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William F. Bassett, Mary Beth Chosak, John C. Driscoll, and Egon Zakrajsek

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

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Abstract

Identifying macroeconomic effects of credit shocks is difficult because many of the same factors that influence the supply of loans also affect the demand for credit. Using bank-level responses to the Federal Reserve's Loan Officer Opinion Survey, we construct a new credit supply indicator: changes in lending standards, adjusted for the macroeconomic and bank-specific factors that also affect loan demand. Tightening shocks to this credit supply indicator lead to a substantial decline in output and the capacity of businesses and households to borrow from banks, as well as to a widening of credit spreads and an easing of monetary policy.

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Keywords: credit supply disruptions; bank lending policies; credit crunch

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*Division of Monetary Affairs, Federal Reserve Board. E-mail: william.f.bassett@frb.gov

†4987 Preakness Place, Bethlehem, PA, 18020, USA. (This paper was written when Mary Beth Chosak was working at the Federal Reserve Board.)

‡Division of Monetary Affairs, Federal Reserve Board. E-mail: john.c.driscoll@frb.gov

§Division of Monetary Affairs, Federal Reserve Board. E-mail: egon.zakrajsek@frb.gov

1 Introduction

The main difficulty confronting any empirical investigation into the roles that banks play in business cycle fluctuations involves identification of credit supply shocks.[1] Most economic disturbances that affect the supply of credit 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 may also affect spending and production through its influence on expectations and interest rates.[2]

To better identify credit supply shocks, this paper develops a new indicator of changes in the supply of bank-intermediated credit: a change in bank lending standards that is not contaminated by the bank-specific and macroeconomic factors that can simultaneously affect the demand for credit.[3] This new measure of changes in the supply of bank-intermediated credit is constructed from the bottom up, using *bank-level* responses on changes in lending standards for businesses and households as reported on the Federal Reserve Board's Senior Loan Officer Opinion Survey on Bank Lending Practices (SLOOS). This is the first paper that uses bank-level responses to study the role of credit supply factors in U.S. economic fluctuations; previous research that employs SLOOS survey data on changes in bank lending standards used aggregated responses.[4]

Specifically, an econometric model is used to adjust the reported changes in lending standards by removing the portions associated with changes in the economic outlook, risk tolerance, and other factors that can simultaneously affect loan demand. Empirical analysis at both the macro and micro levels strongly indicates that the reported changes in bank lending standards that are "purged" of the demand-related factors provide a more accurate measure of movements in the supply of bank loans available to potential borrowers. Such shifts in the effective supply of credit could

[1]The notion that the commercial banking sector—or a financial system more generally—may serve as a propagation mechanism for, or a source of, economic shocks has a long and venerable tradition in macroeconomics; see Bernanke [1993] for a review of the historical literature, More recently, 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 Brunnermeier and Sannikov [2011] and He and Krishnamurthy [2013]).

[2]Although much of the literature on this so-called bank lending channel has documented substantial effects of monetary-policy-induced changes in bank loans on real activity, some researchers have found much smaller effects; see, for example, King [1986], 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], Driscoll [2004], Ashcraft [2005], and Gilchrist and Zakrajšek [2012a].

[3]The adjusted measure of changes in bank lending standards can be downloaded from `http://www.federalreserve.gov/pubs/feds2012/201224/201224abs.html`.

[4]See, for example, Schreft and Owens [1991], Lown, Morgan, and Rohatgi [2000], and Lown and Morgan [2002, 2006]. A closely related research effort using the Bank Lending Survey conducted by the European Central Bank includes the work of De Bondt, Maddaloni, Peydró, and Scopel [2010], Ciccarelli, Maddaloni, and Peydró [2010], Cappiello, Kadareja, Kok Sørensen, and Protopapa [2010], and Maddaloni and Peydró [2013]. The use of bank-level responses, however, is gaining traction. In a recent paper, Del Giovane, Eramo, and Nobili [2011] use a subset of bank-level responses of the ECB's Bank Lending Survey—the subset containing the responses of Italian banks—to quantify the importance of supply and demand factors behind the contraction in business lending during the recent financial crisis.

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 Bassett and Zakrajšek [2003]).

To evaluate systematically the macroeconomic effects of shocks to the supply of bank-intermediated credit, we include the adjusted changes in lending standards in a standard monetary vector autoregression (VAR). This analysis shows that credit supply disturbances have economically large and statistically significant effects on output and core lending capacity of U.S. commercial banks.[5] Specifically, an adverse credit 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 falls more than 4 percent over the same period. Such disruptions in the credit-intermediation process also lead to a substantial rise in corporate bond credit spreads and elicit a significant easing of monetary policy, macroeconomic dynamics typically associated with financial crises.

To test whether this approach indeed generates a more accurate measure of shifts in the supply of loans, we use the bank-level version of an analogous series as an instrument in a regression of loan quantities on loan prices (i.e., loan-rate spreads). If the adjusted changes in bank lending standards are a cleaner indicator of movements in credit supply, then using them in this way should help to trace out the slope of the loan demand curve. A variant of the benchmark econometric model can be used to adjust the reported changes in standards on commercial and industrial (C&I) loans for the macroeconomic and bank-specific factors that can also influence the demand for such loans. These bank-level shifters in the supply of C&I loans are then matched with data from the Federal Reserve's Survey of Terms of Business Lending (STBL), a source of detailed contract information on individual C&I loan originations.

The results indicate that while a simple OLS regression of (log) loan amounts on the corresponding interest rate spreads results in an estimate of the semi-elasticity of loan demand of about -0.5, an IV regression—using the bank-specific adjusted changes in C&I lending standards as instruments for loan-level interest rate spreads—yields an estimate of the semi-elasticity between -1.1 and -1.7, depending on the functional form. The large decrease in the estimated coefficient is consistent with the interpretation that the adjusted changes in banks' lending standards capture shifts in C&I loan supply. All told, the combination of VAR results with those based on loan-level data provides compelling evidence that the adjusted changes in overall lending standards provide a purer measure of movements in the effective supply of bank-intermediated credit.

[5] Core loans are the sum of commercial and industrial 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. The 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, Gilchrist, Weinbach, and Zakrajšek [2011] for discussion and details.

2 Data Sources and Methods

Estimating shifts in the effective supply of bank loans to businesses and households requires combining survey information on the reported changes in bank lending standards with other bank-specific and macroeconomic variables that might affect—either explicitly or implicitly—loan demand. The choice of control variables, described below, was guided in part by the reasons banks report on the survey, as well as by both theoretical models and empirical research on the cyclical behavior of lending standards.

The SLOOS itself is valuable source of information of why banks change their lending standards. In particular, a portion of the SLOOS devoted to questions on C&I lending queries banks to rate the relative importance of several reasons that may have led them to change their lending policies on such loans. The possible reasons include macroeconomic factors, such as a less favorable or more uncertain economic outlook; bank-specific factors, such as changes in tolerance for risk and a deterioration in the bank's current or expected capital position; or borrower-specific factors, such as an increase in industry-specific problems.

In general, changes in the economic outlook and shifts in risk tolerance—cyclical factors that likely have an independent effect on loan demand—are the most commonly cited reasons for changes in bank lending standards and terms on C&I loans (see Figure A-2 in the Appendix A).[6] In addition, banks that ease lending policies very often point to increased competition from other lenders as the reason for doing so. Before the 2007–09 crisis, changes in banks' capital position—a factor one would expect to influence the supply of credit—were almost never given as an important reason for changes in credit policies, a pattern consistent with the generally robust capital position of the commercial banking sector over the past two decades.[7]

More broadly, these survey responses are consistent with the work of Rajan [1994] and Ruckes [2004], whose theoretical models imply that banks soften their lending standards in response to competitive pressures in order to grow their loan books during economic expansions. On the empirical side, Berger and Udell [2004] show that banks tend to tighten credit policies in response to rising loan loss reserves and associated reductions in profitability. Lastly, a related literature has emphasized the relationship between banks' access to stable funding sources, such as core deposits, and their willingness to extend loan commitments (see Kashyap, Rajan, and Stein [2002], Pennacchi [2006], and Gatev and Strahan [2006]).

[6] These responses are consistent with the econometric evidence of Asea and Blomberg [1998], who use a detailed data set of C&I loan contracts to document that terms on business loans vary systematically over the business cycle, with looser credit policies occurring during economic expansions and vice versa.

[7] One might be concerned that banks have strategic reasons for answering the survey—to reassure regulators on the stringency of their standards or to induce a particular monetary policy response. Although this possibility cannot be ruled out a priori, Bassett and Covas [2013] find little evidence that the response to the capital question is biased. To further disincentivize any strategic behavior, respondents are aware that the individual responses are afforded confidential treatment and are not available to Federal Reserve System staff that directly supervise and regulate commercial banks.

2.1 Senior Loan Officer Opinion Survey

The key source of data used in the analysis comes from the Federal Reserve's Senior Loan Officer Opinion Survey of Bank Lending Practices. This survey has queried banks about changes in their lending standards for the major categories of loans to households and businesses beginning with the April 1990 survey and about changes in demand for most of those types of loans starting with the October 1991 survey. The SLOOS is usually conducted four times per year by the Federal Reserve Board, and up to 80 U.S. commercial banks participate in each survey.[8]

Participating banks are asked to report whether they have changed their standards during the survey period 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 answer both questions using a qualitative scale ranging from 1 to 5. In the case of lending policies, the possible answers are 1 = eased considerably; 2 = eased somewhat; 3 = about unchanged; 4 = tightened somewhat; and 5 = tightened considerably. To characterize changes in loan demand, the possible answers include: 1 = increased considerably; 2 = increased somewhat; 3 = about unchanged; 4 = decreased somewhat; and 5 = decreased considerably. Historically, however, SLOOS respondents have very rarely characterized their reported changes in standards or demand as having changed "considerably." Accordingly, the original responses are used to create categorical variables $I^S_{it}[k]$ and $I^D_{it}[k]$, defined as

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

and

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

[8] See Appendix A for detailed information about the SLOOS.

The extent to which changes in a given bank's lending standards or demand conditions affect lending volumes will depend on how active that bank is in a particular lending category. To capture this activity, banks' responses to the questions about each lending category are matched with data from the Reports of Condition and Income (Call Reports) on the amount of outstanding loans the respondent bank has in that category. This information is used to construct a composite index of changes in overall lending standards and overall loan demand for each bank in the survey. Specifically, the two indexes are calculated as the following weighted averages:

$$\Delta S_{it} = \sum_k \omega_{i,t-1}[k] \times I^S_{it}[k] \quad \text{and} \quad \Delta D_{it} = \sum_k \omega_{i,t-1}[k] \times I^D_{it}[k], \tag{1}$$

where $\omega_{i,t-1}[k]$ is 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 at the end of quarter $t-1$.[9]

The two composite indexes of changes in lending standards and loan demand in equation (1) are diffusion indexes (DIs) that take 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. The bank-specific DIs can be aggregated across banks according to:

$$\Delta S_t = \sum_i w_{i,t-1} \times \Delta S_{it} \quad \text{and} \quad \Delta D_t = \sum_i w_{i,t-1} \times \Delta D_{it}, \tag{2}$$

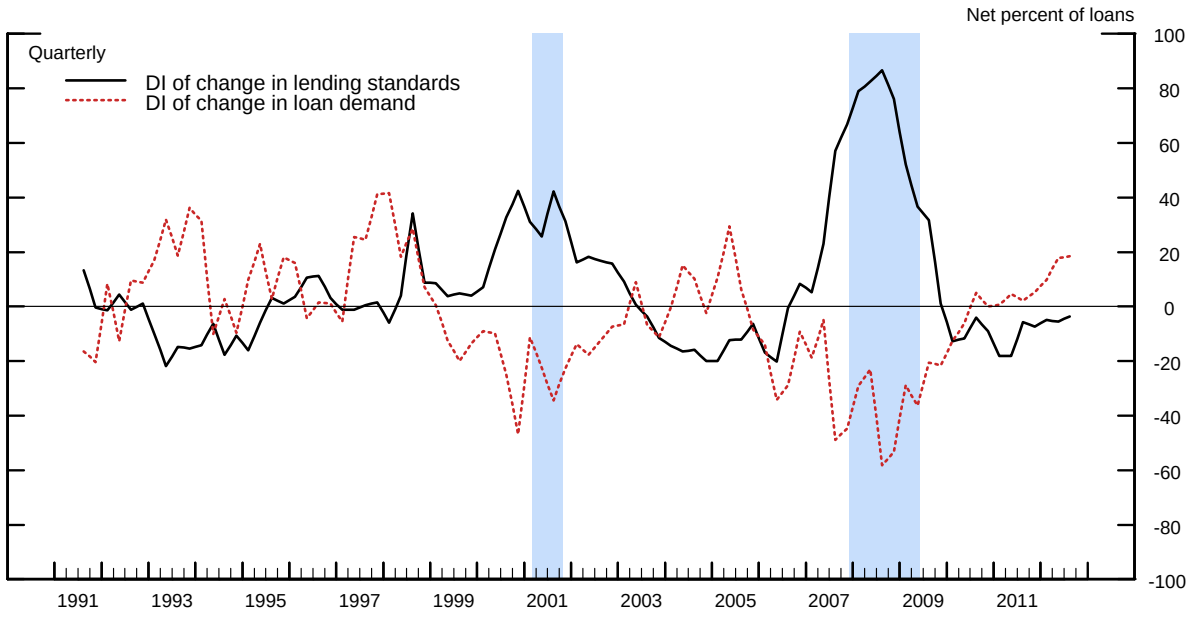
where $w_{i,t-1}$ is the fraction of total core loans on SLOOS respondents' balance sheets that are held by bank i at the end of quarter $t-1$. Constructed in this way, the two aggregate DIs account for the heterogeneity of loan portfolios at the level of an individual bank, as well as for each bank's relative share of outstanding loans.

Figure 1 shows the aggregate DIs (expressed in percent), indicating changes in overall lending standards and loan demand over the past two decades.[10] Note that the cyclical pattern of both series 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 in overall credit conditions also occurred during periods surrounding the 2001 and 2007–

[9] For multi-bank holding companies, outstanding loans across all banks within the same holding company are summed. The values for the entire holding company are not appropriate 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.

[10] Although completely arbitrary, positive values of the two DIs indicate a net tightening/increase in standards/demand, while negative values indicate a net easing/decrease in standards/demand, directions that are consistent with the SLOOS.

Figure 1: Changes in Bank Lending Standards and Loan Demand



NOTE: Sample period: 1991:Q3–2012:Q3. The solid line depicts the DI of the change in overall bank lending standards; the dotted line depicts the DI 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 the NBER-dated recessions.

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-dated recessions during the sample period are characterized by a substantial weakening in loan demand. In fact, the strong negative comovement between the two series suggests that changes in credit availability and loan demand over the course of a business cycle are driven to a significant extent by common shocks.

Over the 1991:Q3–2012:Q3 period, almost 150 different banks participated in the survey. However, in conjunction with the bank-level survey responses, the analysis also employs market data on banks' equity valuations. Accordingly, the sample excludes institutions that were not part of a publicly-traded bank holding company (BHC); in addition, respondents that participated in the survey for less than 20 quarters were excluded. Applying those selection criteria to the respondent panel yielded a sample of 68 banks. Though only about half of the original SLOOS respondent panel, those banks still accounted, on average, for about 55 percent of industry-wide assets over the sample period. Moreover, the growth of total core loans for the sample of 68 banks closely matches the growth rate of core loans for the entire U.S. commercial banking sector (see Figure A-3 in Appendix A). Combined, these results indicate that the sample of banks accurately 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

The Call Reports are used to construct measures of bank profitability, asset quality, and balance sheet composition, factors that may exert an independent influence on the propensity of banks to change their credit policies.[11] Specifically, the change in the bank's net interest margin is used as an indicator of the return on 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 periods of financial turmoil.[12] The ratio of core loans to total assets is used 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.

To control for the influence of financial market conditions on the propensity of banks to change their credit policies, we use the Center for Research in Securities Prices (CRSP) database to calculate quarterly stock returns for the parent BHCs. High equity returns, which represent prospects for growth and ease with which the bank could raise additional capital to support new lending, ought 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 (Keeley [1990]).[13] 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. (Table A-1 in Appendix A contains summary statistics of the bank-specific variables used in the analysis.)

[11] 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 statements, see the appendix in English and Nelson [1998] for details.

[12] The enhanced resiliency to funding shocks by banks that rely heavily on core deposits to fund their interest-earning assets reflects the considerable pricing power individual banks appear to enjoy in the market for this highly homogeneous financial product (see Driscoll and Judson [2013] and Yankov [2013]).

[13] 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.

2.3 Macroeconomic factors affecting changes in lending standards

Most SLOOS respondents 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 important reasons for the change in their credit policies. At the same time, however, these factors are very likely to affect loan demand as well. The economic outlook in any given quarter t is summarized by the following four indicators from the Survey of Professional Forecasters (SPF): (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 factors 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.[14]

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 [2012b]. 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 (Bloom [2009]). Accordingly, the quarterly change in the VIX index is included among the set of macroeconomic factors that could be driving changes in banks' credit policies.

3 An Econometric Model of Changes in Bank Lending Standards

When assessing the supply-side implications of changes in bank lending policies, it is important to keep in mind that the changes in bank 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 lending standards have relied on VAR-based identification strategies to try to identify the component of the change in standards that is orthogonal to the determinants of loan demand (see Lown and Morgan [2002, 2006], Ciccarelli, Maddaloni, and Peydró [2010], and Cappiello, Kadareja, Kok Sørensen, and Protopapa [2010]).

Compared with the VAR-based identification schemes, the alternative strategy of adjusting the bank-level responses to questions about changes in lending standards has the advantage of directly accounting for three important sources of endogeneity. First, the bank-specific responses about changes in loan demand can be used to partial out changes in standards that are related to the reported changes in loan demand at the same bank. Second, the set of control variables includes

[14]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.

bank-specific income, balance-sheet, and market indicators that not only might affect changes in standards but also may respond to other economic shocks that in turn affect loan demand and real activity and are thus at least partly endogenous.[15] Third, survey information, as opposed to VAR-based expectations, on the economic outlook is used 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:

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

where ΔS_{it} is the DI of the change in lending standards at bank i in quarter t; ΔD_{it} is the corresponding bank-specific DI 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, macroeconomic uncertainty, and changes in the current state of the economy; and $\mathbf{Z}_{it}$ is a vector of bank-specific controls.

According to Figure 1, changes in lending standards also tend to be quite persistent over the cycle—once a bank has started to ease or tighten its credit policies, it will likely continue to adjust them in the same direction for some time. To capture this cyclical momentum in the setting of credit policies, the regression (3) includes the lag of the dependent variable among the explanatory variables. The inclusion of bank fixed effects ($\eta_i,\ i = 1, \ldots, N$), in contrast, captures any unobservable (time-invariant) bank-specific factors that could influence the manner in which the SLOOS respondents report changes in their credit policies over time.[16]

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. 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

[15] At least some of these bank-specific variables also move in part for purely exogenous reasons. Thus, partialing out their effects on changes in lending standards may remove some exogenous changes in standards. Hence, the resulting indicator of changes in the supply of bank loans may understate the degree of exogenous shifts in banks' credit policies.

[16] For example, the time-series mean of the diffusion index of the change in overall lending standards (Figure 1) is positive, suggesting a gradual increase in the stringency of credit policies over the sample period. It is possible that this reflects a bias towards reporting a tightening by at least some survey respondents, who may not wish to appear lax in their lending practices. To the extent there is a consistent bias at some respondents, bank fixed effects should pick it up. Fixed effects could also capture the importance of stable banking relationships—such as opportunities to cross-sell products—which are unobservable to the econometrician and which would be adversely affected if a bank significantly changed its lending policies from quarter to quarter (see Santikian [2013]).

VIX (ΔVIX_t), on the other hand, capture changes in the risk attitudes of the financial intermediary sector and fluctuations in macroeconomic uncertainty.

The bank-specific factors ($\mathbf{Z}_{i,t-1}$) 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.[17] Given the relatively long time-series dimension of our panel—an average bank is in the panel for 47 quarters—equation (3) is estimated by OLS. The results of this exercise for three variants of equation (3) are shown in Table 1.

The first specification includes only the lagged change in lending standards and the bank-specific DI 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 persistence in the changes in lending standards is likely due to the banks' reluctance to make abrupt, large changes in their credit policies, which could damage customer relationships or that would need to be reversed quickly if the changes in the economic outlook proved to be temporary; the degree to which these factors are important likely varies across the business cycle and across banks and so would not be captured fully by bank fixed effects or other control variables. According to these estimates, an increase of one standard deviation in the fraction of loans on which banks tightened standards—about 32 percent—leads to an increase of 17 percentage points 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—a one standard deviation increase in the fraction of loans for which greater demand is reported (45 percent) is associated with a decrease in the fraction of loans subject to tightening of about 5 percentage points.

The second specification includes a full set of macroeconomic and financial indicators. The addition of these variables reduces the magnitude of the coefficients on lagged changes in standards and on the DI 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, worsening of both current and expected labor market conditions is associated with a shift to a materially more stringent bank lending posture. An expected rise in the unemployment rate of one percentage point over the subsequent year leads to an immediate increase of about

[17]The 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.

Table 1: Factors Affecting Changes in Banks' Overall Lending Standards

Explanatory Variable	*Est.*	*S.E.*	*Est.*	*S.E.*	*Est.*	*S.E.*
Lagged change in standards: $\Delta S_{i,t-1}$	0.540	0.021	0.385	0.023	0.360	0.023
Change in DI of loan demand: ΔD_{it}	-0.105	0.015	-0.079	0.013	-0.071	0.014
Economic outlook: $E_{t-1}[y_{t+4} - y_t]$	-	-	-0.212	1.269	-0.554	1.471
Economic outlook: $E_{t-1}[u_{t+4} - u_t]$	-	-	14.37	2.101	5.485	3.336
Economic outlook: $E_{t-1}[r^{3m}_{t+4} - r^{3m}_t]$	-	-	-2.497	1.358	-2.691	1.429
Economic outlook: $E_{t-1}[r^{10y}_{t+4} - r^{10y}_t]$	-	-	-0.690	2.487	-6.319	3.077
Change in real GDP: $[y_t - y_{t-4}]$	-	-	-0.166	0.395	-0.695	0.543
Change in unemployment: $[u_t - u_{t-4}]$	-	-	2.481	0.630	2.421	0.638
Change in real FF rate: Δrff_t	-	-	-8.378	1.162	-9.126	1.166
Change in EBP: ΔEBP_t	-	-	10.84	1.604	10.66	1.681
Change in VIX: ΔVIX_t	-	-	0.192	0.116	0.321	0.110
Change in NIMs: $\Delta NIM_{i,t-1}$	-	-	-	-	-1.066	1.317
Change in LLPs: $\Delta LLP_{i,t-1}$	-	-	-	-	1.805	0.936
Share of core loans: $CoreLns_{i,t-1}$	-	-	-	-	0.303	0.133
Share of core deposits: $CoreDep_{i,t-1}$	-	-	-	-	-0.262	0.078
Bank size: $\ln A_{i,t-1}$	-	-	-	-	0.030	0.012
Tobin's Q: $Q_{i,t-1}$	-	-	-	-	0.126	0.109
Stock returns: $R_{i,t-1}$	-	-	-	-	-0.056	0.008
$\Pr > W_1$[a]	-		0.000		0.000	
$\Pr > W_2$[b]	-		-		0.000	
$\Pr > W_3$[c]	0.000		0.000		0.000	
R^2 (within)	0.352		0.419		0.437	

NOTE: Sample period: 1991:Q3–2012:Q3; Obs. = 3,204; No. of banks = 68. Dependent variable in each specification is ΔS_{it}, the DI of change in overall lending standards at bank i in quarter t. Entries under the column headings "*Est.*" denote OLS estimates of the parameters associated with the specified explanatory variables (see text for definitions). 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 exclusion test of common macroeconomic and financial explanatory variables.

[b] p-value for the exclusion test of bank-specific explanatory variables.

[c] p-value for the exclusion test of bank fixed effects.

14 percentage points in the DI 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 policies. 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 about 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 softening 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.[18] Consistent with the banks' responses to the survey, an increase in the EBP—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 EBP leads to an immediate increase of about 11 percentage points in the proportion of loans subject to more stringent standards. In contrast, movements in the VIX—a proxy for changes in economic uncertainty—have an economically negligible effect on the changes in bank lending standards.

Parameter estimates and the associated standard errors of the 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 the changes in lending standards. For example, a jump of one percentage point in the rate of loan loss provisioning leads to an increase in the DI of changes in bank lending standards of almost 2 percentage points in the subsequent quarter.[19] The negative coefficient on the core deposit ratio indicates that banks that rely heavily on such deposits to fund lending activities are less likely to tighten lending standards. Though the size of this effect is small in economic terms, this negative relationship comports with the hypothesis that a stable source of funding allows banks to adjust credit policies more gradually in response to an adverse shock. Note that having experienced higher stock returns in the past quarter is also associated with easier subsequent lending policies, a move that likely reflects a more robust capital base from which to lend.

Most importantly, 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 factors 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 (see Estrella and Mishkin [1998]). At same time, the economic impact of expected changes in the unemployment rate has been appreciably diminished.

This final specification is used to purge the reported changes in bank lending standards of the key macroeconomic and bank-specific factors that may also affect loan demand. Specifically, the

[18]The negative coefficient on the changes in real funds rate contrasts with the results of Maddaloni and Peydró [2013], who present evidence—based on the euro-area Bank Lending Standards Survey—that low policy rates may induce banks to make riskier loans by adopting softer lending standards.

[19]Loan-loss provisioning is likely one factor that in addition to capturing the expected changes in asset quality—which are likely correlated with changes in loan demand—may also purge an exogenous supply-side influence, such as differences in the stringency of supervision between federal and state bank regulators; see Agarwal, Lucca, Seru, and Trebbi [2012] for detailed analysis.

new measure of changes in the supply conditions of bank-intermediated credit—denoted by ΔS_t^a—is given by the standardized sequence of cross-sectional (weighted) averages of the OLS residuals $\hat{\epsilon}_{it}$:

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

where N_t denotes the number of banks that are in our sample in quarter t, and $w_{i,t-1}$ is the ratio of core loans at bank i to total core loans held by banks in the sample at the end of the previous quarter.[20]

The adjusted series ΔS_t^a 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 unadjusted DI of changes in lending standards, the adjusted series should provide a cleaner indicator of shifts in the effective supply of bank loans to businesses and households.[21] Given the large number of bank-specific and macroeconomic conditioning variables and the fact that the adjusted changes in lending standards reflect simultaneous decisions of many banks, fluctuations in the new 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 responses to changes in the structure or intensity of bank supervision and regulation (see Bassett, Lee, and Spiller [2012]).

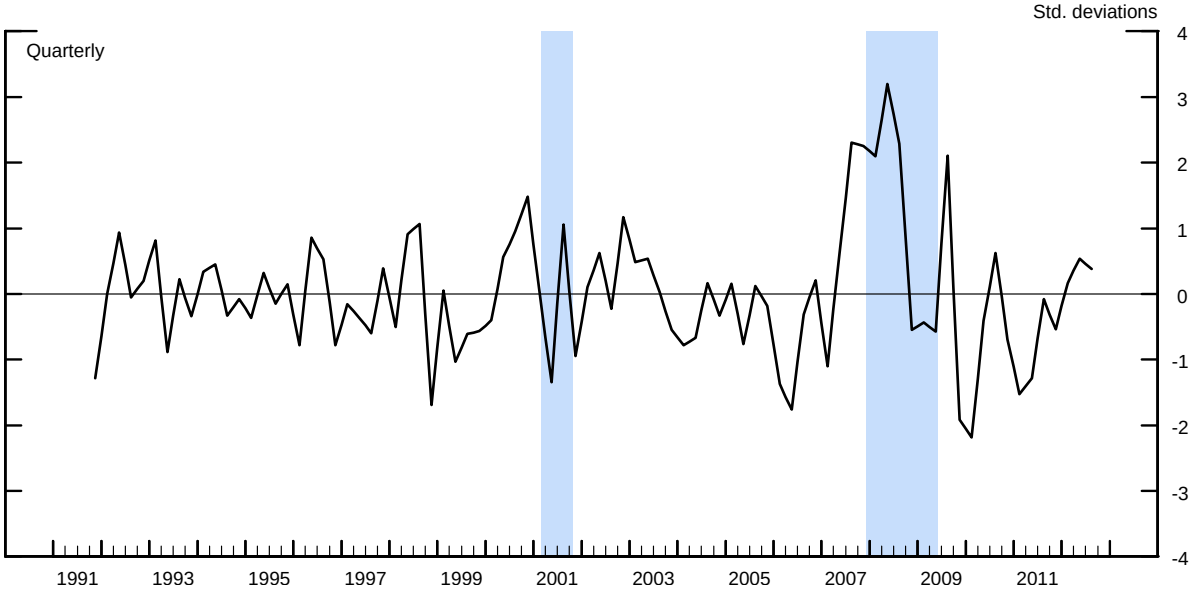
Figure 2 summarizes the various SLOOS-based credit supply indicators. The top panel shows the adjusted change in overall lending standards, whereas the bottom panel shows the unadjusted DI of changes in overall lending standards, along with the net percentage of banks that reported tightening standards on C&I loans, the SLOOS-based credit supply indicator most commonly used by previous researchers. Reflecting the importance of common factors behind changes in the banks' credit policies, the two unadjusted measures in the bottom panel have the most in common, tracking each other closely over the sample period. There is, however, one especially noticeable difference: In the latter half of 2006, the DI of the change in overall standards started to increase sharply, rising sooner and faster than the measure based solely on the changes in C&I credit policies. This difference underscores the usefulness of our broader measure because it includes lending to households—especially through loans secured by residential real estate—a large category that experienced a marked deteriorations in credit quality well before the official start of the recession in December 2007.

In general, the adjusted changes in overall lending standards exhibit many of the same cyclical patterns as the two unadjusted measures—in fact, the correlation between the adjusted series and

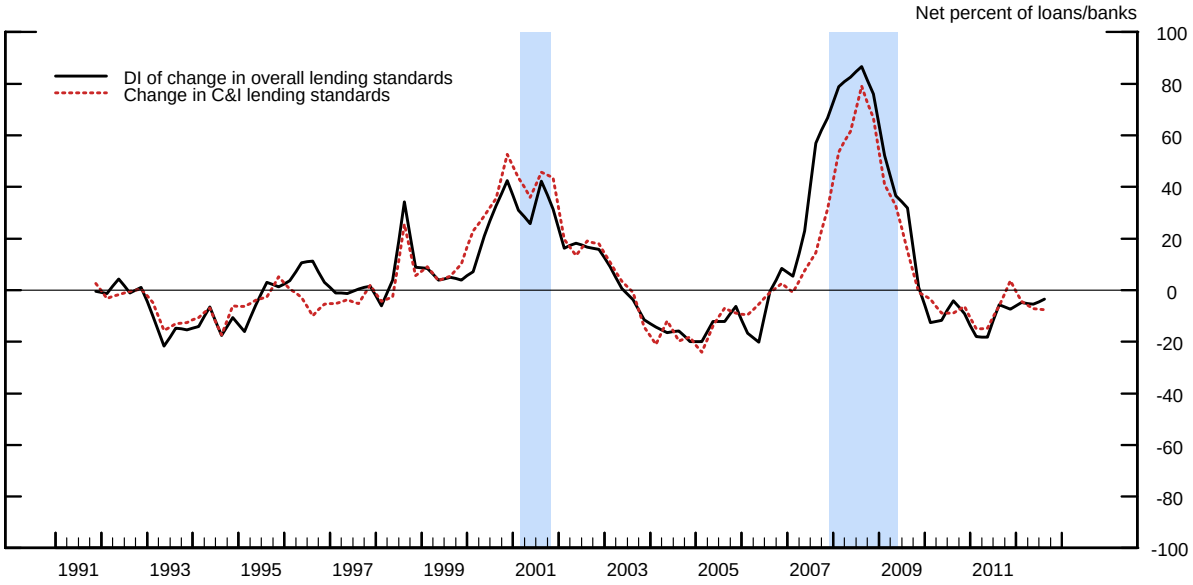
[20]The series is standardized for the ease of interpretation. As a robustness check, we have also computed an unweighted estimate of shifts in the effective supply of bank loans, and the unweighted series closely resembles the weighted one. All the results in the paper are robust to using the unweighted estimate.

[21]In keeping with the directionality of the DI of the change in overall lending standards ΔS_t in Figure 1, *positive* values of ΔS_t^a should indicate a *decrease* in loan supply and vice versa.

Figure 2: Indicators of Changes in the Supply of Bank Loans



(a) Adjusted changes in lending standards



(b) Unadjusted changes in lending standards

NOTE: Sample period: 1991:Q4–2012:Q3. The figure depicts the various SLOOS-based indicators of changes in the supply of bank loans. The solid line in the top panel depicts the adjusted change in overall lending standards, our new indicator of shifts in the effective supply of bank-intermediated credit (the series has been standardized). The solid line in the bottom panel depicts the unadjusted DI of the change in overall bank lending standards (measured as a net percent of loans), while the dotted line depicts the net percentage of banks that reported tightening standards on C&I loans, the most commonly used SLOOS-based indicator. The shaded vertical bars denote the NBER-dated recessions.

the unadjusted DI is 0.60 and 0.45 for the standard C&I measure. Nevertheless, there are a number of important differences. Although lending standards tightened noticeably in the second half of 2000—several quarters before the 2001 recession officially began—changes in lending standards during the subsequent downturn appear to be, on average, about in line with those predicted by the model. In contrast, the DI of changes in overall bank lending standards and the net percentage of banks that tightened C&I lending standards both indicate a cumulative tightening of credit conditions that lasted well past the official end of the recession in November 2001. A 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 high-profile accounting scandals that significantly undermined investor confidence during that period.

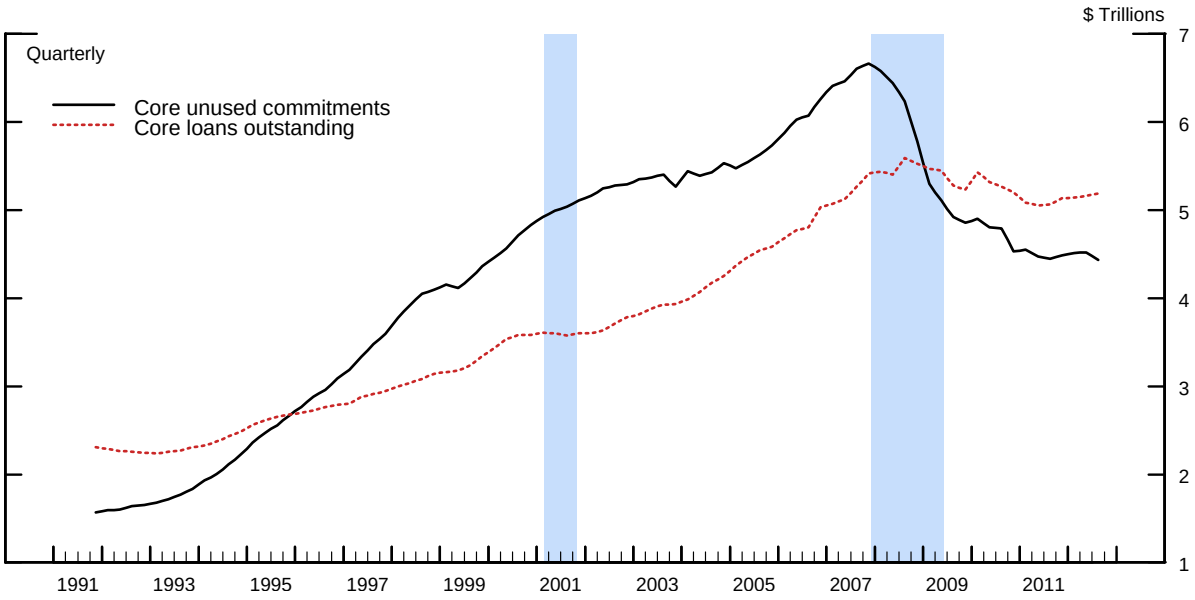
The two unadjusted measures also point to a marked and persistent softening of standards beginning in late 2003. The adjusted measure, in contrast, indicates that this apparent easing of credit conditions was about in line with the macroeconomic and bank-specific factors included in the model until early 2006, definitely a period of easy credit. All series, however, point to a substantial tightening of credit conditions beginning in early 2007. The adjusted estimates also indicate that the massive reported tightening of credit conditions at the apex of the financial crisis at the end of 2008 largely represented the endogenous adjustment in credit policies in response to the severe deterioration in macroeconomic conditions and an extraordinarily heightened level of risk aversion in broader financial markets. In contrast, the two unadjusted measures do not net out these important factors, which, in addition to driving changes in banks' lending standards, also had a significant effect on credit demand.

4 Macroeconomic Implications

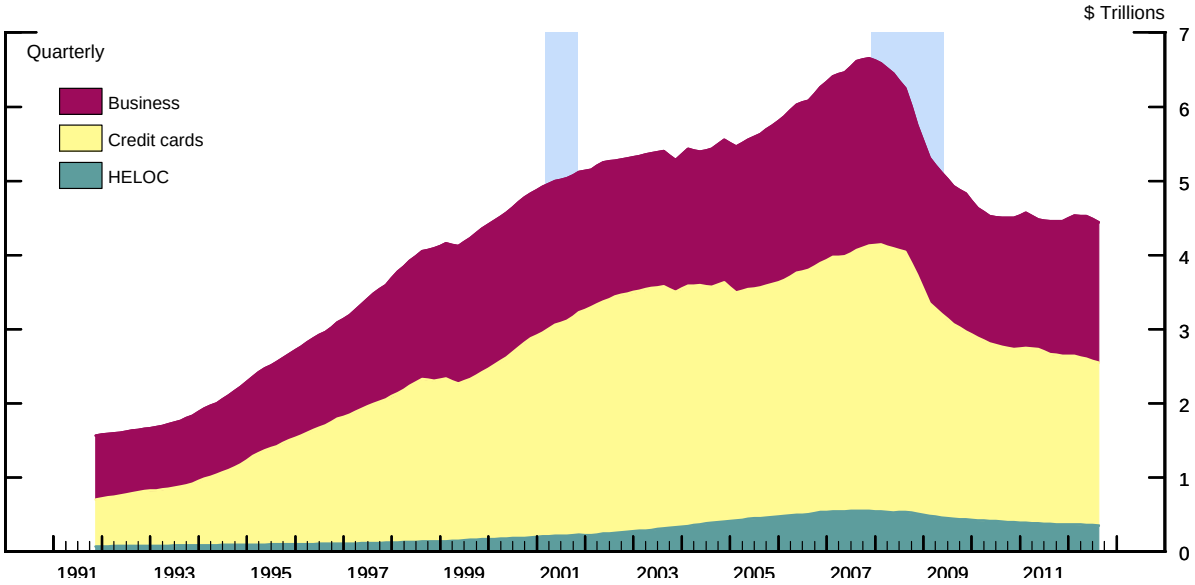
This section examines the macroeconomic implications of credit supply disruptions by including the adjusted changes in bank lending standards into a fairly standard monetary VAR framework. In addition to this indicator of shifts in the effective supply of bank loans, which is ordered first, the benchmark VAR includes the following five endogenous variables: (1) log-difference of real GDP; (2) log-difference of banks' core lending capacity—the sum of core loans outstanding and the corresponding unused commitments; (3) inflation, as measured by the log-difference of the GDP deflator; (4) the "GZ credit spread," a corporate bond credit spread index with high information content for future economic activity constructed by Gilchrist and Zakrajšek [2012b]; 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

Figure 3: 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: 1991:Q4–2012: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). The shaded vertical bars denote the NBER-dated recessions.

existing lines of credit.[22] In addition, banks curtail their credit exposures in the initial phases of an economic downturn primarily by reducing the amount of unused commitments.[23] Figure 3 illustrates the banking sector's unique role in the provision of credit in the form of credit lines. Banks' off-balance-sheet credit exposures have expanded rapidly over time, 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. Moreover, credit card commitments accounted for the majority of this off-balance-sheet exposure, followed closely by business credit lines.[24]

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 interbank funding markets, and an emerging slowdown in economic activity. Given the importance of banks' commitments to fund business and consumer loans, the VAR specification includes the growth in core lending capacity (i.e., core loans plus commitments to fund such loans), 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 benchmark VAR implies that credit supply shocks can have an immediate impact—that is, within a quarter—on output growth, inflation, and the growth of core lending capacity; such innovations 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.[25] This economically appealing identification scheme is made possible by the fact that the indicator of shifts in the effective supply of bank loans has already been purged—at the bank level—of the key macroeconomic and bank-specific factors that can also influence the demand for credit.

To provide a context for our results vis-à-vis the previous literature, we consider two alternative VAR specifications. In Alternative I, the adjusted change in lending standards is replaced with its unadjusted counterpart; Alternative II—which most closely follows the previous literature—uses the net percentage of banks that tightened standards on C&I loans as the summary indicator of

[22] As shown by Gilchrist and Zakrajšek [2012a], 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 provide liquidity insurance for businesses, started to contract immediately with the onset of the crisis in mid-2007. In contrast, loans outstanding on banks' balance sheet expanded briskly during the first year of the recession.

[23] This hypothesis is 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.

[24] 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.

[25] The predictive content of corporate bond credit spreads for future economic activity has been analyzed by Gilchrist, Yankov, and Zakrajšek [2009], Gilchrist and Zakrajšek [2012b], and Faust, Gilchrist, Wright, and Zakrajšek [2012].

changes in the supply of bank-intermediated credit. Both of these alternatives follow the standard practice (see Lown and Morgan [2006]) and identify exogenous credit supply shocks by ordering the SLOOS-based supply indicators last among the endogenous variables. This recursive identification scheme implies that credit supply shocks are orthogonal to the contemporaneous (and lagged) values of the remaining endogenous variables in the VAR system, a considerably smaller information set compared with the one used in our first-stage bank-level regression.[26] All specifications are estimated over the 1991:Q4–2012:Q3 period using two lags of the endogenous variables, a lag length indicated by the Akaike information criterion.

Figure 4 traces out 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 innovation in various SLOOS-based credit-supply measures.[27] Adverse credit supply shocks have significant macroeconomic consequences. The capacity of businesses and households to borrow from the banking sector begins 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.

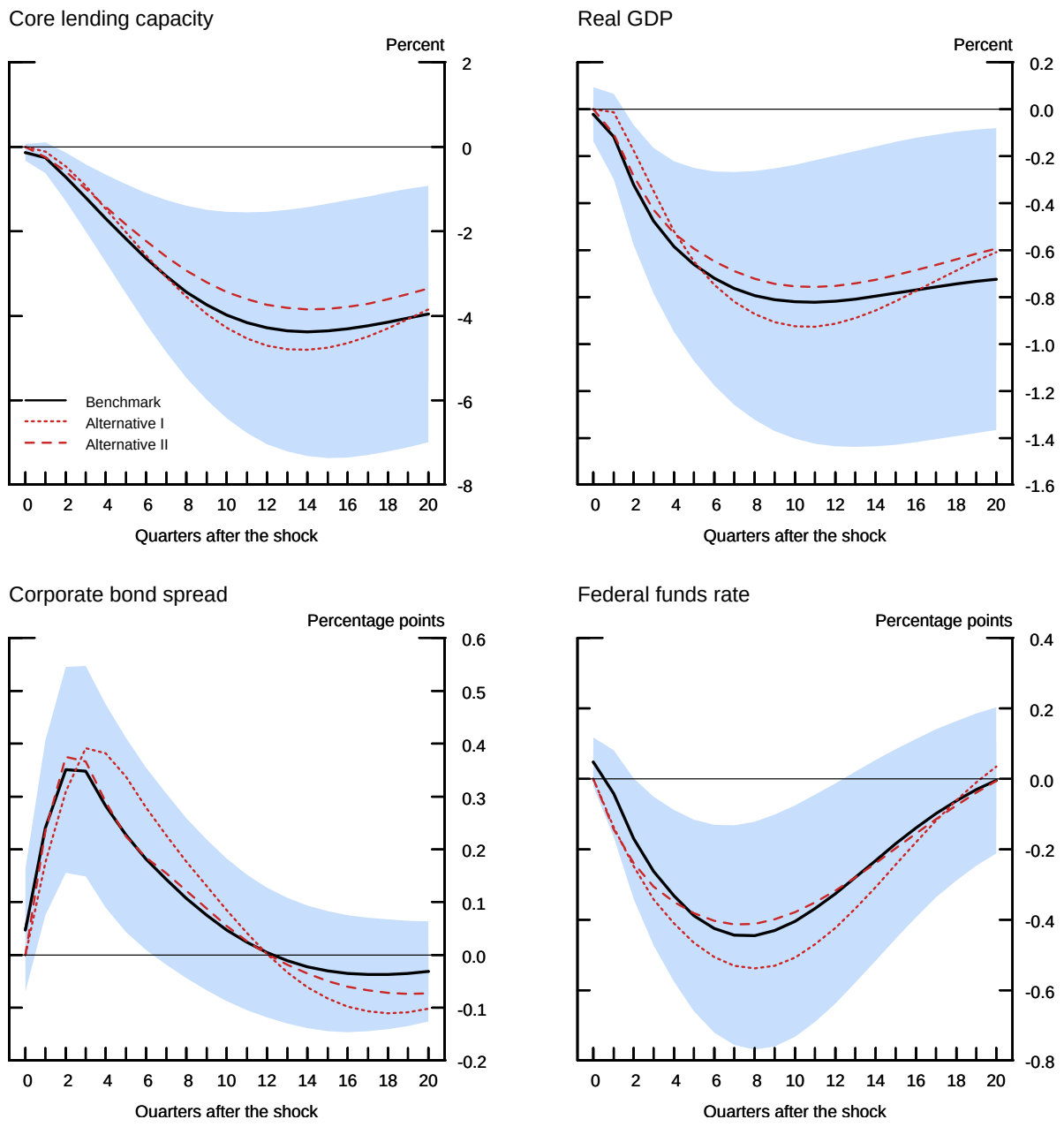
Because a one-time disruption in credit supply leads to permanently tighter credit conditions, it implies a permanent reduction of about 4 percent in the capacity of businesses and households to borrow from the banking sector. The decline in credit intermediation is accompanied by a significant slowdown 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 a significant easing of monetary policy, all trademarks of a classical credit crunch.

The two alternative specifications paint a broadly similar picture. By measuring movements in credit supply using the unadjusted change in overall credit standards (Alternative I), the decline in both bank lending and output in response to an adverse credit shock is somewhat more pronounced compared with the benchmark specification. Although the differences are not statistically significant, this result suggests that the widely used recursive schemes to identify the macroeconomic impact of credit supply shocks using aggregated lending surveys data likely provide an upper bound on the magnitude of such effects. In contrast, when the simple net percentage of banks that tightened credit standards on C&I loans is used as a proxy for changes in credit supply conditions (Alternative II), the impact of credit shocks on lending and economic activity is somewhat attenuated, a result that likely reflects the narrower scope of this indicator.

[26] See Driscoll [2002] for a thorough discussion of various identification issues in the context of identifying shocks to SLOOS-based credit-supply measures.

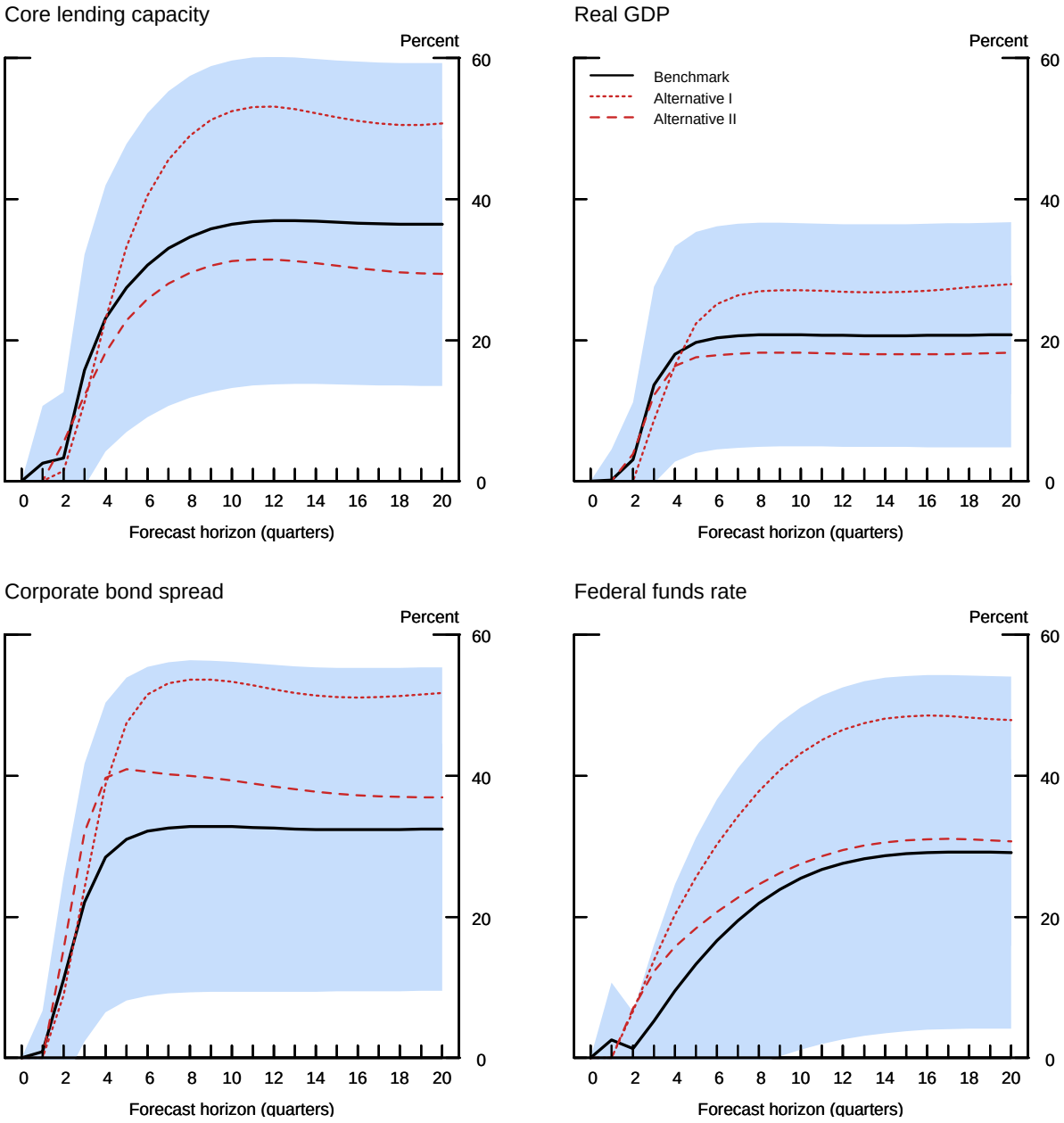
[27] In all three specifications, the effects on output and core lending capacity are accumulated, so that the plotted responses depict the cumulative impact of the adverse credit supply shock on the levels of those variables. The shaded bands in each panel represent the 95-percent confidence intervals, corresponding to the benchmark specification. To conserve on space, we do not show the effect of a credit shock on inflation, which is statistically and economically insignificant in all specifications.

Figure 4: Macroeconomic Implications of an Adverse Credit Supply Shock



NOTE: The panels of the figure depict the impulse response functions of selected macroeconomic variables to an orthogonalized shock of one standard deviation to the various indicators of changes in the supply of bank loans: Benchmark = the adjusted change in overall lending standards; Alternative I = the unadjusted DI of the change in overall bank lending standards; and Alternative II = the net percentage of banks that reported tightening standards on C&I loans. The shaded bands represent the 95-percent confidence intervals—corresponding to the benchmark specification—based on 2,000 bootstrap replications.

Figure 5: Forecast Error Variance Decomposition of a Credit Supply Shock



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 various indicators of changes in the supply of bank loans: Benchmark = the adjusted change in overall lending standards; Alternative I = the unadjusted DI of the change in overall bank lending standards; and Alternative II = the net percentage of banks that reported tightening standards on C&I loans. The shaded bands represent the 95-percent confidence intervals—corresponding to the benchmark specification—based on 2,000 bootstrap replications.

The solid lines in Figure 5 show the amount of variation in the same endogenous variables explained by the orthogonalized shocks to the new indicator of shifts in the effective supply of bank-intermediated credit. Credit supply shocks implied by the benchmark specification account for about 20 percent of the variation in output and almost 40 percent of the variation in core lending capacity at business cycle frequencies. 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.

According to this metric, the economic significance of credit shocks when movements in credit supply are measured using the unadjusted change in overall credit standards (Alternative I) is considerably greater. In this case, such shocks account for about 30 percent and 50 percent of the forecast error variance in output and core lending capacity, respectively, proportions that seem out of line with the recent evidence on the importance of credit shocks for business cycle fluctuations (see Gilchrist, Yankov, and Zakrajšek [2009], Helbling, Huidrom, Kose, and Otrok [2011], and Meeks [2012]); credit supply disturbances implied by this alternative also explain—at business cycle frequencies—more than one-half of the variation in corporate bonds spreads and nearly the same amount of the variation in the federal funds rate. These economically implausible estimates likely reflect the fact that the simple recursive orthogonalization schemes in small-scale VARs are inadequate to fully purge the SLOOS-based credit supply measures of factors associated with credit demand.

Note that when the net percentage of banks that tightened credit standards on C&I loans is used as a proxy for changes in broad credit supply conditions (Alternative II), the economic significance of credit shocks is more comparable to that implied by the benchmark specification. Although the same recursive identification scheme as in Alternative I was used to orthogonalize the VAR innovations in this case, this narrow credit supply measure does not include lending to households or lending to businesses through commercial real estate loans, which suggests that relying on a limited subset of the available survey data likely understates the importance of credit shocks in business cycle fluctuations.

The above results are generally consistent with the previous research, which has found that survey-based qualitative indicators of changes in supply and demand conditions in credit markets contain useful information for macroeconomic outcomes. This paper makes two main contributions. First, it uses all the available bank-level survey data, along with the relevant bank-specific balance sheet data, to construct a more comprehensive indicator of the change in bank lending standards than has been used in previous research. Second, it exploits the cross-sectional aspect of the data to derive a more accurate measure of shifts in the effective supply of bank-intermediated credit, a measure that is not contaminated by the key macroeconomic and bank-specific factors that can also affect the demand for credit. This reduction in the degree of contamination is reflected in the more economically plausible magnitudes of the amount of variation in macroeconomic variables that can

be attributed to credit supply shocks.

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 adjusting 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 to test whether such series represents shifts in the effective supply of bank loans is to see whether it helps in the estimation of the loan demand curve. To the extent that this new indicator reflects fluctuations in loan supply induced by exogenous changes in lending standards, it should serve as a valid instrument in a regression of loan quantities on loan interest rates, thus tracing out the loan demand curve. (This point is illustrated with a simple example in Appendix B.)

To test this hypothesis, we focus on the portion of the SLOOS pertaining to business lending. Specifically, the bank-level SLOOS responses on changes in C&I lending standards are matched with the Federal Reserve Board's Survey of Terms of Business Lending (STBL). The STBL is a quarterly survey that collects from about 300 U.S. commercial banks contract-level information on price and non-price terms—along with the associated loan amounts—on newly originated C&I loans. Between 1997:Q2 and 2012:Q3, 55 SLOOS respondents in our sample also participated in the STBL, reporting information on more than 200,000 unsecured C&I loan contracts.[28]

Loan contracts are characterized by not only the loan amount and interest rate, but also by a number of other important features, including 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 both loan amounts and corresponding interest rates, the sample was restricted to unsecured C&I loans only.

Key characteristics for the sample of loans used in the analysis are reported in Table 2. The average (real) loan amount is about $1 million, with the range running from a bit more than $1,000 to more than $21 million. Though the loan-size distribution is highly skewed to the right, the median loan amount of only $133,000 indicates that the sample consists primarily of small loans, which most likely were extended to small, bank-dependent firms. The average maturity of loans is about 1.4 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

[28]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 2: Summary Statistics of Unsecured C&I Loan Originations

Loan Characteristic	Mean	StdDev	Min	Median	Max
Amount[a]	1,009	2,582	1.2	133	21,356
Maturity (days)	506	586	1	294	10,901
Fixed rate (pct.)	11.3	31.6	-	-	-
Reprice anytime (pct.)[c]	68.1	46.6	-	-	-
Next repricing (days)[d]	27	122	1	1	3,650
Drawn under commitment (pct.)	90.0	30.0	-	-	-
Prepayment penalty (pct.)	12.1	32.6	-	-	-
Effective interest rate (pct.)	5.96	2.44	0.25	5.85	14.9

NOTE: Sample period: 1997:Q2–2012:Q3; No. of loans = 207,885; No. of banks = 55; Avg. number of loans per bank = 3,780. The effective loan rate is computed based on the stated interest rate, payment schedule, and compounding intervals reported in the survey. Summary statistics are based on trimmed data (see text for details).

[a] In thousands of chain-weighted dollars (2005 = 100).

[c] Variable-rate loans only.

[d] Excluding variable-rate loans that can be repriced anytime.

can be repriced at anytime (such as when the prime rate changes); note that the median repricing frequency for variable-rate loans with a fixed repricing interval is one day. Another important feature of the 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 consistent with a significant variation in borrowers' credit quality.

To obtain instruments for the loan-demand regressions, we use a multinomial logit variant of the econometric model in equation (3) to estimate the adjusted changes in C&I lending standards at the bank level. The use of a discrete choice model is necessitated by the fact that the dependent variable in this case is a discrete variable ΔS_{it}, which 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.[29]

Table 3 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 reported for our composite DI 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 an almost 14 percentage points higher likelihood of doing so again next quarter,

[29] In contrast, the dependent variable in Section 3 is a bank-specific composite diffusion index, which takes on continuous values on the $[-1, 1]$ interval. The weighting procedure given by equation (1), in effect, convexifies the discrete survey responses by the bank, whereas the raw bank-level responses to the single question on changes in C& lending standards are used in this section. The only other change made to the baseline specification is that the share of core loans ($CoreLns_{i,t-1}$) was replaced with the share of C&I loans ($C\&ILns_{i,t-1}$) in order to account for the importance of C&I lending in the bank's business model.

Table 3: Factors Affecting Changes in Banks' Lending Standards on C&I Loans

	$\Pr(\Delta S_{it} = T)$		$\Pr(\Delta S_{it} = E)$	
Explanatory Variable	*Est.*	*S.E.*	*Est.*	*S.E.*
Lagged tightening of standards: $\Delta S_{i,t-1} = T$	0.136	0.022	-0.041	0.020
Lagged easing of standards: $\Delta S_{i,t-1} = E$	-0.000	0.028	0.071	0.023
Weaker loan demand: $\Delta D_{it} = W$	0.035	0.014	-0.001	0.015
Stronger loan demand: $\Delta D_{it} = S$	0.017	0.014	0.032	0.015
Economic outlook: $E_{t-1}[y_{t+4} - y_t]$	5.156	1.464	1.206	1.548
Economic outlook: $E_{t-1}[u_{t+4} - u_t]$	9.748	2.771	2.577	3.058
Economic outlook: $E_{t-1}[r^{3m}_{t+4} - r^{3m}_t]$	0.485	1.645	2.563	1.994
Economic outlook: $E_{t-1}[r^{10y}_{t+4} - r^{10y}_t]$	-6.548	3.243	6.564	2.762
Change in real GDP: $[y_t - y_{t-4}]$	-0.238	0.668	0.540	0.687
Change in unemployment: $[u_t - u_{t-4}]$	3.196	1.072	-2.645	1.448
Change in real FF rate: Δrff_t	-5.153	1.007	2.126	1.586
Change in EBP: ΔEBP_t	9.733	2.354	0.510	1.820
Change in VIX: ΔVIX_t	0.207	0.109	-0.084	0.145
Change in net interest margin: $\Delta NIM_{i,t-1}$	-0.017	0.947	0.510	1.367
Change in loan loss provisions: $\Delta LLP_{i,t-1}$	1.384	0.952	-1.020	0.585
Share of C&I loans: $C\&ILns_{i,t-1}$	0.414	0.200	-0.350	0.094
Share of core deposits: $CoreDep_{i,t-1}$	-0.175	0.101	0.249	0.061
Bank size: $\ln A_{i,t-1}$	0.025	0.022	-0.031	0.010
Tobin's Q: $Q_{i,t-1}$	0.328	0.108	-0.103	0.138
Stock returns: $R_{i,t-1}$	-0.047	0.008	0.028	0.009
$\Pr > W_1$[a]	0.000		0.000	
$\Pr > W_2$[b]	0.000		0.000	
$\Pr > W_3$[c]	0.000		0.000	
Cragg & Uhler (pseudo) R^2	0.515			

NOTE: Sample period: 1991:Q3–2012:Q3; Obs. = 3,102; No. of banks = 66. Dependent variable in the multinomial logit regression is a discrete variable $\Delta S_{it} = \{E, U, T\}$, representing the change in C&I lending standards reported by bank i in quarter t: E = easing; U = no change; and T = tightening. Entries under the column headings "*Est.*" are the estimated average marginal effects of the specified explanatory variables (see text for definitions) on the probability of tightening ($\Pr(\Delta S_{it} = T)$) and the probability of easing ($\Pr(\Delta S_{it} = E)$), relative to no reported change in lending standards. 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 exclusion test of common macroeconomic and financial explanatory variables.

[b] p-value for the equation-specific exclusion test of bank-specific explanatory variables.

[c] p-value for the equation-specific exclusion test of bank fixed effects.

while reducing the odds of easing about 4 percentage points. 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. The economic and statistical significance of the reported demand changes underscores the fact that raw bank-level responses on changes in C&I lending standards do not represent pure

movements in the supply of such loans.

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 6.5 percentage points and boost the likelihood of easing by nearly the same amount. Movements in the EBP, 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 Keeley [1990] and Saunders and Wilson [2001]). As before, good recent stock market performance is associated with a move towards softer C&I 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.[30] 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. These two bank-specific loan-supply shifters are used 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.

The loan-demand specification (4) is specified 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. 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.[31] Note

[30] 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.

[31] 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

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 aggregate 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 2). 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 Table 4 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—that is, an unadjusted 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 is evident in the fact that the estimate of semi-elasticity is now between -1.7 and -2.0, a range of values that is significantly above (in absolute value) its OLS counterpart. However, as evidenced by the corresponding standard errors, both IV estimates are subject to a considerable imprecision. More importantly, the first-stage F-tests indicate that the reported changes in C&I lending standards may not be valid instruments because they likely reflect the confluence of demand and supply factors.

The last column in the table reports the results from an IV estimation, which uses our two sets of the adjusted changes in C&I lending standards as instruments. In the semi-log specification, the estimate of semi-elasticity is -1.7, whereas a log-log specification yields an estimate of -1.1. 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 1.1 and 1.7 percent. Moreover, the first-stage F-tests indicate with a high degree of confidence that the adjusted changes in C&I lending standards are valid instruments. Taken together, these results are consistent with our hypothesis

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 4: Semi-Elasticity of C&I Loan Demand

	Semi-Log Specification		
Semi-Elasticity (with respect to)	OLS	GMM-1	GMM-2
Loan-rate spread: $R_{it}[k] - R_t^m[k]$	-0.572	-1.970	-1.685
	(0.097)	(0.953)	(0.523)
R^2 (within)	0.204	-	-
Pr $> F$[a]	-	0.079	0.002
Pr $> J_N$[b]	-	0.760	0.430
	Log-Log Specification		
Semi-Elasticity (with respect to)	OLS	GMM-1	GMM-2
Loan-rate spread: $R_{it}[k] - R_t^m[k]$	-0.430	-1.692	-1.139
	(0.047)	(1.134)	(0.333)
R^2 (within)	0.217	-	-
Pr $> F$[a]	-	0.391	0.003
Pr $> J_N$[b]	-	0.568	0.887

NOTE: Sample period: 1997:Q2–2012:Q3; No. of loans = 207,883; 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.

that the adjusted changes in bank lending standards are largely capturing exogenous changes in loan supply.

6 Conclusion

Using bank-level responses to the Federal Reserve's quarterly Senior Loan Officer Opinion Survey, this paper develops a new measure of movements in the effective supply of bank-intermediated credit. The indicator of shifts in the supply of bank loans to businesses and households corresponds to changes in lending standards that—using an econometric model—have been adjusted for 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 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 VAR framework, orthogonalized innovations to the new 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, macroeconomic dynamics that are typical of financial crises.

As an independent test of how well this micro-level approach captures shifts in the supply of loans, the bank-specific adjusted changes in lending standards on C&I loans were used as an instrument in a regression of individual C&I loan amounts on loan-rate spreads. Compared with OLS, an IV estimation using the adjusted loan-supply shifters as instruments implies an estimate of the semi-elasticity of loan demand that more than doubles—from about -0.5 to between -1.1 and -1.7—a confirmation that the adjusted changes in lending standards are a more accurate indicator of shifts in the effective supply of bank-intermediated credit.

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Appendices

A Senior Loans Officer Opinion Survey of Bank Lending Practices

The Federal Reserve's Senior Loan Officer Opinion Survey of Bank Lending Practices (SLOOS) is a regular survey of changes in lending standards, loan terms, and loan demand. The survey is closely followed by the banking industry, financial market participants, and policymakers because it provides a timely picture of the trends in the availability of, and demand for, bank-intermediated credit. On the credit supply side, banks have reported changes in their lending standards for major categories of loans to households and businesses since 1990:Q2; changes in demand for those loan categories were added to the survey in 1991:Q4. Typically, the Federal Reserve Board conducts the survey four times per year, following a schedule that coincides with the meetings of the Federal Open Market Committee (FOMC).[32]

The scheduling procedure results in a survey frequency that is roughly quarterly. However, it also implies that the SLOOS can occur at various points in any given quarter. Moreover, banks are asked to report changes in their lending practices and loan demand over the three months preceding the date on which the survey was distributed. As a result, the SLOOS data must be merged carefully to ensure that the time periods in the multiple other sources coincide.[33] In general, we matched the quarter of SLOOS responses to the quarter of Call Report and other data so as to maximize the overlap with the period covered by the SLOOS responses.

While the list of actual respondents is confidential, the survey panel contains domestic banks headquartered in all 12 Federal Reserve Districts, with a minimum of 2 and a maximum of 12 domestic banks in the panel from each district.[34] The panel selection criteria are heavily weighted toward inclusion of the largest banks in each district that have a minimum ratio of commercial and industrial (C&I) loans to total assets and that are not specialty banks concentrated in one specific area of lending (e.g., credit cards). Those criteria help to ensure that despite the modest panel size, the respondents account for a substantial fraction of the total loans held by the banking system and of each of the main loan categories covered by the survey.

The size and the composition of the panel is chosen to balance the expected benefits of additional respondents with the burden on the resources of both the Federal Reserve System and the commercial banking sector. Because of the high and increasing concentration of banking sector assets among large banks, considerable care is exercised to ensure that the respondent panel is sufficient to monitor aggregate lending conditions in support of the monetary policy objectives of the Board of Governors. However, the preponderance of large banks in the sample with national or supra-regional scope—combined with the relatively limited sample of smaller banks—makes it difficult to compare survey results by the state or Federal Reserve district in which the bank is headquartered; for an example of such an application of the survey results and a broader discussion of the potential caveats, see Haltenhof, Lee, and Stebunovs [2013].

[32]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.

[33]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.

[34]In addition, by answering a subset of questions—primarily those that pertain 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.

In general, up to 60 domestically chartered U.S. commercial banks participated in each survey from 1990 through mid-2012; beginning with the July 2012 survey, the size of the domestic panel was increased to include as many as 80 institutions. As described in the Federal Register Notice authorizing the SLOOS, the panel of domestic respondents as of September 30, 2011 contained 55 banks, 34 of which had assets of $20 billion or more. The combined assets of the respondent banks totaled $7.5 trillion and accounted for 69 percent of the $10.9 trillion in total assets at domestically-chartered institutions. The respondent banks also held between 40 percent and 80 percent of total commercial bank loans outstanding in each major loan category regularly queried in the survey, with most categories falling in the upper end of that range.[35]

Selection bias among the respondents and in their responses is likely very limited. Participation in the survey is voluntary, but banks that are asked to participate almost always agree to do so. Once a bank joins the survey, it remains on the panel until it either asks to be replaced or ceases to operate as an independent institution. The primary cause of attrition in the sample is the acquisition of a respondent bank by another survey respondent—very few banks that join the panel subsequently decide to stop participating. After the merger is complete, the management of the surviving institution is asked to continue in the survey. The surviving institution is generally the largest among the banks engaged in the merger and the weights applied to subsequent responses are based on the balance sheet of the combined institution.

Among the survey participants, the response rate to each of the individual questions is almost always 100 percent; although loan officers could choose not to respond to specific questions in the survey, they rarely avail themselves of this option. In order to ensure that respondents are as comfortable as possible in providing accurate information about their credit policies, the individual bank responses are confidential and are not shared with the Federal Reserve System staff acting in a supervisory or regulatory capacity.

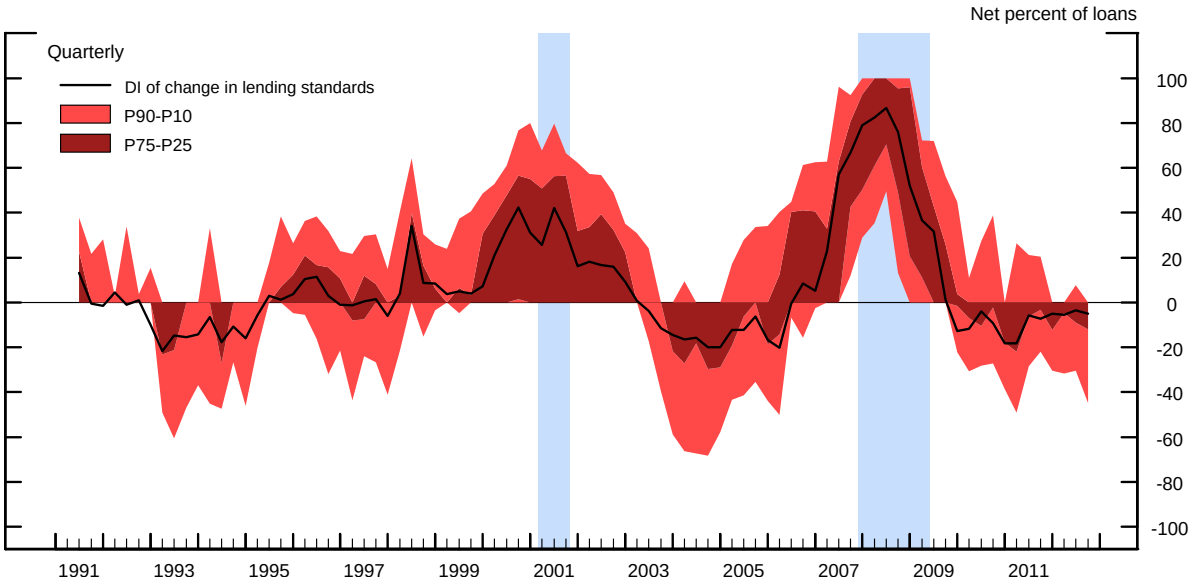
Currently, banks are asked to report whether they have changed their credit standards—or have experienced a change in loan demand during the survey period (i.e., over the previous three months)—on the following seven categories of loans: C&I; commercial real estate; residential mortgages to purchase homes; home equity lines of credit; credit cards; auto; and consumer loans (other than credit cards or auto loans). However, the number of loan categories covered by the SLOOS has generally increased over time. In constructing the diffusion indexes (DIs) for changes in lending standards and loan demand, we used information on the most disaggregated set of loan categories available in each survey.[36]

The solid line in the top panel of Figure A-1 shows the DI of the change in overall lending standards, along with the selected percentiles of the distribution of changes in standards across

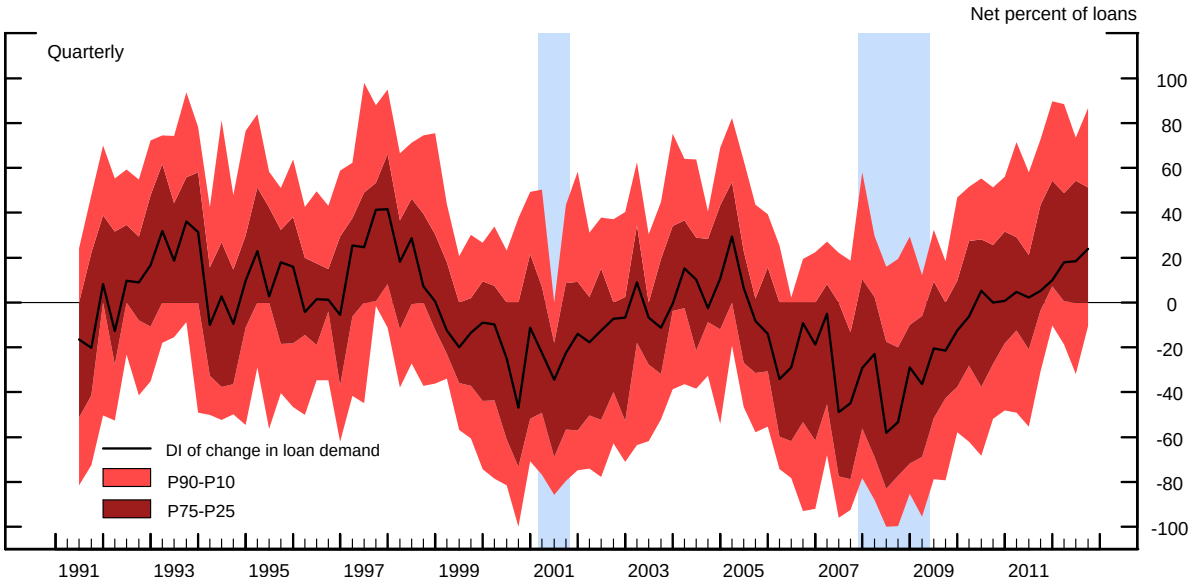
[35]For a complete description of the panel selection criteria, wording of individual questions, and methods used to conduct the survey, see `http://www.federalreserve.gov/boarddocs/SnLoanSurvey`.

[36]Data on changes in standards on C&I loans, commercial real estate loans, and residential mortgages are all available beginning with the May 1990 survey. Questions regarding changes in standards 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 to make consumer installment loans is available over the entire sample period; we use this series to proxy for changes in standards on all consumer loans prior to 1996. Starting with the April 2007 survey, the respondents were asked about changes in standards and demand on residential mortgages by type of mortgage product (prime, nontraditional, or subprime). In constructing our series, we use only the response that banks provide for prime mortgages, because many banks discontinued nontraditional and subprime lending after 2008 and so the continuity of the panel would be compromised. Starting with the February 2008 survey, banks were asked about changes in their credit standards on home equity lines of credit. Starting with the May 2011 survey, the respondents were asked about changes in standards and demand on auto loans.

Figure A-1: SLOOS-Based Indicators of Supply and Demand for Bank Loans



(a) Changes in overall lending standards



(b) Changes in overall loan demand

NOTE: Sample period: 1991:Q3–2012:Q3. The black line in the top panel depicts the diffusion index of the change in overall lending standards, while the solid line in the bottom panel depicts the corresponding diffusion index of the change in the 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. The shaded bands represent the P75−P25 and the P90−P10 ranges of the cross-sectional distribution of bank-level diffusion indexes. The shaded vertical bars denote the NBER-dated recessions.

banks. Note that even in periods where the DI is near a high or low for that series, substantial variation in the responses across banks is observed at the 10th and 90th percentiles. The degree of cross-sectional dispersion among the survey respondents during 2005 and early 2006 is particularly notable, as some banks apparently got ahead of the curve in anticipating the financial crisis, even while others were still easing credit policies across their largest business lines. The bottom panel depicts the same information for the change in overall loan demand, which is also subject to considerable heterogeneity across banks in the panel.

Another aspect of the SLOOS that helped inform the analysis in the paper is the battery of questions about the reasons that banks changed their lending policies on C&I loans. Since 1996, banks have been asked to rate the importance of a number of possible reasons for changes in lending standards or terms on a scale from 1 to 3 where: 1=not important, 2=somewhat important, and 3=very important.[37] Among the reasons typically queried are changes in the economic outlook or the uncertainty of that outlook, industry-specific factors, tolerance for risk, competition from other banks and nonbank sources of funds, the bank's capital and liquidity positions, and trends in defaults in public bond markets,

The bars in the panels of Figure A-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.[38]

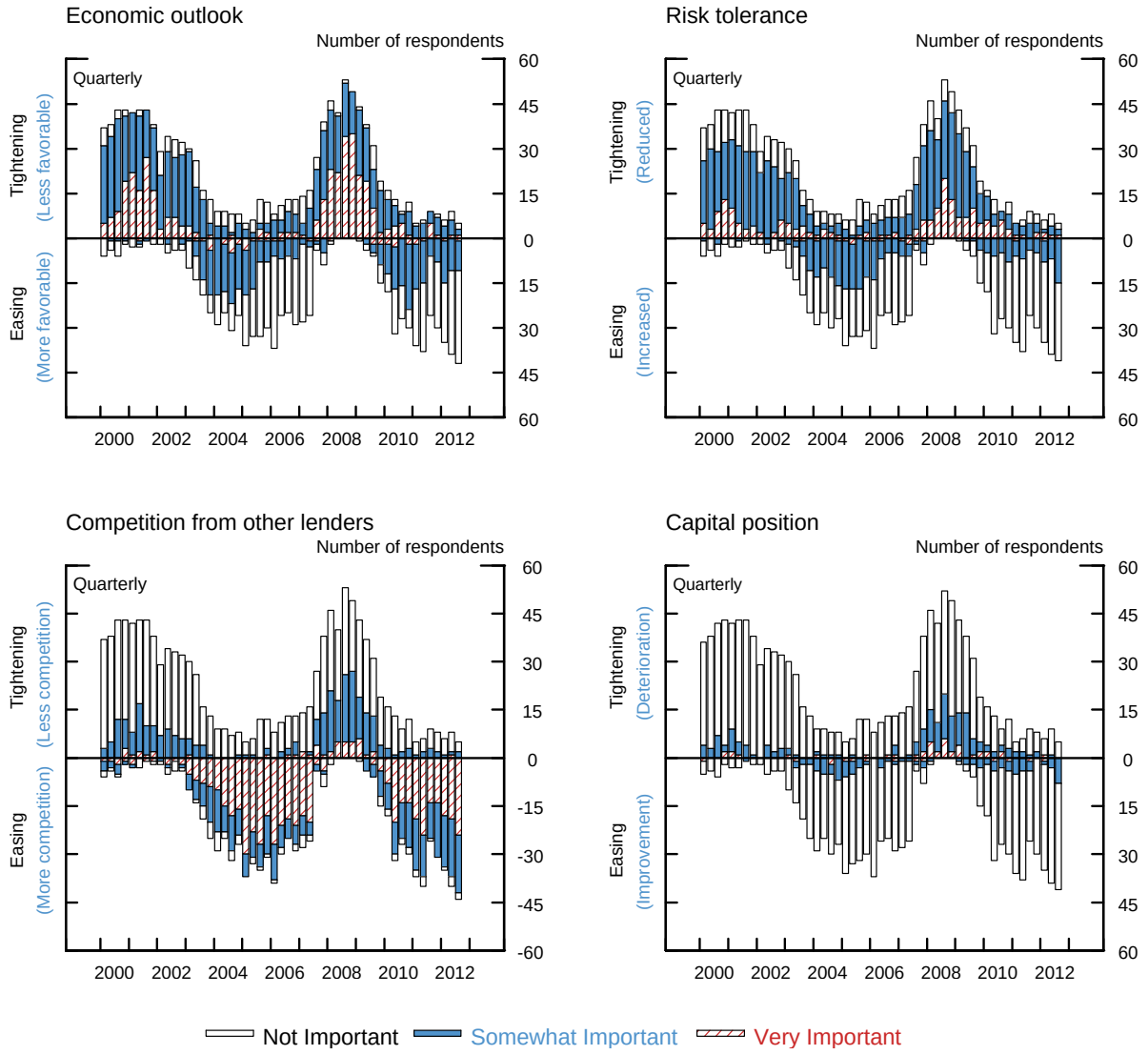
The top two panels show that changes in the economic outlook and shifts in risk tolerance—factors that likely have an independent effect of loan demand—tend to be the most commonly-cited reasons for changes in bank lending standards and terms on C&I loans. Both of those reasons were cited as particularly 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 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.

As discussed in the main text, more than 140 different banks participated in the survey over our sample period (1991:Q3–2012:Q3). However, our analysis also relies on 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); we also dropped those respondents that participated in the survey for less than 5 years (20 quarters). Those two selection criteria yielded a sample of 68 banks, which still accounted, on average, for about 55 percent of industry-

[37] Between 1990 and 1995, banks were asked to provide an ordinal ranking of a set of possible reasons that changed relatively more frequently.

[38] 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.

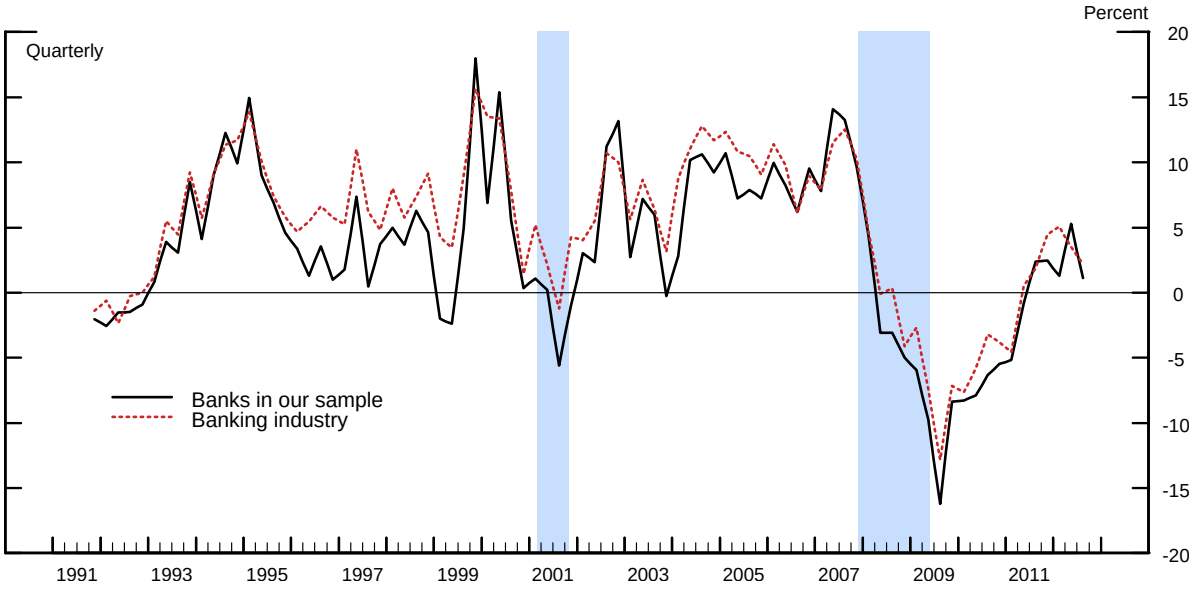
Figure A-2: Selected Reasons for Tightening or Easing Standards on C&I Loans



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.

wide assets over the sample period. Moreover, as shown in Figure A-3, the growth of total core loans for our sample of 68 banks closely matches the growth rate of core loans for the entire U.S. commercial banking sector.

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



NOTE: Sample period: 1991:Q3–2012:Q3. The solid line depicts the (annualized) quarterly growth rate of core loans for the 68 publicly-traded SLOOS respondents used in the analysis; 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.

Key characteristics of these 68 banks are summarized in Table A-1.[39] With more than $130 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. As suggested by the remaining columns in the table, the first two sample moments for the panel of publicly-traded banks are not materially different from those based on the entire SLOOS respondent panel or from those based on all banks with more than $2 billion in assets as of 2012:Q1. These results highlight the level of concentration in the banking industry and the importance of the large, publicly-traded institutions in determining the availability of credit availability at the macroeconomic level.

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

Table A-1: Summary Statistics of Selected Bank Characteristics

	Our Sample		SLOOS Panel		Large Banks	
Variable	Mean	StdDev	Mean	StdDev	Mean	StdDev
Net interest margin (NIM)	3.82	0.86	3.80	0.89	3.93	1.05
Loan loss provisions (LLP)	0.74	1.00	0.82	1.12	0.92	1.70
Core loans[a]	53.7	16.3	56.2	15.6	58.8	15.5
C&I loans[b]	26.1	10.3	24.6	10.6	21.9	13.6
CRE loans[b]	16.5	13.0	20.8	13.5	29.2	19.8
RRE loans[b]	32.1	15.8	30.4	14.1	29.4	16.8
Credit card loans[b]	3.9	5.8	3.2	6.4	2.7	9.7
Other consumer loans[b]	9.92	6.0	10.7	7.1	9.4	8.7
Core deposits[c]	51.9	13.5	55.6	16.4	57.4	16.2
Total assets[d]	128.4	269.6	64.4	187.1	32.5	130.6
Tobins's Q	1.08	0.08	-	-	-	-
Stock returns	8.54	61.9	-	-	-	-

NOTE: Sample period: 1991:Q3–2012:Q3; Our Sample = sample of 68 publicly-traded SLOOS respondents used in the analysis (Obs. = 3,208); SLOOS Panel = 149 SLOOS respondents (Obs. = 7,646); and Large Banks = 559 banks with assets greater than $2 billion as of 2012:Q1 (Obs. = 16,637). 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).

B Estimating the 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, $\text{plim}\,\hat{\beta}_{IV} = -\beta^D$. 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.