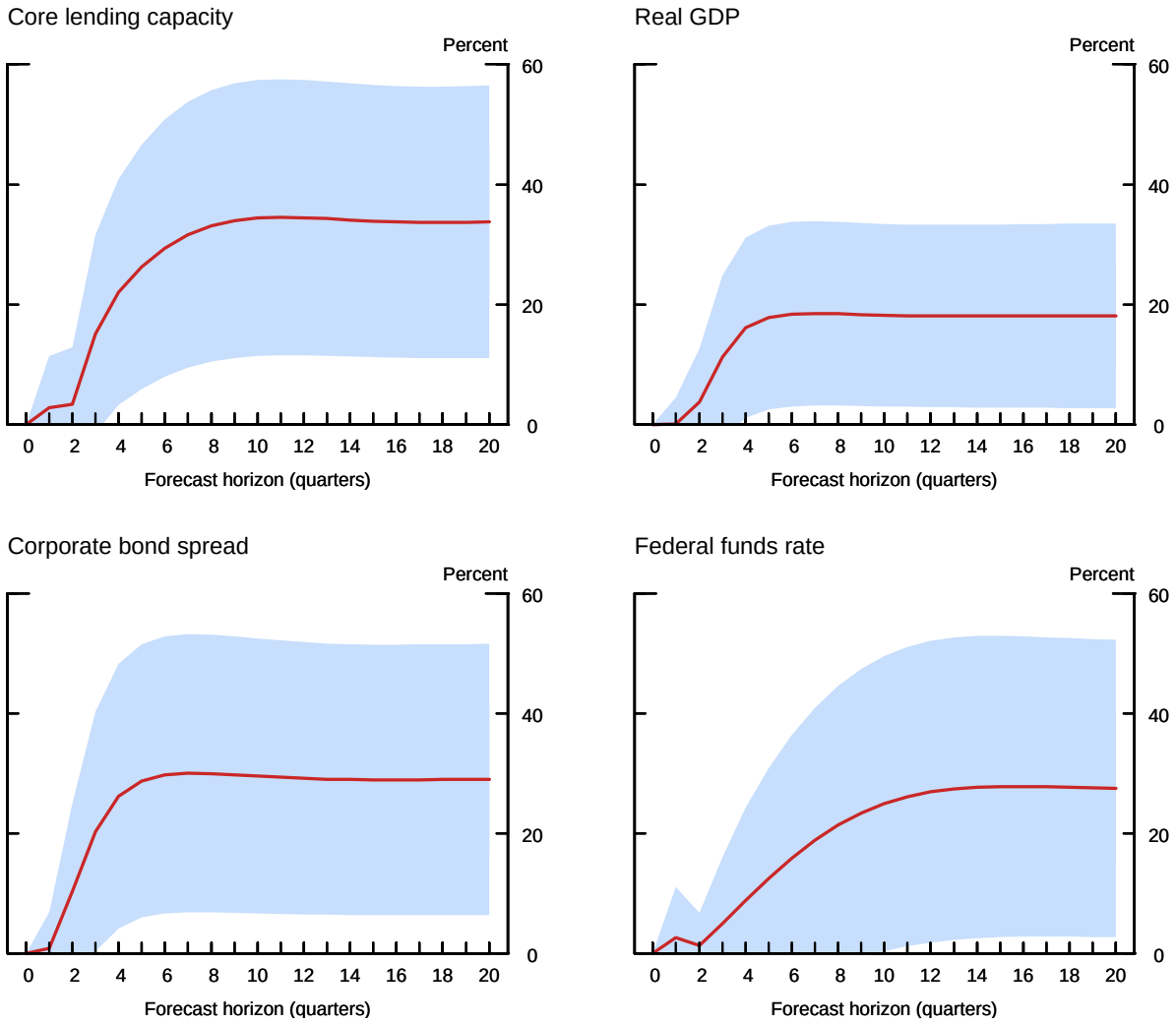
Figure 6: Macroeconomic Implications of an Adverse Credit Supply Shock



NOTE: The panels of the figure depict impulse response functions of selected macroeconomic variables to an orthogonalized shock of one standard deviation to the estimated exogenous change in bank lending standards (see text for details). The shaded bands represent 95-percent confidence intervals based on 2,000 bootstrap replications.

to decline within two quarters after the initial credit disruption, and the resulting reduction in this broad measure of credit intermediation is very persistent and protracted. Because a one-time credit supply shock leads to permanently tighter credit conditions, it implies a permanent reduction of about 4 percent in the capacity of businesses and households to borrow from the banking sector. The decline in credit intermediation is accompanied by a significant slowdown in economic growth, resulting in a permanently lower level of real GDP. The disruption in the supply of bank-intermediated credit is also associated with a substantial jump in credit spreads and elicits

Figure 7: Forecast Error Variance Decomposition



NOTE: The panels of the figure depict the decomposition of the forecast error variance of selected macroeconomic variables to an orthogonalized shock of one standard deviation to the estimated exogenous change in bank lending standards (see text for details). The shaded bands represent 95-percent confidence intervals based on 2,000 bootstrap replications.

a significant easing of monetary policy, all trademarks of a classical credit crunch.[29]

[29]The magnitude of these effects is broadly consistent with the results of Lown and Morgan [2006], who include a measure of the change in C&I lending standards from the SLOOS into a standard macroeconomic VAR, with the change in standards ordered after real GDP, the nominal federal funds rate, and real C&I loans outstanding. Using the Choleski decomposition to orthogonalize the reduced-form VAR disturbances, they find that an orthogonalized shock to the change in C&I lending standards—an increase of 8 percent in the net fraction of banks reporting a tightening of standards—ultimately leads to a reduction in C&I loans outstanding of about 3 percent and a decline in the level of real GDP of about 0.5 percent; they find similar effects when they extend the model to include the

Figure 7 shows the amount of variation in the same endogenous variables explained by the orthogonalized shocks to our indicator of shifts in the effective supply of bank-intermediated credit. These innovations account for almost 20 percent of the variation in output and about 35 percent of the variation in core lending capacity at business cycle frequencies, proportions that exceed the amount of variation typically explained by monetary policy shocks. In addition, such disruptions in the credit-intermediation process explain a significant portion of the variation in corporate bond credit spreads and short-term nominal interest rates.

5 Estimating the Demand for C&I Loans

The aim of the empirical approach used above was to obtain a cleaner indicator of movements in the supply of bank-intermediated credit by purging the reported change in lending standards from the direct effect of changes in loan demand, as well as from both the bank-specific and macroeconomic factors that influence credit supply but might also be correlated with changes in loan demand. One way of ascertain whether our series is capturing exogenous changes in bank lending standards—and therefore represents shifts in the effective supply of bank loans—is to see whether it helps us to estimate the slope of the loan demand curve. To the extent that our indicator reflects exogenous changes in lending standards associated with shifts in loan supply, it should serve as a valid instrument in a regression of loan quantities on loan interest rates, thus tracing out the loan demand curve. (We illustrate this point with a simple example in Appendix B.)

To examine this hypothesis, we focus on the portion of the SLOOS pertaining to business lending. Specifically, we matched the bank-level SLOOS responses on changes in C&I lending standards with the Federal Reserve Board's Survey of Terms of Business Lending (STBL), a source of detailed loan-level information on C&I loan originations. The STBL is a quarterly survey that collects from about 300 U.S. commercial banks detailed information on price and non-price terms—along with the associated loan amounts—on C&I loan originations. Between 1997:Q2 and 2011:Q3, 55 SLOOS respondents in our sample also participated in the STBL, reporting detailed information on 195,569 unsecured C&I loans.[30]

Loan contracts are characterized by not only the loan amount and the corresponding interest rate, but also by the loan's maturity and repricing frequency; whether the loan is extended under commitment—that is drawn under under a credit line—or in a spot market; whether it is secured by collateral; and by other possible price and non-price characteristics. Many of those factors also affect the risk of the loan and hence its interest rate spread. To abstract from the effect that changes in the amount or type of collateral required (which are not available in the STBL) have on

paper-bill spread and measures of bank and borrower health, such as banks' capital-to-asset ratio and the coverage ratio for nonfinancial firms.

[30]The beginning of the matched sample is chosen because the composition and coverage of the STBL changed significantly in 1997:Q2. More information on the STBL may be found at the Federal Reserve's website at `http://www.federalreserve.gov/releases/e2/`.

Table 3: Summary Statistics of Unsecured C&I Loan Originations

Variable	Mean	StdDev	Min	Median	Max
Loan size[a]	1,053	2,692	1.2	135	21,965
Loan maturity (days)	502	584	1	290	10,901
Fixed rate (pct.)	11.4	31.8	-	-	-
Reprice anytime (pct.)[c]	67.1	47.0	-	-	-
Next repricing (days)[d]	27	123	1	1	3,650
Drawn under commitment (pct.)	90.0	30.4	-	-	-
Prepayment penalty (pct.)	11.5	31.9	-	-	-
Effective loan rate (pct.)	6.11	2.41	0.23	5.98	14.9

NOTE: Sample period: 1997:Q2–2011:Q3; No. of loans = 195,569; No. of banks = 55. The effective loan rate is computed based on the stated interest rate, payment schedule, and compounding intervals reported in the survey.
[a] In thousands of chain-weighted dollars (2005 = 100).
[c] Variable-rate loans only.
[d] Excluding variable-rate loans that can be repriced anytime.

both loan amounts and corresponding interest rates, we restricted our sample to unsecured C&I loans only.

Key characteristics for our sample of unsecured C&I loans are reported in Table 3. The median loan amount is $135,000, with the range running from a bit more than $1,000 to almost $2 million. The average maturity of loans is about 1.3 years, though the sample contains many overnight loans (i.e., maturity of one day). About 11 percent of loans have fixed interest rates and of those that have variable rates, two-thirds of them can be repriced at anytime (such as when the prime rate changes); note that the median repricing frequency for variable-rate loans with fixed repricing interval is one day. Another important feature of our sample is that 90 percent of loans were extended under a previous commitment. Effective loan rates run from a low of about 0.25 percent to a high of almost 15 percent, a range that points to a substantial amount of borrower heterogeneity and cyclical variation in the cost of bank-intermediated business credit.

To obtain instruments for the loan-level regressions, we use a multinomial logit variant of our econometric model to estimate the bank-specific unanticipated changes in C&I lending standards. Specifically, the dependent variable in equation (3) is a discrete variable ΔS_{it} that takes on the following three values: $\Delta S_{it} = T$ if bank i reported tightening its standards on C&I loans in quarter t; $\Delta S_{it} = N$ if bank i reported no change in its business credit policies (the reference category); and $\Delta S_{it} = E$ if bank i indicated an easing of standards on C&I loans during the survey period.[31]

Table 4 contains the average marginal effects of macroeconomic and bank-specific variables on the probability of tightening and the probability of easing. These results comport well with those

[31] Given our focus on C&I lending, the only other change made to the specification is that we replaced the share of core loans ($CoreLns_{i,t-1}$) with the share of C&I loans ($C\&ILns_{i,t-1}$).

Table 4: Factors Affecting Changes in C&I Lending Standards at Commercial Banks

	$\Pr(\Delta S_{it} = T)$		$\Pr(\Delta S_{it} = E)$	
Explanatory Variable	*Est.*	*S.E.*	*Est.*	*S.E.*
Lagged tightening of standards: $\Delta S_{i,t-1} = T$	0.141	0.023	-0.043	0.019
Lagged easing of standards: $\Delta S_{i,t-1} = E$	0.001	0.029	0.066	0.023
Weaker loan demand: $\Delta D_{it} = W$	0.037	0.015	-0.003	0.015
Stronger loan demand: $\Delta D_{it} = S$	0.019	0.015	0.028	0.014
Economic outlook: $E_{t-1}[y_{t+4} - y_t]$	5.204	1.560	-.0134	1.640
Economic outlook: $E_{t-1}[u_{t+4} - u_t]$	10.51	3.037	2.249	3.028
Economic outlook: $E_{t-1}[r^{3m}_{t+4} - r^{3m}_t]$	0.094	1.763	2.021	2.066
Economic outlook: $E_{t-1}[r^{10y}_{t+4} - r^{10y}_t]$	-5.546	3.520	8.188	3.128
Change in real GDP: $[y_t - y_{t-4}]$	0.071	0.683	0.425	0.668
Change in unemployment: $[u_t - u_{t-4}]$	3.757	1.192	-3.321	1.469
Change in real FF rate: Δrff_t	-5.184	1.035	1.997	1.624
Change in EBP: ΔEBP_t	10.37	2.521	0.611	2.039
Change in VIX: ΔVIX_t	0.246	0.109	-0.184	0.146
Change in net interest margin: $\Delta NIM_{i,t-1}$	0.000	0.978	0.495	1.382
Change in loan loss provisions: $\Delta LLP_{i,t-1}$	1.438	0.995	-1.291	0.524
Share of C&I loans: $C\&ILns_{i,t-1}$	0.426	0.197	-0.329	0.097
Share of core deposits: $CoreDep_{i,t-1}$	-0.168	0.105	0.265	0.063
Bank size: $\ln A_{i,t-1}$	0.026	0.023	-0.027	0.011
Tobin's Q: $Q_{i,t-1}$	0.326	0.113	-0.117	0.134
Stock returns: $R_{i,t-1}$	-0.047	0.008	0.026	0.010
$\Pr > W_1$[a]	0.000		0.000	
$\Pr > W_2$[b]	0.000		0.000	
Cragg & Uhler (pseudo) R^2	0.523			

NOTE: Sample period: 1992:Q1–2011:Q3; Obs. = 2,978; No. of banks = 66. Dependent variable in the multinomial logit regression is the indicator variable $\Delta S_{it} = \{E, U, T\}$ of the change in C&I lending standards reported by bank i in quarter t: E = easing of standards; U = unchanged standards; and T = tightening of standards. Entries under the column headings "*Est.*" are the estimated average marginal effects of the specified explanatory variables on the probability of tightening/easing (relative to no reported change in lending standards). The indicator variable $\Delta D_{it} = \{S, U, W\}$ is the change in C&I loan demand reported by bank i in quarter t: S = stronger demand; U = unchanged demand; and W = weaker demand. $E_{t-1}[y_{t+4} - y_t]$ = SPF expectations of the year-ahead growth in real GDP; $E_{t-1}[u_{t+4} - u_t]$ = SPF expectations of the year-ahead change in the unemployment rate; $E_{t-1}[r^{3m}_{t+4} - r^{3m}_t]$ = SPF expectations of the year-ahead change in the 3-month Treasury bill rate; $E_{t-1}[r^{10y}_{t+4} - r^{10y}_t]$ = SPF expectations of the year-ahead change in the 10-year Treasury yield; $[y_t - y_{t-4}]$ = four-quarter growth in real GDP; $[u_t - u_{t-4}]$ =four-quarter change in the unemployment rate; Δrff_t = quarterly change in the real federal funds rate; ΔEBP_t = quarterly change in the excess bond premium; ΔVIX_t = quarterly change in the option-implied volatility on the S&P 500 stock market index. For definitions of the bank-specific variables see the notes to Table 1. Robust asymptotic standard errors are clustered at the bank level and are reported under the column headings "*S.E.*" The specification includes bank fixed effects (not reported).

[a] p-value for the equation-specific (robust) exclusion test of macroeconomic and financial indicators.

[b] p-value for the equation-specific (robust) exclusion test of bank-specific indicators.

reported for our composite diffusion index of changes in bank lending standards. The direction of changes in C&I credit policies, for example, tends to be quite persistent: Having tightened lending standards this quarter implies a 14 percent higher likelihood of doing so again next quarter, while reducing the odds of easing more than 4 percent. Fluctuations in C&I loan demand also play a role in the setting of credit policies: A reported weakening in C&I loan demand increased the odds of a tightening, while having experienced stronger demand tends to result in softer lending standards.

As before, the economic outlook is an important determinant of banks' current business credit policies. A projected increase in the unemployment rate significantly boosts the probability of tightening, as does a deterioration in the current labor market conditions. Expected changes in longer-term interest rates again exert a significant influence—in both economic and statistical terms—on the probability that banks will modify their current lending standards: An expected increase of 100 basis points in the 10-year Treasury yield over the next four quarters is estimated to lower the probability of tightening in the current quarter about 5.5 percent and boost the likelihood of easing more than 8 percent. Movements in the excess bond premium, a proxy for changes in the risk aversion of the financial sector, also significantly shape banks' willingness to engage in business lending, with reductions in risk tolerance implying significantly higher odds of more stringent lending standards.

Among bank-specific factors, a higher Tobin's Q increases the likelihood of having more stringent credit policies, a result consistent the notion that high franchise values provide an internal incentive for banks to restrain risk taking; see, for example, Keeley [1990] and Saunders and Wilson [2001]. As before, good recent stock market performance is associated with a move towards softer lending standards, as is a decline in the rate of loan loss provisioning, an indicator of improving asset quality.

Using the estimated parameters of the multinomial logit, we calculate the bank-specific predicted probabilities of tightening and easing at each point in time. These probabilities are matched to the reported outcomes, yielding two sets of "crude residuals:" a set corresponding to "unanticipated" tightenings and a set corresponding to "unanticipated" easings.[32] The former should capture exogenous reductions in the supply of C&I loans, whereas the latter should represent expansions in the supply of such loans. We use these two bank-specific loan-supply shifters as instruments in the following regression:

$$\ln L_{it}[k] = \beta(R_{it}[k] - R_t^m[k]) + \boldsymbol{\gamma}'\mathbf{X}_{it}[k] + \eta_i + \lambda_t + \epsilon_{it}[k], \tag{4}$$

where $L_{it}[k]$ denotes the amount of C&I loan k (in thousands of 2005 dollars), originated by bank i in quarter t and $(R_{it}[k] - R_t^m[k])$ is the corresponding loan-rate spread.

[32] As shown by Cramer [2000], these crude residuals share—though only asymptotically—the zero mean and orthogonality properties of the OLS residuals from a linear regression. In our sample, these asymptotic properties are approximately true.

We specify the loan-demand specification (4) in terms of loan-rate spreads in order to abstract from fluctuations in market rates that banks use as a base when pricing C&I loans.[33] Specifically, the spread for each loan k is calculated as the difference between the effective loan rate ($R_{it}[k]$) and the prevailing rate on an appropriately matched overnight interest rate swap (OIS) or interest rate swap contract ($R_t^m[k]$), which serves as a proxy for the bank's marginal cost of funds.[34] Note that the specification also includes a bank fixed effect η_i, which should capture any systematic differences in the type of borrowers across banks, while the time fixed effect λ_t captures common shocks that could affect the demand for business credit either through output or interest rates.

The vector $\mathbf{X}_{it}[k]$ controls for other observable loan characteristics that potentially can influence the terms of the loan contract (see Table 3). The specific controls are an indicator for overnight loans; an indicator for loans extended under a previous commitment; an indicator for loans subject to a prepayment penalty; an indicator for fixed rate loans; and an indicator for floating rate loans that can be repriced anytime. We also control for the maturity of non-overnight loans by including the logarithm of the remaining days to maturity into $\mathbf{X}_{it}[k]$, whereas the inclusion of the logarithm of days to next repricing controls for the repricing frequency of floating rate loans with a fixed repricing schedule. Controlling for the days to maturity and repricing allows for the possibility of a term premium in the spread. As an alternative functional form to the semi-log specification in equation (4), we also consider a log-log specification, in which the loan-rate spread is replaced by its logarithm, a useful transformation given that the distribution of loan-rate spreads is quite skewed.

The first column in the top and bottom panels of Table 5 contains estimates of the semi-elasticity of loan demand based on OLS. Both estimates are negative and highly statistically significant and imply that an increase in loan-rate spreads of 100 basis points is associated with a decline in unsecured C&I loan originations of about one-half percent. The second column contains the results from an IV estimation, in which the loan-rate spreads are instrumented with the banks' reported change in C&I lending standards—a 0/1-indicator for tightenings and a 0/1-indicator for easings. The extent to which these two instruments are capturing changes in the supply of C&I loans—and therefore help identify the slope of the loan demand curve—is evident in the fact that the estimate of semi-elasticity is now around -1.5, significantly greater (in absolute value) than its OLS counterpart. Nevertheless, it is estimated with considerable imprecision, and the first-stage F-tests indicate that the reported changes in bank lending standards may not be valid instruments because they likely reflect the confluence of both demand and supply factors.

The last column in the table reports the results from an IV estimation, which uses our two sets of the "unanticipated" changes in C&I lending standards as instruments. In the semi-log

[33] The results were virtually the same if spreads were replaced by loan rates.

[34] The matching between the loan rate and the relevant market rate is chosen by matching to the maturity of fixed-rate loans and the stated repricing interval of floating rate loans. To ensure that our results were not unduly influenced by a small number of extreme observations, we eliminated from the sample all loans with amounts or spreads below the 0.5th and above the 99.5th percentiles of their respective distribution.

Table 5: Semi-Elasticity of C&I Loan Demand

	Semi-Log Specification		
Semi-Elasticity (with respect to)	OLS	GMM-1	GMM-2
Loan-rate spread: $R_{it}[k] - R_t^m[k]$	-0.596	-1.695	-1.536
	(0.091)	(0.780)	(0.450)
R^2 (within)	0.213	-	-
Pr $> F$ [a]	-	0.051	0.001
Pr $> J_N$ [b]	-	0.710	0.526
	Log-Log Specification		
Semi-Elasticity (with respect to)	OLS	GMM-1	GMM-2
Loan-rate spread: $R_{it}[k] - R_t^m[k]$	-0.433	-1.566	-1.060
	(0.044)	(1.055)	(0.299)
R^2 (within)	0.221	-	-
Pr $> F$ [a]	-	0.323	0.002
Pr $> J_N$ [b]	-	0.617	0.587

NOTE: Sample period: 1997:Q2–2011:Q3; No. of loans = 195,569; No. of banks = 55. Dependent variable is $\ln L_{it}[k]$, the log of the unsecured C&I loan origination k made by bank i in quarter t. Entries in the table are estimates of the semi-elasticity of loan demand with respect to the loan-rate spread ($R_{it}[k] - R_t^m[k]$). GMM-1 instruments set: indicator variables for reported changes in C&I lending standards (tightened and eased); GMM-2 instrument set: residuals from the multinomial regression of the reported changes in C&I lending standards (tightened and eased). All specifications include bank and time fixed effects and a set of loan-level control variables (not reported). Robust asymptotic standard errors are clustered at the bank level and are reported in parentheses.
[a] p-value for the (robust) first-stage F-test of instrument validity.
[b] p-value for the Hansen [1982] J-test of overidentifying restrictions.

specification, the estimate of semi-elasticity is about -1.5, whereas a log-log specification yields an estimate of about -1.0. Both estimates are statistically highly significant and imply that an increase of 100 basis points in a C&I loan rate spread lowers the demand for such loans between 1.0 and 1.5 percent. Moreover, the first-stage F-tests both indicate with a high degree of confidence that the "unanticipated" changes in lending standards are valid instruments. Taken together, all of these results are consistent with our hypothesis that these "unanticipated" changes in bank lending standards are largely capturing changes in loan supply, rather than in loan demand.

6 Conclusion

In this paper, we used bank-level responses to the Federal Reserve's quarterly Senior Loan Officer Opinion Survey (SLOOS) over the 1992–2011 period to derive a new measure of movements in the effective supply of bank-intermediated credit. Our indicator of shifts in the supply of bank loans

to businesses and households corresponds to changes in composite lending standards that—using an econometric model—have been purged of the bank-specific and macroeconomic factors that, in addition to affecting banks' credit policies, can also have a simultaneous effect on the demand for credit. Fluctuations in this credit supply indicator, which accord well with narrative descriptions of changes in credit conditions during the 1992–2011 period, appear to be most plausibly accounted for by fundamental reassessments of the riskiness of certain types of bank lending, changes in banks' business strategies, or banks' response to changes in the structure or intensity of bank supervision and regulation.

When included in a standard monetary VAR framework, orthogonalized innovations to our measure of changes in the supply of bank-intermediated credit have significant macroeconomic effects. An adverse credit supply shock is associated with a substantial reduction in the capacity of businesses and households to borrow from the banking sector and a significant decline in real GDP. These credit disruptions also prompt a sharp widening of corporate credit spreads and elicit a significant easing of monetary policy.

As a further test of how well our series captures exogenous shifts in the supply of loans, we use an analog of the series corresponding to bank-specific "unanticipated" changes in lending standards on C&I loans as an instrument in a regression of individual C&I loan amounts on the corresponding loan-rate spreads. Compared with OLS, an IV estimation using our loan-supply shifters as instruments implies a doubling of the semi-elasticity of loan demand—from about -0.5 to between -1.0 and -1.5—an indication that our instruments are largely capturing exogenous movements in loan supply, rather than in loan demand.

References

Acharya, V. V., H. Almeida, and M. Campello (2009): "Aggregate Risk and the Choice Between Cash and Credit Lines," Working Paper, Dept. of Finance, University of Illinois at Urbana-Champaign.

Adrian, T. and H. S. Shin (2010): "Liquidity and Leverage," *Journal of Financial Intermediation*, 19, 418–437.

Ang, A., M. Piazzesi, and M. Wei (2006): "What Does the Yield Curve Tell Us About GDP Growth?" *Journal of Econometrics*, 131, 359–403.

Ashcraft, A. B. (2005): "Are Banks Really Special? New Evidence from the FDIC-Induced Failure of Healthy Banks," *American Economic Review*, 95, 1712–1730.

Bassett, W. F., S. Gilchrist, G. C. Weinbach, and E. Zakrajšek (2011): "Improving Our Ability to Monitor Bank Lending," Chapter in NBER Book Systemic Risk and Macro Modeling, Markus K. Brunnermeier and Arvind Krishnammurthy, editors. Available at SSRN: http://ssrn.com/abstract=1943992.

Bassett, W. F. and E. Zakrajšek (2003): "Recent Developments in Business Lending by Commercial Banks," *Federal Reserve Bulletin*, December, 477–492.

Bayoumi, T. and O. Melander (2008): "Credit Matters: Empirical Evidence on U.S. Macro-Financial Linkages," IMF Working Paper No. 169.

Bekaert, G., M. Hoerova, and M. Lo Duca (2010): "Risk, Uncertainty, and Monetary Policy," NBER Working Paper No. 16397.

Berger, A. N. and G. F. Udell (2004): "The Institutional Memory Hypothesis and the Procyclicality of Bank Lending Behavior," *Journal of Financial Intermediation*, 13, 458–495.

Bernanke, B. S. (1983): "Nonmonetary Effects of the Financial Crisis in Propagation of the Great Depression," *American Economic Review*, 73, 257–276.

Bernanke, B. S. and A. S. Blinder (1988): "Credit, Money, and Aggregate Demand," *American Economic Review*, 78, 435–439.

Bernanke, B. S. and M. Gertler (1989): "Agency Costs, Net Worth, and Business Fluctuations," *American Economic Review*, 79, 14–31.

Bernanke, B. S., M. Gertler, and S. Gilchrist (1999): "The Financial Accelerator in a Quantitative Business Cycle Framework," in *The Handbook of Macroeconomics*, ed. by J. B. Taylor and M. Woodford, Amsterdam: Elsevier Science B.V, 1341–1393.

Bernanke, B. S. and C. S. Lown (1991): "The Credit Crunch," *Brookings Papers on Economic Activity*, 2, 205–239.

Bloom, N. (2009): "The Impact of Uncertainty Shocks," *Econometrica*, 77, 623–685.

Brunner, K. and A. H. Meltzer (1963): "The Place of Financial Intermediaries in the Transmission of Monetary Policy," *American Economic Review*, 53, 372–382.

Brunnermeier, M. K. and Y. Sannikov (2011): "A Macroeconomic Model with a Financial Sector," Working Paper, Dept. of Economics, Princeton University.

Cappiello, L., A. Kadareja, C. Kok Sørensen, and M. Protopapa (2010): "Do Bank Loans and Credit Standards have an Effect on Output? A Panel Approach for the Euro Area," ECB Working Paper No. 1150.

Ciccarelli, M., A. Maddaloni, and J.-L. Peydró (2010): "Trusting the Bankers: A New Look at the Credit Channel of Monetary Policy," ECB Working Paper No. 1228.

Cramer, J. S. (2000): "Asymptotic Properties of Predicted Probabilities in Discrete Regression," Tinbergen Institute Discussion Papers 00-006/4.

Cunningham, T. J. (2006): "The Predictive Power of the Senior Loan Officer Survey: Do Lending Officers Know Anything Special?" Working Paper No. 24, Federal Reserve Bank of Atlanta.

De Bondt, G., A. Maddaloni, J.-L. Peydró, and S. Scopel (2010): "The Euro Area Bank Lending Survey Matters: Empirical Evidence for Credit and Output Growth," ECB Working Paper No. 1160.

English, W. B. and W. R. Nelson (1998): "Profits and Balance Sheet Developments at U.S. Commercial Banks in 1997," *Federal Reserve Bulletin*, 84, 391–419.

Estrella, A. and G. A. Hardouvelis (1991): "The Term Structure as Predictor of Real Economic Activity," *Journal of Finance*, 46, 555–576.

Estrella, A. and F. S. Mishkin (1998): "Predicting U.S. Recessions: Financial Variables as Leading Indicators," *Review of Economics and Statistics*, 80, 45–61.

Faust, J., S. Gilchrist, J. H. Wright, and E. Zakrajšek (2011): "Credit Spreads as Predictors of Real-Time Economic Activity: A Bayesian Model-Averaging Approach," NBER Working Paper No. 16725.

Gatev, E. and P. Strahan (2006): "Banks' Advantage in Hedging Liquidity Risk: Theory and Evidence From the Commercial Paper Market," *Journal of Finance*, 61, 867–892.

Gertler, M. and S. Gilchrist (1993): "The Role of Credit Market Imperfections in the Monetary Transmission Mechanism: Arguments and Evidence," *Scandinavian Journal of Economics*, 95, 43–64.

Gertler, M. and C. S. Lown (1999): "The Information in the High-Yield Bond Spread for the Business Cycle: Evidence and Some Implications," *Oxford Review of Economic Policy*, 15, 132–150.

Gilchrist, S., V. Yankov, and E. Zakrajšek (2009): "Credit Market Shocks and Economic Fluctuations: Evidence From Corporate Bond and Stock Markets," *Journal of Monetary Economics*, 56, 471–493.

Gilchrist, S. and E. Zakrajšek (1995): "The Importance of Credit for Macroeconomic Activity: Identification Through Heterogeneity," in *Is Bank Lending Important for the Transmission of Monetary Policy?*, ed. by J. Peek and E. S. Rosengren, Boston: Federal Reserve Bank of Boston, 129–158.

——— (2011a): "Bank Lending and Credit Supply Shocks," Working Paper, Dept. of Economics, Boston University.

——— (2011b): "Credit Spreads and Business Cycle Fluctuations," NBER Working Paper No. 17021, Forthcoming *American Economic Review*.

Hamilton, J. D. and D. H. Kim (2002): "A Reexamination of the Predictability of Economic Activity Using the Yield Spread," *Journal of Money, Credit, and Banking*, 34, 340–360.

Hansen, L. P. (1982): "Large Sample Properties of Generalized Method of Moment Estimators," *Econometrica*, 50, 1029–1054.

Harvey, C. R. (1988): "The Real Term Structure and Consumption Growth," *Journal of Financial Economics*, 22, 305–322.

He, Z. and A. Krishnamurthy (2012): "A Macroeconomic Framework for Quantifying Systemic Risk," Working Paper, Kellogg School of Management, Northwestern University.

Kashyap, A. K., R. G. Rajan, and J. C. Stein (2002): "Banks as Liquidity Providers: An Explanantion for the Coexistence of Lending and Deposit-Taking," *Journal of Finance*, 57, 33–73.

Kashyap, A. K. and J. C. Stein (1994): "Monetary Policy and Bank Lending," in *Monetary Policy*, ed. by N. G. Mankiw, Chicago: The University of Chicago Press, 221–262.

——— (2000): "What Do a Million Observations on Banks Say About the Transmission of Monetary Policy?" *American Economic Review*, 90, 407–428.

Keeley, M. C. (1990): "Deposit Insurance, Risk, and Market Power in Banking," *American Economic Review*, 80, 1183–1200.

King, T. B., A. T. Levin, and R. Perli (2007): "Financial Market Perceptions of Recession Risk," Finance and Economics Discussion Series Paper 2007-57, Federal Reserve Board.

Kiyotaki, N. and J. H. Moore (1997): "Credit Cycles," *Journal of Political Economy*, 105, 211–248.

Lown, C. S. and D. P. Morgan (2002): "Credit Effects in the Monetary Mechanism," *Economic Policy Review, Federal Reserve Bank of New York*, 8, 217–235.

——— (2006): "The Credit Cycle and the Business Cycle: New Findings from the Loan Officer Opinion Survey," *Journal of Money, Credit, and Banking*, 38, 1575–1597.

Lown, C. S., D. P. Morgan, and S. Rohatgi (2000): "Listening to Loan Officers: The Impact of Commercial Credit Standards on Lending and Output," *Economic Policy Review, Federal Reserve Bank of New York*, 6, 1–16.

Maddaloni, A. and J.-L. Peydró (2012): "The Low Monetary Rates Paradox, Banking Stability, and Credit: Evidence From the Euro Area," Working Paper, Dept. of Economics and Business, Universitat Pompeu Fabra.

Mody, A. and M. P. Taylor (2004): "Financial Predictors of Real Activity and the Financial Accelerator," *Economic Letters*, 82, 167–172.

Morgan, D. P. (1998): "The Credit Effects of Monetary Policy: Evidence From Using Loan Commitments," *Journal of Money, Credit, and Banking*, 30, 102–118.

Mueller, P. (2009): "Credit Spreads and Real Activity," Working Paper, London School of Economics.

Peek, J. and E. S. Rosengren (1995a): "Bank Regulation and the Credit Crunch," *Journal of Banking and Finance*, 19, 679–692.

——— (1995b): "The Capital Crunch: Neither a Borrower nor a Lender Be," *Journal of Money, Credit, and Banking*, 27, 625–638.

——— (2000): "Collateral Damage: Effects of the Japanese Bank Crisis on Real Activity in the United States," *American Economic Review*, 90, 30–45.

Pennacchi, G. G. (2006): "Deposit Insurance, Bank Regulation, and Financial System Risks," *Journal of Monetary Economics*, 53, 1–30.

Rajan, R. G. (1994): "Why Bank Credit Policies Fluctuate: A Theory and Some Evidence," *Quarterly Journal of Economics*, 109, 399–441.

Ramey, V. A. (1993): "How Important is the Credit Channel in the Transmission of Monetary Policy?" *Carnegie-Rochester Conference Series on Public Policy*, 39, 1–45.

Romer, C. D. and D. H. Romer (1990): "New Evidence on the Monetary Transmission Mechanism," *Brookings Papers on Economic Activity*, 1, 149–198.

Ruckes, M. E. (2004): "Bank Competition and Credit Standards," *Review of Financial Studies*, 17, 1073–1102.

Saunders, A. and B. Wilson (2001): "An Analysis of Bank Charter and Its Risk-Constraining Incentives," *Journal of Financial Services Research*, 19, 185–195.

Schreft, S. L. and R. E. Owens (1991): "Survey Evidence of Tighter Credit Conditions: What Does it Mean?" *Federal Reserve Bank of Richmond Economic Review*, 77, 29–34.

Swiston, A. (2008): "A U.S. Financial Conditions Index: Putting Credit Where Credit is Due," IMF Working Paper No. 161.

Appendices

A The Senior Loan Officer Opinion Survey: A Primer

The Senior Loan Officer Opinion Survey on Bank Lending Practices (SLOOS) is a regular survey of changes in lending standards, loan terms, and loan demand, conducted by the Federal Reserve.[35] This paper uses the responses from the up to 60 domestic commercial banks that answer each survey.[36] The survey panel of domestic banks encompasses the 12 Federal Reserve Districts, while balancing the need to keep it heavily weighted towards large institutions. The survey is voluntary, but banks that are asked to participate in the survey almost always agree to do so. The primary cause of attrition in the sample is the acquisition of a respondent bank by another bank that already participates in the survey. Thus, selection bias in the composition of the respondent panel is likely to be limited.

The survey is generally conducted four times each year on a schedule that coincides with the meetings of the Federal Open Market Committee (FOMC).[37] Although this procedure results in a frequency that is roughly quarterly, the survey can occur at various points in any given quarter. In answering the questions, banks are asked to report changes in their lending practices (i.e., standards and terms) or loan demand experienced over the previous three months.

Because of the somewhat irregular schedule, the SLOOS data must be merged carefully to ensure that the time periods in the multiple other sources coincide. For instance, the January SLOOS refers to the period from October to December of the prior year; in that case the SLOOS data would be merged with the fourth quarter Call Report data. However, the SLOOS can occur at various points in a given quarter. In general, we matched the quarter of SLOOS responses to the quarter of Call Report and other financial data so as to maximize the overlap with the period covered by the survey.

The number of loan categories covered by the SLOOS has increased noticeably over time. In constructing the diffusion indexes for changes in standards and demand, this paper uses information on the most disaggregated set of loan categories available in each survey. However, not all seven loan categories are available over the entire sample period. Data on changes in lending standards on C&I loans, commercial real estate loans, and residential mortgages are all available beginning with the May 1990 survey; changes in loan demand for those loan categories were added to the survey about a year later in August 1991. Questions regarding changes in standards/demand on credit card loans and other consumer loans were added to the survey in February 1996 and May 1996, respectively. However, a series indicating changes in banks' willingness/demand to make consumer installment loans is available over the entire sample period; we use this series as a proxy for changes in standards/demand on all consumer loans prior to 1996.

Starting with the February 2008 survey, banks were also asked about changes in their lending standards/demand on home equity lines of credit. Questions about changes in standards/demand on residential mortgages by type of mortgage (i.e., prime, nontraditional, or subprime) were added

[35] More information on the SLOOS, as well as the aggregated data, may be found at the Federal Reserve's website at `http://www.federalreserve.gov/boarddocs/SnLoanSurvey/`.

[36] By answering a subset of questions pertaining to business lending, up to 24 U.S. branches and agencies of foreign banks also participate in the survey. Answers of foreign institutions were not used in the analysis.

[37] The Federal Reserve Board has the authority to conduct up to six surveys each year; the extra surveys, however, are usually only carried out when conditions in credit markets are particularly strained or volatile. The occasional extra surveys were not used in the analysis.

to the survey in April 2007. In constructing our diffusion indexes, we use only the response that banks provided for prime mortgages, because the majority of SLOOS respondents had a very small on-balance-sheet subprime exposure. And lastly, starting with the May 2011 survey, the respondents were asked about changes in standards/demand on auto loans.

B Estimating a Demand for C&I Loans: A Simple Example

This appendix shows that in a linear supply and demand framework, an IV estimator of the slope of the demand curve will be biased towards zero to a lesser extent the more the candidate instrument is correlated with supply rather than demand shocks.

Consider a simple model of demand and supply:

$$\begin{aligned} \text{demand equation:} \quad Q_i^D &= -\beta^D P_i + \epsilon_i^D; \\ \text{supply equation:} \quad Q_i^S &= \beta^S P_i + \epsilon_i^S, \end{aligned}$$

where ϵ_i^D and ϵ_i^S—the demand and supply shocks, respectively—satisfy $E(\epsilon_i^D \epsilon_i^S) = 0$, $Var(\epsilon_i^D) = \sigma_D^2$, and $Var(\epsilon_i^S) = \sigma_S^2$. The reduced-form solution implied by the equilibrium condition $Q_i^D = Q_i^S = Q_i$ is given by

$$\begin{aligned} P_i &= \frac{1}{\beta^D + \beta^S}(\epsilon_i^D + \epsilon_i^S); \\ Q_i &= \frac{\beta^S}{\beta^D + \beta^S}\epsilon_i^D + \frac{\beta^S}{\beta^D + \beta^S}\epsilon_i^S. \end{aligned}$$

Given a sample of N observations on Q_i and P_i, an OLS regression of quantities on prices will yield

$$\hat{\beta}_{OLS} = \left(\sum_i P_i^2\right)^{-1} \left(\sum_i P_i Q_i\right).$$

Substituting Q_i from the demand equation into the above expression yields:

$$\hat{\beta}_{OLS} = -\beta^D + \left(\sum_i P_i^2\right)^{-1} \left(\sum_i P_i \epsilon_i^D\right).$$

Taking probability limits as $N \to \infty$ and using Slutsky's theorem implies

$$\operatorname{plim} \hat{\beta}_{OLS} = -\beta^D + \operatorname{plim}\left(\frac{1}{N}\sum_i P_i^2\right)^{-1} \operatorname{plim}\left(\frac{1}{N}\sum_i P_i \epsilon_i^D\right),$$

which simplifies to:

$$\operatorname{plim} \hat{\beta}_{OLS} = -\beta^D + (\beta^D + \beta^S)\left[\frac{\sigma_D^2}{\sigma_D^2 + \sigma_S^2}\right]. \tag{B-1}$$

Equation (B-1) shows the usual result that the OLS estimate of the coefficient on prices will be a mixture of the slopes of the demand curve and the supply curve. Note that with respect to the demand curve, the OLS estimator is biased towards zero.

Now suppose there is an "instrumental" variable Z_i, which is correlated with the supply shock ϵ_i^S but may also be correlated with the demand shock ϵ_i^D, so that $Z_i = \alpha^D \epsilon_i^D + \alpha^S \epsilon_i^S$. In an IV regression of Q_i on P_i using Z_i as an instrument,

$$\hat{\beta}_{IV} = \left(\sum_i Z_i P_i\right)^{-1} \left(\sum_i Z_i Q_i\right).$$

As before, using the demand curve to substitute out for Q_i, taking probability limits, and using Slutsky's theorem yields

$$\operatorname{plim} \hat{\beta}_{IV} = -\beta^D + \operatorname{plim} \left(\frac{1}{N} \sum_i Z_i P_i \right)^{-1} \operatorname{plim} \left(\frac{1}{N} \sum_i Z_i \epsilon_i^D \right),$$

which simplifies to

$$\operatorname{plim} \hat{\beta}_{IV} = -\beta^D + (\beta^D + \beta^S) \left[\frac{\sigma_D^2}{\sigma_D^2 + \left(\frac{\alpha^S}{\alpha^D} \right) \sigma_S^2} \right]. \tag{B-2}$$

From equation (B-2), it is clear that Z_i is a strictly valid instrument for the demand curve only if $\alpha^D = 0$; that is, the instrument is uncorrelated with the demand shock, in which case, $\operatorname{plim} \hat{\beta}_{IV} = -\beta^D$. However, even if $\alpha^D \neq 0$, the IV estimator will be less biased towards zero than the OLS estimator provided that

$$\frac{\sigma_D^2}{\sigma_D^2 + \left(\frac{\alpha^S}{\alpha^D} \right) \sigma_S^2} < \frac{\sigma_D^2}{\sigma_D^2 + \sigma_S^2} \Leftrightarrow \alpha^S > \alpha^D.$$

In other words, if the instrument Z_i depends more strongly on supply shocks than demand shocks, then the IV estimate of the slope of the demand curve will be less biased towards zero—that is, more negative—than the OLS estimate.