Identifying the Macroeconomic Effects of Bank Lending Supply Shocks

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Abstract

Researchers have long hypothesized that exogenous changes to the supply of bank loans should affect economic activity. However, identifying such loan supply shocks is difficult, since loan supply and demand likely share many determinants. In this paper, we use the Federal Reserve's quarterly Senior Loan Officer Opinion Survey to create a new measure of loan supply shocks. We regress banks' individual responses to questions on how they have changed their lending standards over the preceding three months on bank-specific and macroeconomic variables that would be expected to affect loan demand or supply. We aggregate the residuals from this regression across banks to create a quarterly series of unexplained changes in bank lending standards from 1992 to 2010. This series accords well with narrative accounts of the period, for example showing sharp and historically large tightenings in 2007 and 2008. When we include the shock measure as the exogenous variable in a VAR-X model with growth in real GDP, inflation, growth in bank lending capacity, a credit spread index, and the federal funds rate, we find economically large effects of shocks to changes in lending standards. A one standard deviation increase in tightening leads to a drop in real GDP of 0.4 percent in the first year after the shock. The effects are asymmetric, with tightenings having larger effects than easings. Using the shocks as an instrument in a regresion of loan quantities on loan spreads, we estimate the semi-elasticity of loan demand to be -1.4.

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1 Introduction

Researchers have long hypothesized that commercial banks may serve as a propagation mechanism for, or a source of, macroeconomic shocks. In the 1960s, Karl Brunner and Allan Meltzer criticized small-scale macroeconomic models for not including multiple measures of credit prices and quantities, including those of bank loans.[1] In the 1980s, Ben Bernanke argued that bank failures helped exacerbate the Great Depression.[2] Subsequent work by Bernanke and others evaluated whether monetary policy might have effects on real activity through the market for bank loans: if banks were not able to readily substitute other sources of funding for deposits, then changes in the federal funds rate (which affects banks' opportunity cost of issuing certain kinds of deposits) would affect the price and supply of bank loans, which in turn would affect firms' and consumers' investment and consumption decisions if they were not readily able to substitute other forms of finance.[3] This "bank lending channel" of monetary policy transmission was subsequently broadened into the "broad credit channel" or "financial accelerator," in which changes in short-term interest rates would lead to changes in the quality of borrowers' balance sheets.[4] An increase in short-term rates would, for example, by reducing the net present value of collateral, increase the cost of all forms of borrowing (including, but not limited to, bank loans). This increased cost would in turn reduce firm investment, output, and cash flow, further worsening firms' balance sheets and increasing the cost of borrowing even more, thus multiplying the impact of the original change in short-term rates. Other researchers over the past several decades have looked at the macroeconomic impact of developments within the banking sector (for example, changes in banks' risk ratings).

At least two severe endogeneity problems complicate empirical investigations of the roles that banks and other financial institutions play in economic fluctuations. First, many macroeconomic shocks that may affect the supply of bank loans likely have independent effects on other real variables. For example, monetary policy shocks may change the interest rates on or quantity of bank loans; they likely also affect consumption and investment through their influence on other interest rates. Thus, parsing the marginal effects of monetary policy shocks on consumption and investment through the market for bank loans requires additional identifying assumptions, which may be difficult to obtain. Second, even apparently exogenous shocks to the banking sector may have their origins in disturbances that also separately affect other macroeconomic variables. For example, a tightening of

[1] Brunner and Meltzer (1963).

[2] Bernanke (1983).

[3] See, for example, Bernanke and Blinder (1988), Bernanke and Lown (1991), Kashyap and Stein (1994, 2000), and Peek and Rosengren (1994a,1995b, 2000). We discuss the related literature in greater detail below.

[4] Bernanke and Gertler (1989), Bernanke, Gertler, and Gilchrist (1999), Oliner and Rudebusch (1996).

bank lending standards could reflect reductions in expected future output, which could in turn also be depressing current and future economic activity. As with the previous example, disentangling the marginal effects of the shock to the banking sector requires additional identifying assumptions.

As a result of these difficulties, there is arguably as yet no consensus on the magnitudes of the role of commercial banks, or even the financial system more broadly, in economic fluctuations. Some research has found quite large effects of financial variables, while others have found a more limited role. The extraordinary events before and during the recession that began in December 2007 do provide strong support for the idea that the magnitudes can be quite large.

In this paper, we use the Federal Reserve Board's quarterly Senior Loan Officer Opinion Survey on Bank Lending Practices (SLOOS) to develop a measure of bank loan supply shocks. We do so by estimating a panel regression of bank-specific responses to questions on how lending standards for businesses and households have changed over the preceding three months on two sets of variables: bank-specific variables that might affect loan demand or supply, including information from bank financial statements and SLOOS answers to a question about changes in customers' demand for loans; and year-ahead survey forecasts for macroeconomic variables. We then take the bank-level residuals and average them across banks to obtain a measure of the unexplained changes in lending standards in a specific quarter. We think these changes in standards in turn represent changes in loan supply; if standards tighten, for example, a given borrower will likely be able to borrow less and at a higher price, and is thus facing a reduced supply of credit.

The resulting series, which is constructed over the period from 1992 to 2010, is in accord with narrative accounts of the time. At the beginning of the sample, at the tail end of the early-1990s "credit crunch," there are unexplained tightenings in standards. There are similar tightenings around the time of the Long-Term Capital Management Crisis and before, during, and after the 2001 recession. Much of the 2000s is a period of unexplained easings in credit, while the recession that started in December 2007 was preceded and accompanied by historically-large unexplained tightenings in credit standards.

We evaluate the macroeconomic effects of the loan supply shock measure by including it as the exogenous variable in a VAR-X model; the endogenous variables in the model are the growth in real GDP, inflation, the growth in total core lending capacity (the sum of loans to businesses and households and unused commitments), an index of credit spreads, and the federal funds rate. Since we have already removed the effects of bank-specific variables and expected future macroeconomic variables from the shock measure, we do not use the VAR to try to orthogonalize it further. We also do not try to impose other identifying assumptions in the VAR to make it a structural VAR; rather, the framework simply serves as a convenient

way to estimate the effects of the loan supply shock on a set of macroeconomic variables, conditional on other variables. We find that the shock has large effects on real GDP and core lending capacity; a one-standard deviation increase in the measure leads to about a 0.4 percent decline in the level of real GDP in the first year after the shock, and declines in the level of core lending capacity growth of more than half a percentage point over the same period. The impact on the federal funds rate, the credit spread index, and inflation are smaller but still economically meaningful. We also find that the effects of the shocks are asymmetric; unexplained tightenings produce larger impacts than unexplained easings.

Although we have tried, through our panel regression approach, to remove all of the endogenous component from the changes in lending standards series, we have likely not completely succeeded in doing so. One way of testing the extent to which our approach captures shocks to the supply of lending is to use our series as an instrument in a regression of loan quantities on loan prices. If our series is a good measure of loan supply shocks, using it in this way should help trace out the loan demand curve. Using the Federal Reserve's Survey of Terms of Business Lending (STBL) as a data source, we find that while a simple OLS regression of (log) loan quantities on interest rate spreads results in a semi-elasticity estimate of loan demand of -0.6, an IV regression using an analog to our measure of lending shocks for just C&I loans as instruments boosts the semi-elasticity estimate to -1.4. This large decrease suggests that our shocks are to a large degree capturing movements in loan supply, rather than in loan demand.

The remainder of the paper is organized as follows. Section 2 describes the data from which the shock measure is constructed. Section 3 outlines our empirical strategy for estimating the shock series and presents the series. Section 4 discusses the macroeconomic impact of the series. Section 5 presents two extensions: allowing different effects for standards tightenings and easings, and using our shock series to estimate the slope of the loan demand curve. Section 6 concludes.

2 Data

2.1 Overview

This paper combines survey information on changes in bank lending standards with other bank-specific and macroeconomic variables to construct a measure of bank loan supply shocks. In this section, we describe the data used to derive the shock series; in the next section, we describe the empirical methodology for deriving the series and present it.

2.2 Senior Loan Officer Opinion Survey

Our shock series is based on bank-specific responses to questions about changes in lending standards from the Federal Reserve's Senior Loan Officer Opinion Survey of Bank Lending Practices (SLOOS). The survey is usually conducted four times per year by the Federal Reserve Board, and up to 60 banks participate in each survey.[5] The survey is voluntary but typically includes the largest banks in each Federal Reserve district and is roughly nationally representative.[6] The survey has asked banks about changes in lending standards for loans to households and businesses since 1990:Q2 and about changes in demand for those loan categories since 1991:Q3.[7] Banks are asked to report whether they have changed their credit standards over the past three months on the following six categories of core loans: C&I; commercial real estate; residential real estate; home equity lines of credit; credit cards; and consumer loans other than credit cards (for the full text of the questions, and more information on the survey, please see http://www.federalreserve.gov/boarddocs/SnLoanSurvey/).[8]

For example, one of the questions about changes in standards is, "Over the past three-months, how have your bank's credit standards for approving C&I loans and credit lines for large and middle- market firms changed?" Banks respond to that question using a categorical scale from 1 to 5:

[5]The Federal Reserve Board has the authority to conduct up to six SLOOSs each year, but extra surveys are usually only carried out when market conditions are particularly uncertain. These occasional extra surveys are not used in this analysis.

[6]Although the SLOOS is a voluntary survey, it does not suffer from any significant response biases. Very few banks voluntarily drop off the survey panel, and banks that are asked to participate in the survey almost always agree to do so. The primary cause of attrition in the sample is the acquisition of a respondent bank by bank that also participates in the survey.

[7]Because of the somewhat irregular schedule of SLOOS and the wording of the questions, the data must be merged carefully to ensure that the time periods in the multiple sources coincide. The SLOOS asks banks to report changes in their lending practices over the previous three months, and the survey is conducted so that it coincides with regular meetings of the Federal Open Market Committee. Hence, the January SLOOS refers to the period from October to December of the prior year. Thus, in that case the SLOOS data would be merged with the prior quarter of data from the Call Reports and financial market data. However, the SLOOS can occur at various points in a given quarter. So, more generally the quarter of SLOOS responses are matched to the quarter of Call Report and securities price data that overlaps the most days with the period covered by the SLOOS responses.

[8]Not all six loan categories are available over our sample period. Data measuring changes in credit standards on C&I loans, residential real estate loans, and commercial real estate loans 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 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 February 2008 survey, banks were asked about changes in their credit standards on home equity lines of credit.

$$\Delta S_{it} = \left\{ \begin{array}{rcl} 1 & = & \text{Eased considerably} \\ 2 & = & \text{Eased somewhat} \\ 3 & = & \text{Remained about unchanged} \\ 4 & = & \text{Tightened somewhat} \\ 5 & = & \text{Tightened considerably} \end{array} \right\},$$

where ΔS_{it} is the change in standards for that category of loans for bank i in quarter t.

Because banks were extremely unlikely to characterize their changes in lending standards as "eased considerably" or "tightened considerably," we use only three classifications for those variables rather than the five classifications available to survey respondents.[9] Letting i index the respondent banks, j index the SLOOS loan categories, and t index time, we define an indicator variable $\Delta S_{it}(j)$ as follows:

$$\Delta S_{it}(j) = \left\{ \begin{array}{cl} -1 & \text{if bank } i \text{ reported easing standards on loan category } j \text{ at time } t \\ 0 & \text{if bank } i \text{ reported no change in standards on loan category } j \text{ at time } t \\ 1 & \text{if bank } i \text{ reported tightening standards on loan category } j \text{ at time } t \end{array} \right.$$

Using these indicator variables, we can construct a composite index of changes in lending standards at each bank i by calculating the following weighted average for each quarter t:

$$\bar{\Delta} S_{it} = \sum_j \phi_{it}(j) \Delta S_{it}(j) \tag{1}$$

where $\phi_{it}(j)$ denotes the fraction of bank i's loan portfolio that is accounted for by core loans in category j, as reported on bank i's Call Report in quarter t. The resulting composite index of changes in lending standards, $\bar{\Delta} S_{it}$, can be interpreted as the net percentage of core loans on the SLOOS respondent's balance sheet that were in categories for which the bank reported tightening lending standards over the survey period.

The bank-specific indexes given in equation **??** for each period can be aggregated for each quarter t according to:

$$\bar{\Delta} S_t^* = \sum_i \psi_{it} \Delta S_{it} \tag{2}$$

where ψ_{it} denotes the fraction of core loans on SLOOS respondents' balance sheets that are held by bank i.

The SLOOS also asks banks about changes in demand for several categories of loans over the preceding three months. The question is structured in the same way as for the

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

change in standards. We can use a similar technique to the above to construct a composite index of changes in the demand for loans.

Figure 1 plots the composite measures of changes in standards and changes in demand over the period 1991:Q3 to 2010:Q2. Two aspects of this chart are of interest. First, both series qualitatively match narrative accounts of the period. Lending standards tighten substantially during the Long-Term Capital Management crisis of 1998, and again surrounding the 2001 and 2007-2009 recessions. Banks reported that demand was strengthening during much of the 1990s and the middle of the 2000s, during periods of solid economic growth, and was weakening persistently during the last two recessions. Second, there is a strong relationship between the two series; as shown in the inset, the correlation between the two is -.66. The large magnitude of the correlation strongly suggests that movements in standards and demand are indeed driven by common shocks.

The SLOOS also asks banks to rate the importance of reasons why they have tightened or eased standards on C&I loans over the past three months. For tightening, reasons include macroeconomic reasons, such as a less favorable or more uncertain economic outlook; bank specific reasons, such as a deterioration in the bank's current or expected capital position; or borrower-specific reasons, such as an increase in defaults by borrowers in public debt markets.

Figure 2 plots the number of respondents offering four of the eight responses banks are allowed to choose as reasons for tightening or easing of standards: changes in the economic outlook (upper left panel); changes in risk tolerance (upper right panel); changes in defaults by borrowers in public debt markets (lower left panel); and changes in the bank's current or expected capital position. In each chart, positive bars give the number of respondents citing that reason as not important (no shading), somewhat important (blue shading) or very important (red shading) for tightening, while negative bars give the number citing that reason as not, somewhat, or very important for easing.

The top two panels show that changes in the economic outlook and in risk tolerance are important reasons for changes in lending standards throughout the sample period. Both sets of reasons were particularly important as reasons for tightening standards during the 2001 and 2007-2009 recessions. By contrast, the lower left panel of the figure shows that defaults in public debt markets were important reasons during the last two recessions, but not as much during the expansion. The lower right panel shows that changes in capital position was not an important reason for changes in standards until the most recent recession.

2.3 Bank-Specific Balance Sheet and Income Variables

We control for possibly endogenous changes in lending standards by conditioning on bank-specific and macroeconomic variables that might affect loan demand or supply, guided by

the reasons banks report on the survey. We use the Reports of Condition and Income (or Call Reports) for data on banks' profitability and balance sheet composition.[10] Our variable choice is suggested by both theoretical models and empirical research on the setting of bank lending standards. The models of Rajan (1994) and Ruckus (2004) suggest that banks ease lending standards in response to competitive pressures to grow their loan books during expansions. Berger and Udell (2004) show that banks tend to tighten credit standards in response to rising loan loss reserves and associated reductions in profitability. Ashcraft and Morgan (2003) use the average interest rate on new originations of commercial and industrial loans as a proxy for bank lending standards, and find that among indicators of credit quality this interest rate is more positively correlated with subsequent delinquency rates than with charge-offs and provisions. Kashyap, Rajan, and Stein (2002), Pennacchi (2006), and Gatev and Strahan (2006) examine the relationship between banks' access to core deposits and their willingly to extend loan commitments.

At the bank level, lending standards should be influenced by the credit quality of its current portfolio, the profitability of lending opportunities facing the bank, and the bank's capital and liquidity position. The bank's net interest margin is used as an indicator of the profitability of the bank's lending operations. We use delinquency rates to control for the current credit quality of the bank's loan portfolio; we expect banks to tighten lending standards when credit quality deteriorates. 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 change lending standards less frequently or more slowly. We use the ratio of loans to total assets to control for both liquidity and for the importance of lending operations in the bank's business model.[11]

2.4 Other Bank-Specific Variables

We derive bank equity prices and returns from daily time series for bank holding companies (BHCs) in the Center for Research in Securities Prices (CRSP) database. We calculate quarterly stock returns by summing the logged daily returns for the past 63 trading days,

[10] 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, see the appendix in English and Nelson (1998).

[11] Our results are robust to inclusion of a measure of capital adequacy, the leverage ratio. For a more complete definition of the leverage ratio, as well as other regulatory capital requirements see Bassett and Zakrajsek (2003).

as of the last day of the quarter.[12] We proxy for volatility of the stock returns by using the annualized standard deviation of the logged daily returns over the same period. We also use a measure of Tobin's q, 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; the book value of assets is the firm's total assets reported in the FR Y-9C.[13]

2.5 Macroeconomic Variables

Most of the respondents to the SLOOS that change their lending standards report that changes to the economic outlook, or in the degree of certainty about the outlook, are important reasons for their change in standards. We capture changes in the outlook by using data from the Survey of Professional Forecasters (SPF) to include explanatory variables that represent the expected year-ahead change in the unemployment rate and in short and long-term Treasury yields. Specifically, we incorporate the expected four-quarter change in the three-month Treasury-bill rate and the ten-year Treasury-bond rate, and the four-quarter growth rate in real GDP.

To capture the effects of changes in the degree of certainty about the economic outlook, we compute a forecast dispersion index. The dispersion index is the first principal component of 11 series: two market-based measures of uncertainty in Treasury bond yields and equity returns (the MOVE index and the VIX index), the standard deviations of Survey of Professional Forecasters respondents' expectations of the year-ahead level of unemployment, and of the year-ahead change in real GDP, industrial production, housing starts, the GDP price index, corporate profits, personal consumption expenditures, nonresidential fixed investment, and residential fixed investment. The top panel of figure 3 plots the index. For much of the earlier part of the sample–the "Great Moderation" period–the series is relatively close to zero, indicating substantial agreement. The series deviates substantially from zero in the early 2000s and reaches an all-time high during the latter stages of the recent recession, suggesting the great degree of uncertainty at that time.

We use five additional series in the portion of the paper that explores the macroeconomic significance of credit supply shocks. Three of the variables are standard to macroeconomic analysis. Real GDP and the GDP deflator come from the Bureau of Economic Analysis. The target federal funds rate is available from the Federal Reserve.

[12] Data are filtered for outliers before summing by dropping any observations with a daily return with an absolute value greater than 50 percent.

[13] The market capitalization of the firm is equal to the product of the closing stock price and the unadjusted number of publicly held shares on NYSE, Amex, NASDAQ, and NYSE Arca exchanges as recorded by CRSP on the last day of a quarter. If the closing price is not available on any given trading day, the price is recorded as the average of bid and ask prices, not an actual closing price.

The fourth variable is an index of credit spreads, defined as the first principal component of spreads on rates on several consumer and corporate securities over comparable-maturity Treasury securities.[14]

The bottom panel of figure 3 plots this credit spread index. The series shows low levels of spreads during the expansions of the 1990s and 2000s, and higher levels of spreads during the 2001 and 2007-2009 recessions, reaching a historic high level of over four standard deviations in the most recent recession. Qualitatively, the series resembles the forecast dispersion measure plotted in the upper panel. It is perhaps not surprising that a measure of forecast uncertainty should behave similarly to a measure of credit spread.

The fifth variable is core lending capacity, a measure of the funds available to businesses and households constructed from the commercial bank Call Reports. Core lending capacity is the sum of outstanding core loans and unused commitments to fund loans. Core loans are defined as commercial and industrial loans, loans secured by residential or commercial real estate, and consumer loans. These components cover the majority of lending to households and nonfinancial businesses. [15] We use core lending capacity rather than core loans in our baseline specification since businesses and households may draw on unused portions of credit lines to fund themselves.

Figure 4 plots the behavior of core lending capacity (the solid line), including the contributions of core loans (the blue bars) and core unused commitments (the red bars). Over the whole sample period, generally the contribution of unused commitments to the growth in core lending capacity has been in the same direction as that of core loans, but somewhat larger in absolute value. In the most recent downturn, core lending capacity in the commercial banking sector has contracted even more severely than core loans. Moreover, the decline in credit available to consumers and businesses has been especially sharp, even in comparison to past recessions.[16]

[14]Specifically, the spreads are: the contract rate on 30-year, fixed-rate conventional home mortgage commitments over the 10 year Treasury (corresponding to the duration, not the maturity of the mortgage loans); the contract rate on 30-year, adjustable-rate conventional home mortgage (indexed to the 1-year, constant-maturity Treasury yield) over the 10 year Treasury; the corporate AA 10-year yield over the 10 year Treasury; the corporate BBB 10-year yield over the 10 year Treasury; the corporate high yield 10-year yield over the 10 year Treasury; the corporate AA 2-year yield over the 2 year Treasury; the corporate BBB 2-year yield over the 2 year Treasury; the corporate high yield 5-year yield over the 5 year Treasury; the finance rate on consumer installment loans at commercial banks, new autos 48 month loan (not seasonally adjusted) over the 2 year Treasury; the finance rate on personal loans at commercial banks, 24 month loan (not seasonally adjusted) over the 1 year Treasury; the A1/P1 1 month commercial paper rate over 1 month Treasury; and the weighted average effective C&I lending rate across loans of various maturities at domestic banks over the 1 month LIBOR rate.

[15]The measure of core lending capacity includes commitments to banks and nonbank financial institutions because they are not reported separately from commitments to nonfinancial firms. Conversely, loans to financial institutions are not reported in sufficient detail on the Call Reports to include in the measure of core loans. The SLOOS does not consistently query banks about their standards and terms on loans to financial institutions.

[16]Our results below are qualitatively robust to using core loans instead of core lending capacity.

3 Identifying Loan Supply Shocks

3.1 Overview

Changes in the price and quantity of bank lending generally reflect both changes in the supply of and demand for bank loans. Thus, any attempts to determine the macroeconomic effects of exogenous shocks to loan supply must make sure that the loan supply shock measure is not affected by changes in loan demand. This may be especially difficult, since some macroeconomic shocks may jointly affect loan demand, supply, and economic activity. For example, a weakening in the economic outlook may reduce loan demand by firms and consumers, thus reducing output, but also lead to a tightening in credit standards by banks concerned about the creditworthiness of potential borrowers.

Hence even the changes in lending standards reported in the SLOOS reflect the confluence of demand and supply factors. Previous work by Lown and Morgan (2002, 2006) has used an aggregate SLOOS-based index of changes in lending standards in a VAR with other macroeconomic variables to try to identify the component of the change in standards that is orthogonal to other determinants of loan supply and demand.

In this paper, we propose an alternative approach that relies on bank-level responses to SLOOS questions about changes in standards on several categories of loans. This allows us to control for three potential sources of endogeneity. First, we are able to use the bank-specific SLOOS responses to questions about changes in loan demand to partial out changes in standards that are related to perceived changes in demand. Second, we can control for the effects of other bank-specific income, balance-sheet, and equity-market variables that might affect changes in standards. Such variables may respond in part to other economic shocks that in turn affect loan demand and real activity, and are thus at least partly endogenous.[17] Third, we control for the effects of expected future macroeconomic variables that might plausibly also affect loan demand and economic activity; our estimation method allows for variations in the response of individual banks to these variables.

In the remainder of this section, we construct a new indicator of credit supply shocks from bank-specific responses to the SLOOS. In the next section, we use that variable to investigate the effect of a shock to loan supply on lending and economic activity.

[17]These bank-specific variables also move in part for purely exogenous reasons. Thus, by partialing out their effects on changes in lending standards, we are also removing some purely exogenous changes in standards. Hence our loan supply shock measure could also understate the degree of unexplained tightening.

3.2 Construction of the Loan Supply Shock Series

3.2.1 Panel Regression of Standards Series on Supply and Demand Determinants

Taking the measure of bank-level standards derived above, $\bar{\Delta}S_{it}$

We use the following mixed model factor specification to estimate the impact of bank-specific and macroeconomic variables on the bank-level standards series:

$$\bar{\Delta}S_{it} = \alpha_i + \lambda' f_t + \beta' z_{it} + \epsilon_{it} \tag{3}$$

where α_i is a bank fixed effect, f_t is a vector of observable macroeconomic factors capturing changes in the economic outlook and the degree of certainty about the outlook, and z_{it} is a vector of observable bank-specific factors.
The macroeconomic variables in f_t include:

- the expected four-quarter change in the three-month T-bill rate,
- the expected four-quarter change in the 10-year T-bond rate,
- the expected four-quarter growth in real GDP,
- the credit spread index, and
- the forecast dispersion index.

The bank specific controls in z_{it} include:

- the composite index of the change in credit standards at bank i at time $t-1$,
- the index of change in demand for loans at bank i at time t,
- the net interest margin for bank i at time $t-1$,
- the delinquency rate for bank i at time $t-1$,
- the core loan share for bank i at time $t-1$,
- the core deposit share for bank i at time $t-1$,
- the ratio of market to book value of bank i at time $t-1$,
- the return on the stock of bank i's parent BHC at time $t-1$, and
- the volatility of the above return, bank i's parent BHC at time $t-1$.

Table 1 provides summary statistics on the variables in the regression. Table 2 gives the estimated coefficients, sequentially adding to the set of regressors used in each model. The first column of Table 2 reports the results of just including the lagged standards index and the index of changes in demand. As might be expected by the serial correlation of the series, having tightened standards in the preceding period has a large and statistically significant effect on further tightening standards in the current period–perhaps indicating that banks are unwilling to reverse recent changes in standards or change standards by large amounts from period-to-period. Specifically, a one-standard deviation increase in the fraction of loans tightened–about 33 percent–leads to a further 12 percent increase in the fraction of loans subject to tightening the next period. An increase in demand in the same period is associated with a small easing in standards–a one-standard deviation increase in the fraction of loans for which greater demand is reported (46 percent) is associated with about a 2.5 percent decrease in the fraction of loans subject to tightening in the next period.

The second column of Table 2 shows the impact of including bank fixed effects, which allows for differences across banks in the propensity to tighten or ease standards. Adding fixed effects substantially increases the magnitude of lagged changes in standards and contemporaneous changes in demand, with the latter nearly doubling. The third column adds the macroeconomic variables described above. Adding these variables reduces the coefficients on the lagged standards and the demand terms, but leaves them economically and statistically significant. Expected increases in the Treasury bill or bond rates are associated with easings in standards, as is an increase in expected real GDP growth. The effects are somewhat small–one standard deviation increases in each of these variables reduces the fraction of loans subject to tightening by a few percentage points. Expected improvements in the economy may lead all three variables to increase, and in turn lead to easings in current lending standards. An increase in the credit spread index is associated with somewhat greater tightening–a one standard deviation increase in the former leads to about a 12 percent increase in the fraction of loans subject to tightening. An increase in the forecast dispersion index is associated with a small amount of additional easing. Both of these measures try to capture risk and uncertainty. It is possible, given their strong correlation, that the change in the credit spread index is masking the effects of the increase in the dispersion index; if the credit spread index is replaced with a single corporate bond spread, the sign on the dispersion index variable turns positive.[18]

The fourth column presents the full specification, including other bank-level variables. The inclusion of these additional variables do not generally change the statistical or economic significance of the macroeconomic and other variables describe above, though the effect of

[18]We have also tried as a variant allowing for bank-specific coefficients on the macroeconomic variables. The resulting shock series and regression results are qualitatively and quantitatively similar.

a change in the 10-year Treasury bond rate on changes in lending standards does become substantially larger. Of the bank-level variables, an increase in net interest margins leads to a small easing in lending standards. Banks with somewhat higher shares of core loans as a fraction of total loans have moderately tighter standards. Having higher lagged stock returns appears to lead to more easing of lending standards.

To obtain an aggregate series of the exogenous shocks to changes in banks' lending standards, we construct a weighted average of the residual ϵ_{it} from the full specification across banks in each period.

$$\epsilon_t = \frac{1}{N_t} \sum_{i=1}^{N_t} \psi_{it} \epsilon_{it},$$

where ψ_{it} is the ratio of bank i's loans to total loans in period t. We interpret the resulting ϵ_t as the component of the shock to lending standards that is economy-wide at time t and interpret each bank's deviation from this mean, $\epsilon_{it} - \epsilon_t$, as the idiosyncratic component of the shock to bank i's change in lending standards. As unexpected tightenings and easings in lending standards likely lead banks to decrease loan quantities and increase loan terms, and to increase loan quantities and decrease loan terms, respectively, these unexplained aggregate changes in lending standards represent shocks to the supply of loans.[19]

Figure 5 plots the industry-wide series.[20] The series shows many of the same qualitative patterns as the non-orthogonalized series: periods of unexplained easings in the 1990s and the middle of the 2000s, and tightenings around the Long-Term Capital Management crisis and the last two recessions. However, there are also several notable differences. This supply shock series shows unexplained tightenings in standards in 1992 and early 1993, while the simple standards series shows little change in standards over that period. The new series also shows unexplained easings in standards as the Long-Term Capital Management Crisis receded, while the non-orthogonalized series showed small net increases in tightening.

Finally, the new series shows relatively large swings in the unexplained portions of changes in standards in late 2008 through mid-2009. Our regression specification predicts that the unprecedented increase in credit spreads at the end of 2008 should have led to a extremely large tightening in lending standards; In actuality, standards did tighten further, but by less than predicted, producing a large negative residual. As credit spreads receded to lower, though still high, levels in early 2009, the regression specification predicts a substantial reduction in the degree of additional tightening. In actuality, standards continued to tighten, by more than the model predicted, producing an especially high residual. It is possible that the relative smoothness of the amount of actual additional tightening may be

[19] Note that *increases* in the series should produce *decreases* in loan supply, and vice-versa.

[20] The plot starts in 1992:Q1 due to limitations in the availability of some of the right-hand-side variables.

attributable to actions by policymakers to try to ameliorate disruptions to financial markets during this period.[21]

4 The Macroeconomic Effects of Loan Supply Shocks

We can now use our estimate of aggregate shocks to loan supply obtained in the previous section to estimate the effects of loan supply shocks on macroeconomic variables. We do so by including it as the exogenous variable in a VAR-X model. We do not include the series as an endogenous variable in a VAR model because the series is already orthogonal to several expected future macroeconomic variables by construction.

The VAR-X includes five endogenous variables: growth in real GDP; inflation, as measured by growth in the GDP deflator; growth in total core lending capacity; the credit spread index defined above; and the target federal funds rate. The last two variables are intended to in part capture financial shocks that may originate outside the banking system, and the effects of monetary policy, respectively.

The VAR-X model estimates:

$$Y_t = \alpha + A(L)Y_{t-1} + \beta\epsilon_t + \nu_t, \tag{4}$$

where:

- Y_t is the vector of five endogenous macroeconomic variables described above
- $A(L)$ is a lag polynomial, and
- ϵ_t is the aggregate loan supply shock series.

We estimate the model using two lags of the dependent variable over the period 1992:Q1-2010:Q2. Since our primary interest is in the response of the endogenous macroeconomic variables to the loan supply shock series, we do not try to place further identifying assumptions on the VAR to try to identify other macroeconomic shocks.

Figure 6 gives the impulse response of four of the endogenous macroeconomic variables–core lending capacity, real GDP, the credit spread index, and the target federal funds rate–to a one-time, one-standard deviation increase in the loan supply shock series. The effects on GDP and core lending capacity are cumulated, so that the plotted responses reflect the effects of the shock on the levels of those variables. We omit the effects of the shock on the GDP deflator, which are statistically and economically insignificant, for clarity of

[21] We have also computed an unweighted series. It closely resembles the weighted series, with the principle difference being that the tightening shocks peak at about 3.5 standard deviations. The estimates below are not qualitatively affected by using this series.

presentation. The two shaded areas indicate 70 percent and 90 percent confidence bands around the estimates; the bands are generated by Monte Carlo simulation.

The increase in lending standards–which presumably decreases loan supply–reduces the level of core lending capacity and real GDP, increases the credit spread index, and produces a reduction in the target federal funds rate. The decreases in core lending capacity and real GDP are substantial: by one year after the shock, the level of core lending capacity has declined by about two percentage points and the level of real GDP by about 0.4 percentage point. By five years after the shock, core lending capacity has declined by 4 percentage points and real GDP by 0.6 percentage points. These effects do not disappear over time because, by assumption, the increase in standards leads to a permanently higher level of lending standards. In practice, one might expect periods of tighter lending standards are eventually followed by periods of easier standards, leaving the overall level of standards over long periods of time about the same.[22] The effects of the shock on the credit spread index and the target federal funds rate are somewhat smaller–an increase of as much as 0.1 standard deviation and a decrease of as much as 20 basis points, respectively. Note also that shocks during the most recent recession peaked at about three standard deviations, implying very substantial depressions in real GDP growth and core lending capacity growth.

4.1 Comparison with Previous Results

Lown and Morgan (2006) include a measure of the aggregate change in C&I standards from the SLOOS in a VAR. When the change in standards is ordered after real GDP, the nominal federal funds rate, and real C&I loans, and structural shocks are identified by Choleski decomposition, they find that an 8 percent increase in the net fraction of banks reporting tightening leads ultimately to a 3 percent decrease in loan volume and a 0.5 percent decrease in real GDP. They find similar results when they extend the model to have measure of prices and bank health; expected real GDP; the paper-bill spread; and measures of bank and financial health, such as banks' capital to asset ratio and the coverage ratio to nonfinancial firms. They also find evidence that standards matter in a reduced-form model of inventory investment.

The results in this paper are slightly larger than those in Lown and Morgan. There are a number of differences in our approaches that may account for the results. We identify shocks to changes in standards by doing bank-level panel regressions of the change in standards on bank-specific variables, measures of aggregate uncertainty, financial market variables, and expected future macroeconomic variables. Lown and Morgan use the residual from

[22]Note, though, that the mean for the change in standards series is positive, suggesting a gradual tightening of standards over the sample period. It is possible that this reflects bias towards reporting tightening by survey respondents, who may not wish to appear lax in their lending standards. To the extent there is bias, fixed effects and other regressors in the panel regression will pick it up.

a just-identified VAR, in which the shocks are orthogonal to current and some expected future macroeconomic variables.[23] We also use changes in standards for multiple types of loan categories, while Lown and Morgan use those for C&I loans.

To better compare the two approaches, in Figure 7 we plot the results of taking the composite changes in lending standards plotted in Figure 1, putting it in a VAR with real GDP growth, the GDP deflator, core lending capacity, our credit spread index, and the federal funds rate, and doing a Choleski decomposition. For comparison, we also plot the residual series from our panel approach. The two series behave in a broadly similar fashion, though the VAR series shows less unexplained easings in standards in the expansion of the 2000s. Figure 8 shows the impulse responses to a lending standards shock. These results are qualitatively similar, though again somewhat larger, than those in Lown and Morgan. The effects on the macroeconomic variables appear to be beginning to return to zero by four to five years after the shock, as changes in lending standards turn from tightening to easing by that time.

Gorton and He (2008) find that increased dispersion across banks for the index on changes in standards on C&I loans matters for bank lending, but is not one of the most important determinants of changes in lending. Briggeman and Zakrzewicz (2009) show that a survey by the Federal Reserve Bank of Kansas City of credit standards at agricultural banks reliably predicts changes in credit quality of agricultural loans.

Other previous work attempting to identify the effects of exogenous changes in the banking market on real economic activity has achieved mixed results; Kashyap and Stein (1994) provides an early survey.[24] Peek and Rosengren (1995b, 2000), and Peek, Rosengren and Tootell (2003) have used regulatory actions and shocks to the parent banks of foreign-owned subsidiaries as measures of loan supply shocks, and have found effects on regional real estate markets. Gertler and Gilchrist (1994) and Kashyap, Stein, and Wilcox (1993) have found that small firms appear to substitute to forms of finance other than bank loans after monetary policy contractions. Samolyk (1994) finds that measure of local-credit tightness have greater predictive power for state-level output in states that have had lower quality of bank loans in the past. Driscoll (2004) finds that state-level money demand shocks do appear to lead to changes in the quantity of bank loans, but that changes in the latter do not appear to affect state-level output. Miron, Romer and Weil (1994) found no evidence for change in the strength of a lending channel of monetary policy over time; given the increased availability of other forms of finance, one would have expected that, if such a channel existed, its importance would have weakened.

Bernanke and Gertler (1989) and Bernanke, Gertler and Gilchrist (1996) proposed a 'fi-

[23] See Lown and Morgan (2002) and the commentary by Driscoll (2002) for further discussion of identification of shocks using the SLOOS.

[24] Also see the accompanying discussion by Eichenbaum (1994).

nancial accelerator' model, in which increases in the external finance premium faced by firms would lower borrowers' net worth, further raising the external finance premium. Bernanke, Gertler and Gilchrist (1999) embodied this mechanism in a DSGE model; variants of this model are frequently used to model the role of financial frictions in the short run. In such models, the distinction between bank and other forms of finance is often unclear. Oliner and Rudebusch (1996) argued that some of the evidence for the macroeconomic effects of the banking system was in fact evidence for the existence of a 'broad credit channel,' in which monetary policy shocks affect all forms of borrowing by changing the value of collateral.

5 Extensions

5.1 Asymmetry

Although tightenings and easings in standards likely lead to increases and decreases in loan supply, the effects need not be the same. To test this possibility, we divide our shock series into positive values (unexplained tightenings), and negative values (unexplained easings), and re-run the VAR-X for each set. Figures 9 and 10 plot the impulse responses for the tightenings and easings cases, respectively. The tightening responses are qualitatively very similar to those presented in Figure 6, though somewhat larger. The easing responses, by contrast, show no economically or statistically significant changes in the macroeconomic variables. Thus, responses to unexplained tightenings appear to be much greater than those for easings.

5.2 How Good is Our Measure of Loan Supply Shocks? Estimating the Slope of the Loan Demand Curve

Although we have tried to remove variables that might affect loan demand, and loan supply variables that might also be correlated with loan demand, from our changes in standards series, we likely have not fully purged the change in standards series of endogeneity. One way of testing the extent to which our series is capturing changes in standards is to see whether it helps us to estimate loan demand. To the extent that our variable captures exogenous changes in standards that lead to changes in loan supply, it should serve as a good instrumental variable for shocks to loan supply in a regression of loan quantity on loan price, thus tracing out the loan demand curve.

We can construct such estimates by using the Federal Reserve Board's Survey of Terms of Business Lending (STBL). The STBL is a quarterly survey of about 400 banks on price and non-price terms and quantities on C&I loans. More information on the STBL may be found at the Federal Reserve's website, at http://www.federalreserve.gov/releases/e2/.

Our sample uses observations on 218,621 loans from 53 banks over the period 1997:Q2 to 2010:Q2.

Estimation of a loan demand curve is complicated by the fact that loans are multidimensional products; loans are characterized by not only their amount and their interest rate, but by their duration, whether they are a credit line (or loan under commitment) or spot-market loan, whether they are secured by collateral or not, and by other price and non-price characteristics. Variations in lending standards, or in factors that might affect loan supply more generally, will generally affect many characteristics other than the interest rate or loan quantity. To simplify matters, we restrict our sample to unsecured loans, thus removing changes in the amount of collateral required as a source of variation.

Table 3 reports the results of regressing the log of loan size (in thousands of dollars) on the spread of that loan's rate over a market interest rate of constant maturity (units are percentage points). We also include a dummy variable equal to one if the loan was made under commitment (i.e. is a credit line) and zero otherwise, and the interaction of that dummy with the loan-rate spread variable. The behavior of credit line draws may be different from that of spot-market loans. The first column reports results from an OLS regression. We see that the semi-elasticity on the spread is negative and statistically significant.

The second column reports the results of repeating the regression, but now using an analog to our lending standards shock series as an instrument.[25] The coefficient on the spread shows a large increase in absolute value to -1.4. The results imply that a 1 percentage point increase in the loan spread is associated with a 1.4 percent reduction in loan demand. The differences between loans under commitment and not under commitment are not statistically significant.[26]

The result that the negative coefficient on the loan spread more than doubles in size when going from the OLS to the IV regression when our lending standards shock series is used as an instrument is consistent with the idea that the latter is largely capturing changes in loan supply, rather than loan demand.

[25] Because the STBL only includes C&I loans, we only use the change in standards for C&I loans. We constuct two measures: one for tightenings in standards and one for easings. In each case, we regress a dummy for tightenings(easings) on the same set of variables as in Table 2, though replaced the credit spread index with a BBB corporate bond spread. The qualitative behavior of these series together closely match the series we use elsewhere in the paper. As instruments, we use both of these series, and the interactions of these series with the commitment status dummies.

[26] Replacing the spread with the loan rate makes no economic or statistically significant difference.

6 Conclusion

The recent recession has highlighted the potentially critical role that banks and financial institutions more generally may play in economic fluctuations–either as sources of macroeconomic shocks or a transmission mechanisms for such shocks. Researchers have long attempted to determine the importance of such roles. Their efforts have been complicated by a difficult endogeneity problem: many economic shocks likely simultaneously affect both the supply and demand for bank loans and measures of real economic activity.

In this paper, we derive a loan supply shock series using a panel dataset of answers to the Federal Reserve's quarterly Senior Loan Officer Opinion Survey (SLOOS), bank-specific information (income and balance-sheet measures and equity market measures), and expected future macroeconomic variables. The survey asks banks how they have changed their standards over the preceding three months for making various categories of loans. Such changes in standards are likely partly endogenous to other macroeconomic shocks. By regressing these changes on both bank-specific variables, including survey responses on changes in loan demand, and expected future macroeconomic variables, we believe we have eliminated much of this endogeneity.

The resulting shock series accords well with narrative descriptions of the period, showing unexplained tightenings in standards (restrictions in credit supply) during the early 1990s credit crunch, the 1998 Long-Term Capital Management Crisis, and around the last two recessions, and showing unexplained easings in standards during the periods of high economic growth in the 1990s and middle of the 2000s.

When we use a VAR-X model to estimate the effects of lending shocks on macroeconomic variables, we find large, economically significant effects on real GDP and core lending capacity, and smaller but still nontrivial effects on an index of credit spreads and on the federal funds rate. The estimates imply very large macroeconomic effects during the most recent recession, since the shock series reached historically high levels. The results are asymmetric, with unexplained tightenings in standards producing larger effects than easings.

We try to further test how well our series captures shocks to loan supply by using an analog of it for just c&I loans as an instrument in a regression of loan quantity on loan rate spreads, using bank-level panel data from the Federal Reserve's Survey of Terms of Business Lending. We find that the estimated semi-elasticity of loan demand more than doubles in size, to -1.4, when our lending shocks series is used as an instrument, suggesting that it is indeed largely capturing shocks to loan supply.

There are some caveats to the results. First, we may not have completely purged endogenous changes in standards from the shock series, which would lead to an overstatement of the macroeconomic effects of the shocks. Second, we may have improperly controlled for

the effects of some bank-specific variables that in fact produce exogenous changes in lending standards. This would lead to an understatement of the macroeconomic effects of the lending shocks. Third, our bank lending shocks may also be picking up the effects of broader shocks to the financial system not adequately captured by our exogenous variables, thus leading to an overstatement of the effects of bank lending specifically on macroeconomic variables. We have tried to address this possibility by including an index of credit spreads into both the panel regressions underlying the shock series and into the VAR-X analysis, but our efforts may be imperfect. It would be of interest to see how this measure of lending supply shocks interacts with other measures of financial market disruptions during the recent financial crisis.

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Table 1: Summary Statistics of Variables in Panel Regression

Variable	Min	Max	Mean	Std Dev
Bank-level variables (N=2,879)				
ΔS_{it}	-1	1	0.090	0.327
$\Delta Demand_{it}$	-1	1	-0.039	0.464
$NetIntMarginBOP_{it}$	-0.001	0.025	0.009	0.002
$DelinqBOP_{it}$	0.002	0.110	0.022	0.015
$CoreLnShrBOP_{it}$	0.012	.831	0.516	0.177
$CoreDepShrBOP_{it}$	0.025	1.001	0.489	0.144
$TobinsQ_{it}$	0.900	1.500	1.087	0.075
$StkRtrn_{it}$	-1.033	0.890	0.027	0.146
$StkRtrnVol_{it}$	0.067	2.306	0.299	0.207
Macro variables (N=74)				
$\Delta TBillYld_{t+4}$	-0.003	0.016	0.004	0.004
$\Delta TBondYld_{t+4}$	-0.002	0.009	0.003	0.003
$\Delta RealGDP_{t+4}$	-0.008	0.039	0.027	0.006
$CredSprdIndex_t$	-1.328	4.174	0.033	1.039
$DispersionIndex_{t+4}$	-1.529	3.775	-0.015	0.998

NOTE: For all variables, i indexes the bank and t the time period. $\Delta S_{i,t}$ is the weighted change in standards as defined in the text. $\Delta Demand_{i,t}$ is the weighted change in demand for loans. $NetIntMargin_{i,t}$ is the net interest margin. $Delinq_{i,t}$ is the delinquency rate on all loans and leases. $CoreLnShr_{i,t}$ is the ratio of core loans to total assets, where core loans equals the sum of real estate, C&I, credit card, and consumer loans. $CoreDepShr_{i,t}$ is the ratio of core deposits to total liabilities, where core deposits equals transaction accounts (including demand deposits), savings accounts, and small time deposits. $TobinsQ_{i,t}$ is the ratio of the market value of bank i's parent bank holding company plus its total liabilities to the holding company's total assets in period t. $StkRtrn_{i,t}$ is the quarterly return earned on bank i's parent holding company's stock as of the end period t. $StkRtrnVol_{i,t}$ is a measure of the volatility of bank i's parent holding company's stock, based on daily returns in period t. $\Delta TBillYld_{i,t+4}$, $\Delta TBondYld_{i,t+4}$, and $\Delta RealGDP_{i,t+4}$ are expectations about the four quarter change in the three-month Treasury bill rate, the ten-year Treasury bond rate, and real gross domestic product. $CredSprdIndex_t$ is the first principal component of several consumer and corporate credit spreads. $DispersionIndex_{t+4}$ is the first principal component of several series that measure the amount of dispersion in expectations about year ahead values of variables that track growth in the real economy.

Table 2: Panel regression of change in standards on bank-specific and macro variables

Dependent variable: ΔS_{it} (weighted change in standards)

Explanatory Variable	(1)	(2)	(3)	(4)
ΔS_{it-1}	0.358 (0.003)	0.540 (0.019)	0.405 (0.022)	0.387 (0.022)
$\Delta Demand_{it}$	-0.054 (0.001)	-0.096 (0.015)	-0.075 (0.013)	-0.069 (0.013)
$\Delta TBillYld_{t+4}$			-5.662 (1.397)	-4.237 (1.594)
$\Delta TBondYld_{t+4}$			-6.597 (3.192)	-10.338 (3.231)
$\Delta RealGDP_{t+4}$			-5.452 (1.300)	-4.369 (1.319)
$CredSprdIndex_t$			0.116 (0.010)	0.120 (0.010)
$DispersionIndex_{t+4}$			-0.064 (0.008)	-0.047 (0.009)
$NetIntMarginBOP_{it}$				-8.638 (3.406)
$DelinqBOP_{it}$				-1.064 (0.524)
$CoreLnShrBOP_{it}$				0.291 (0.099)
$CoreDepShrBOP_{it}$				-0.138 (0.072)
$TobinsQ_{it-1}$				0.070 (0.094)
$StkRtrn_{it-1}$				-0.143 (0.038)
$StkRtrnVol_{it-1}$				-0.066 (0.037)
Bank Fixed Effects	No	Yes	Yes	Yes
Generalized R^2 (N = 2,879)	0.140	0.389	0.439	0.449

NOTE: Variables are defined as in Table 1. Standard errors are in parentheses.

Table 3: Regression of loan size on spread of loan rate above reference rate using data from the Survey of Terms of Business Lending

Dependent variable: $Loansize_{ijt}$ (Log of loan size in thousands of dollars)

Explanatory Variable	(OLS)	(Instrumental Variables Regression)
$Spread_{ijt}$	-0.61	-1.44
	(0.10)	(0.45)
$Commit_{ij}$	-0.24	-0.75
	(0.56)	(1.25)
$CommitSpread_{ijt}$	-0.07	0.11
	(0.10)	(0.40)

NOTE: $Spread_{ijt}$ is the spread of the rate of loan i, made by bank j, in period t over the market interest rate on an instrument of comparable maturity. $Commit_{ij}$ is an indicator variable that is equal to one if loan i at bank j was made under commitment and equal to zero otherwise. $CommitSpread_{ijt}$ is the variable created by interacting $Spread_{ijt}$ and $Commit_{ij}$. Standard errors are in parentheses. The first column reports the results of an OLS regression, and the second column an IV regression using our standards shock series as an instrument. All regressions include bank fixed effects.

Figure 1: Indexes of changes in lending standards and demand

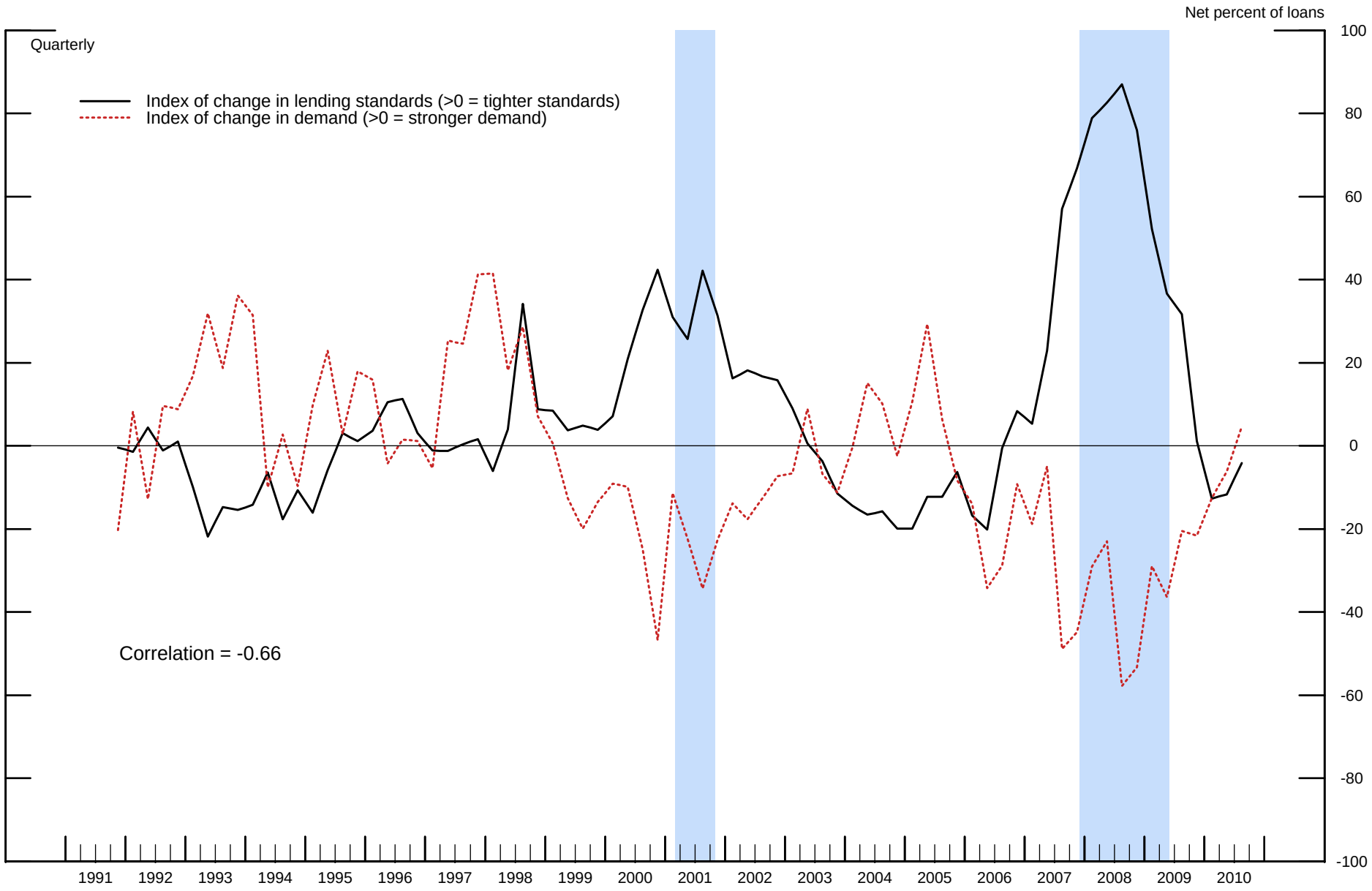
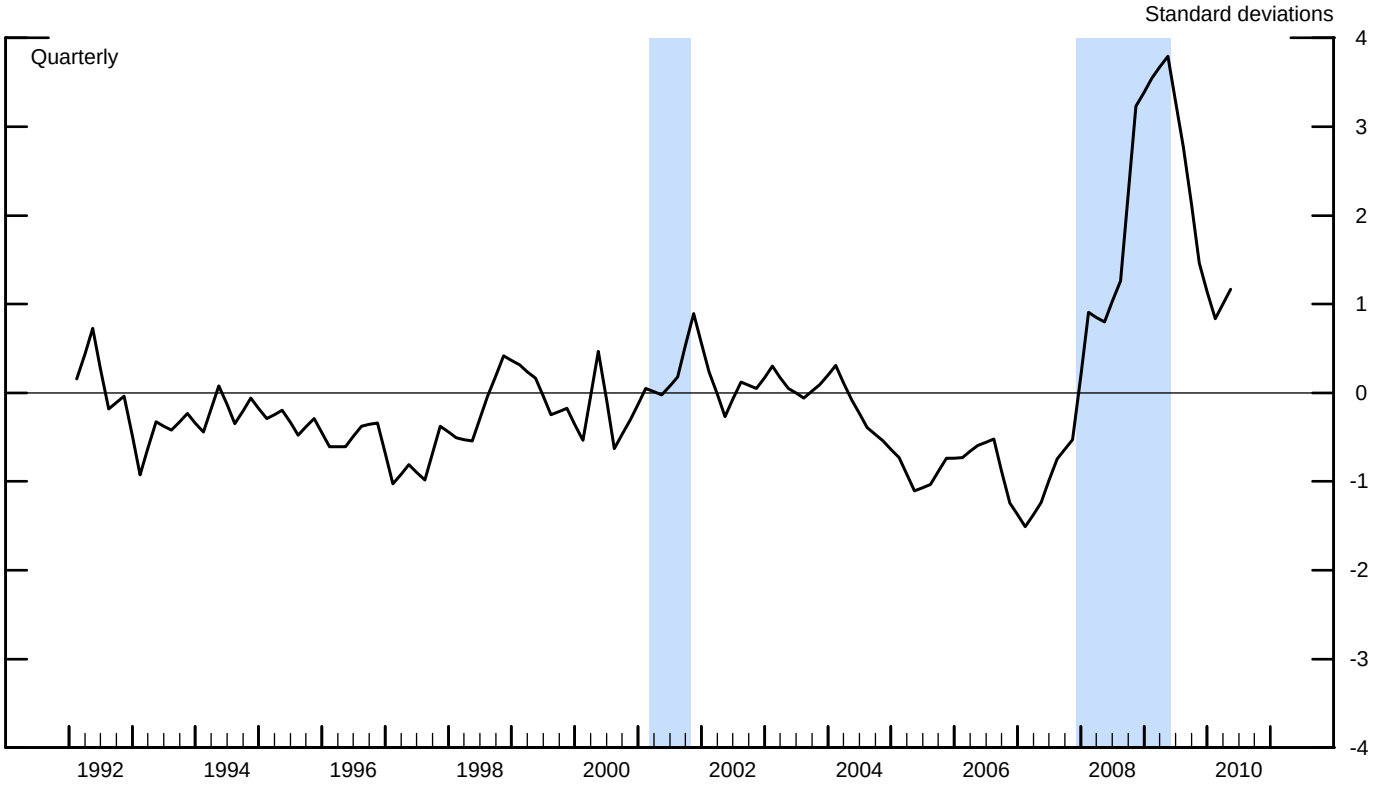


Figure 2

Forecast dispersion index



Credit spread index

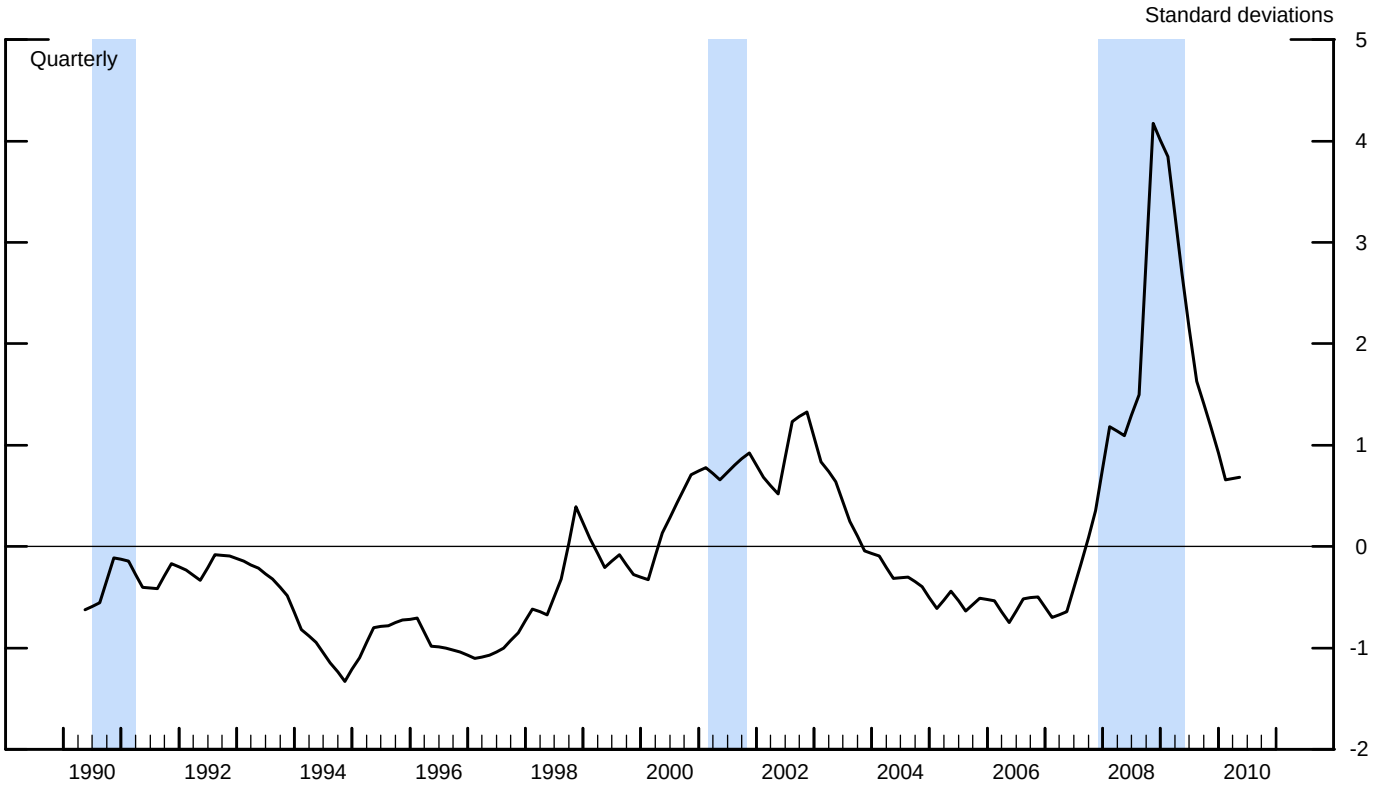


Figure 3: Core lending, unused commitments, and lending capacity

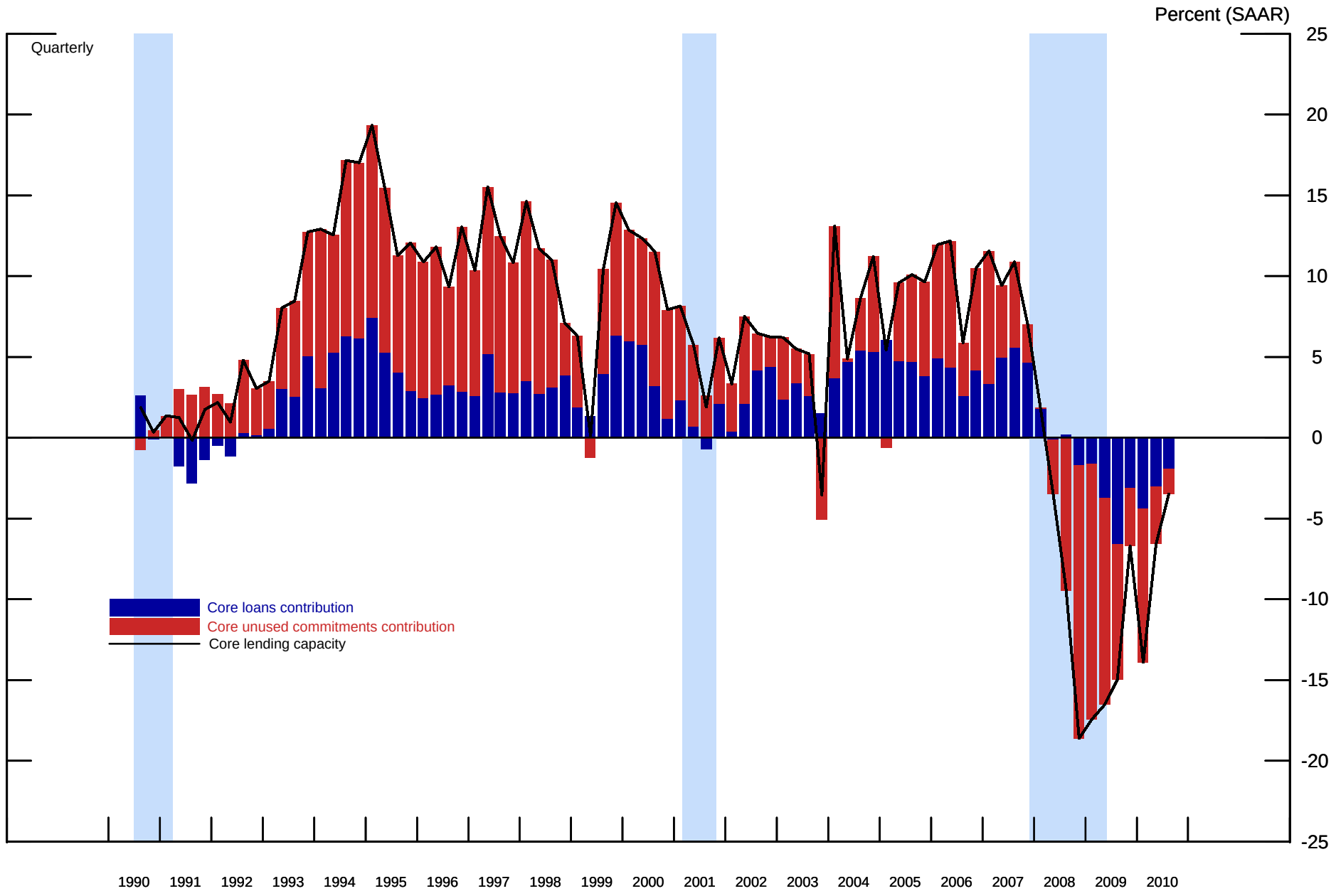


Figure 4: Reasons for tightening or easing standards on C&I loans

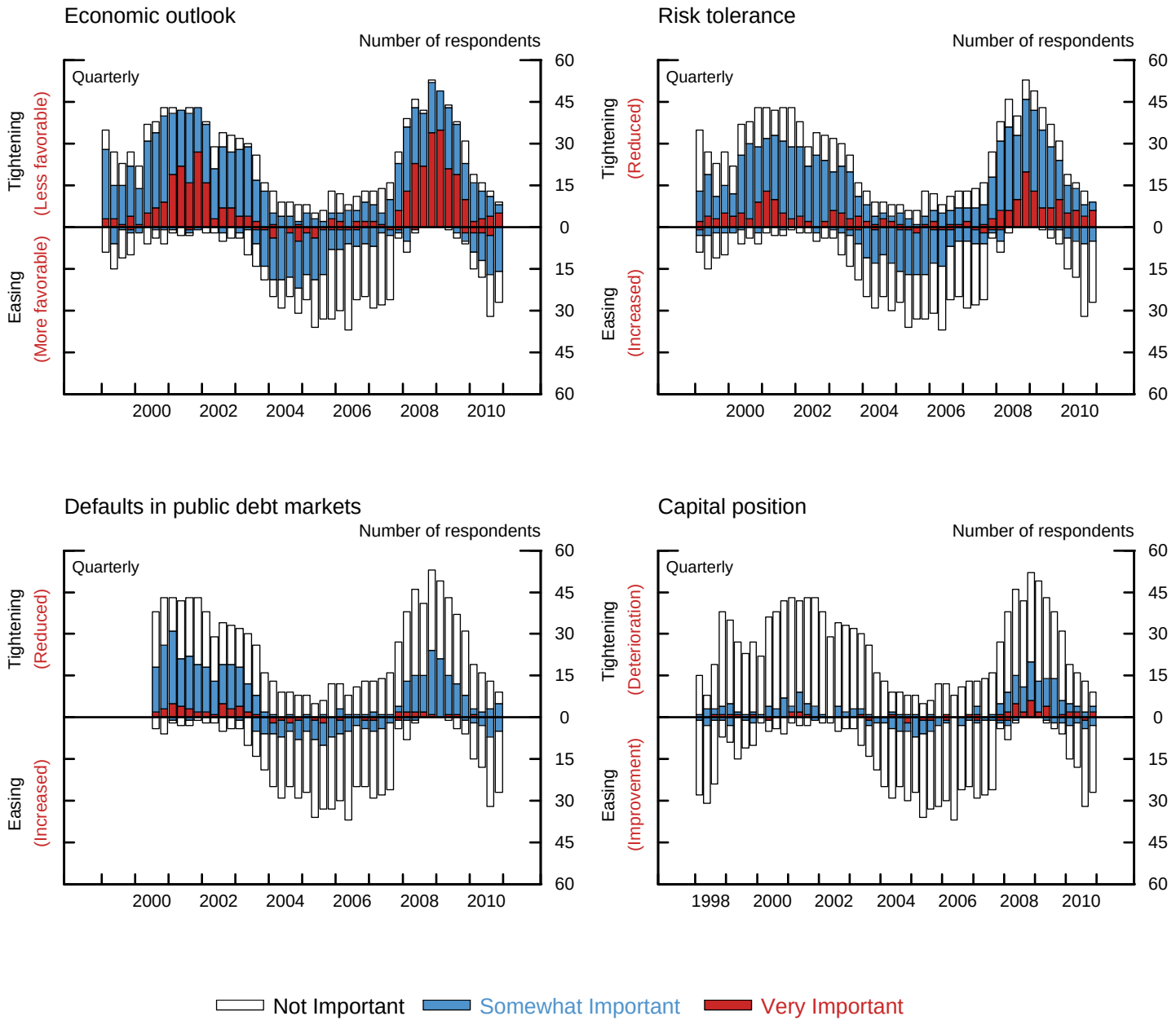


Figure 5: Exogenous shocks to bank lending standards

Average of bank-specific residuals from panel regression

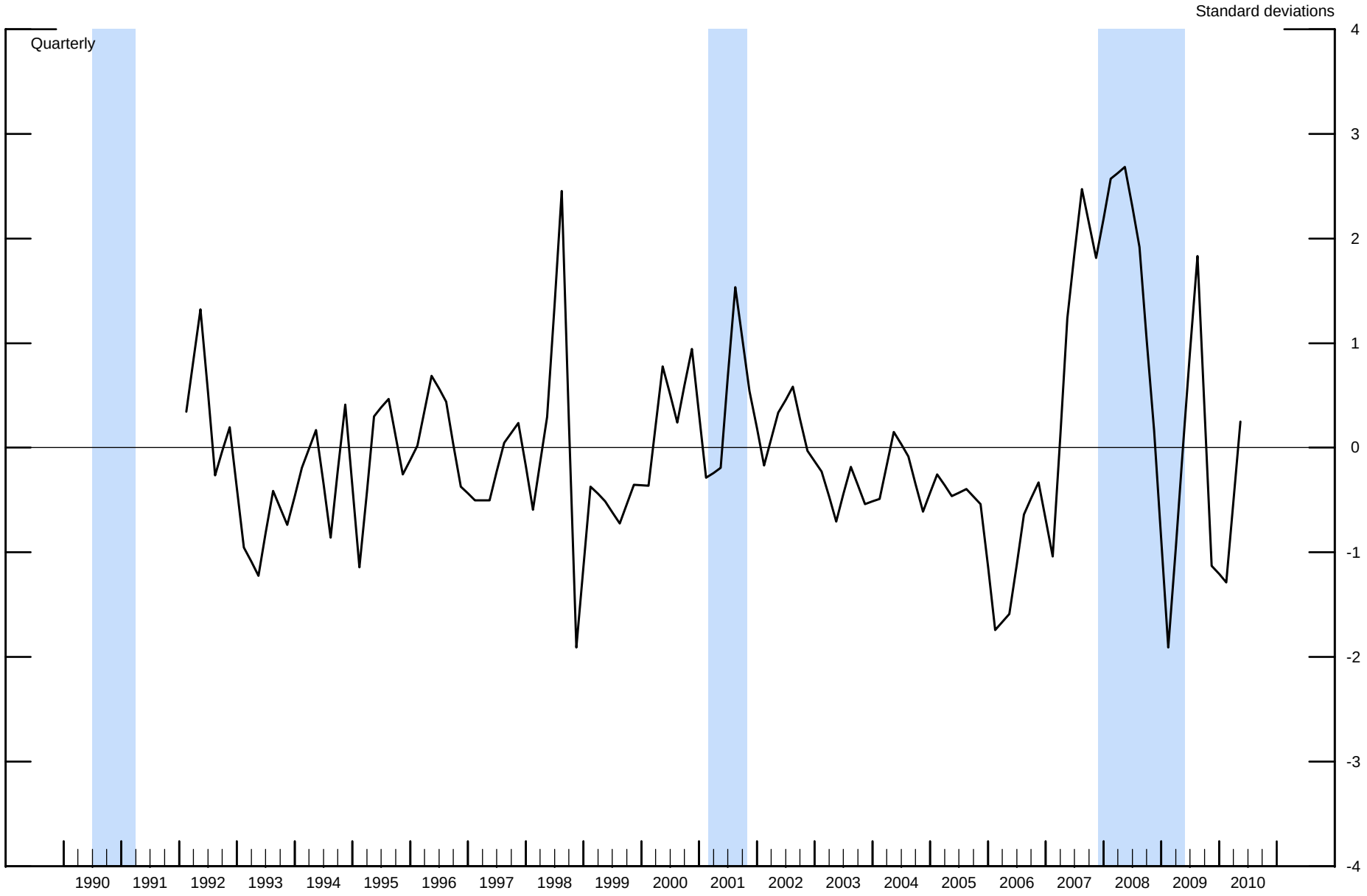
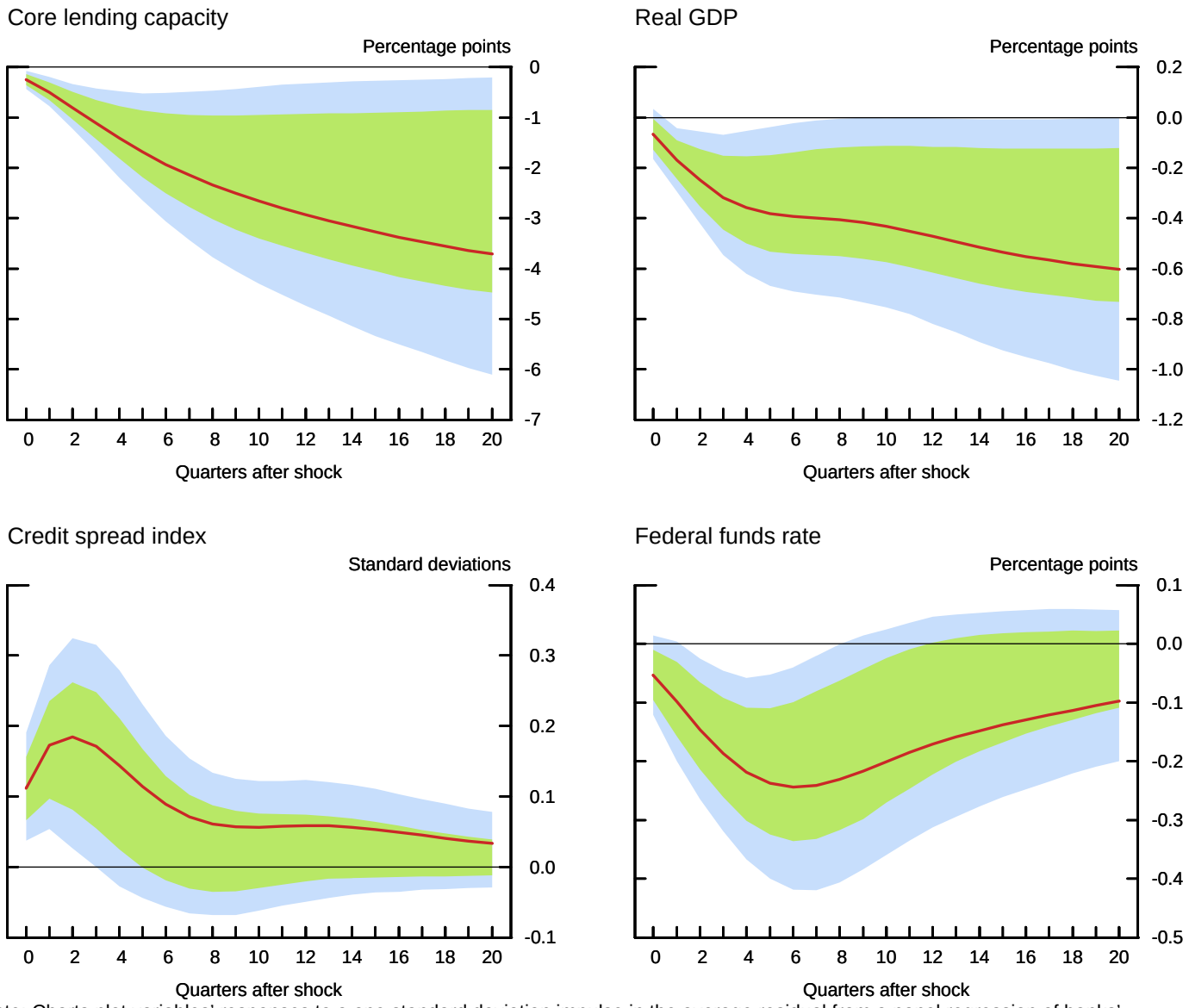


Figure 6: Implications of a tightening of lending standards



Note: Charts plot variables' responses to a one standard deviation impulse in the average residual from a panel regression of banks' tightening indexes on macroeconomic and bank-specific explanatory variables.

Figure 7: Comparison of lending standards shock series: panel regression and identified VAR

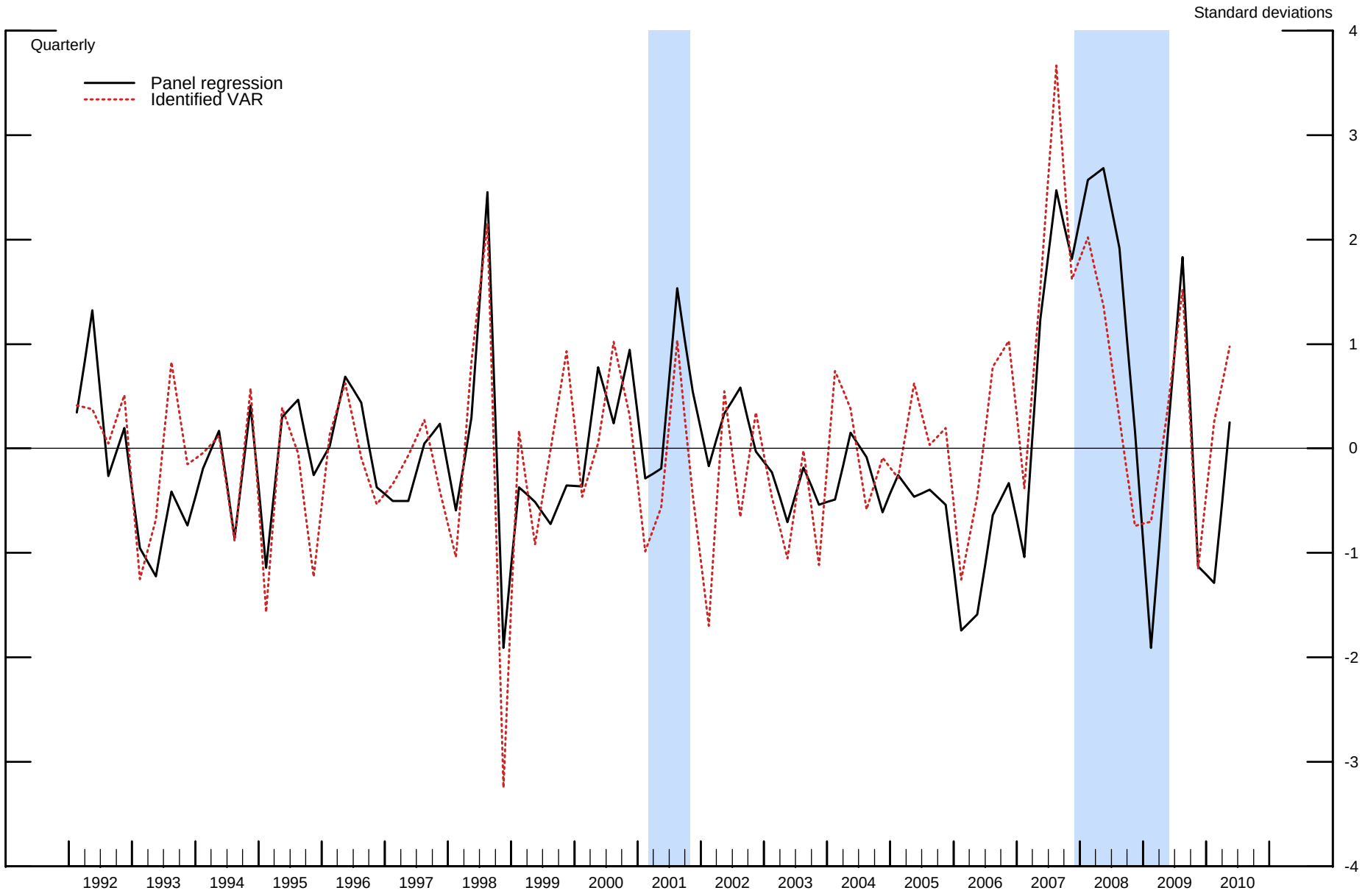


Figure 8: Impulse responses from identified VAR

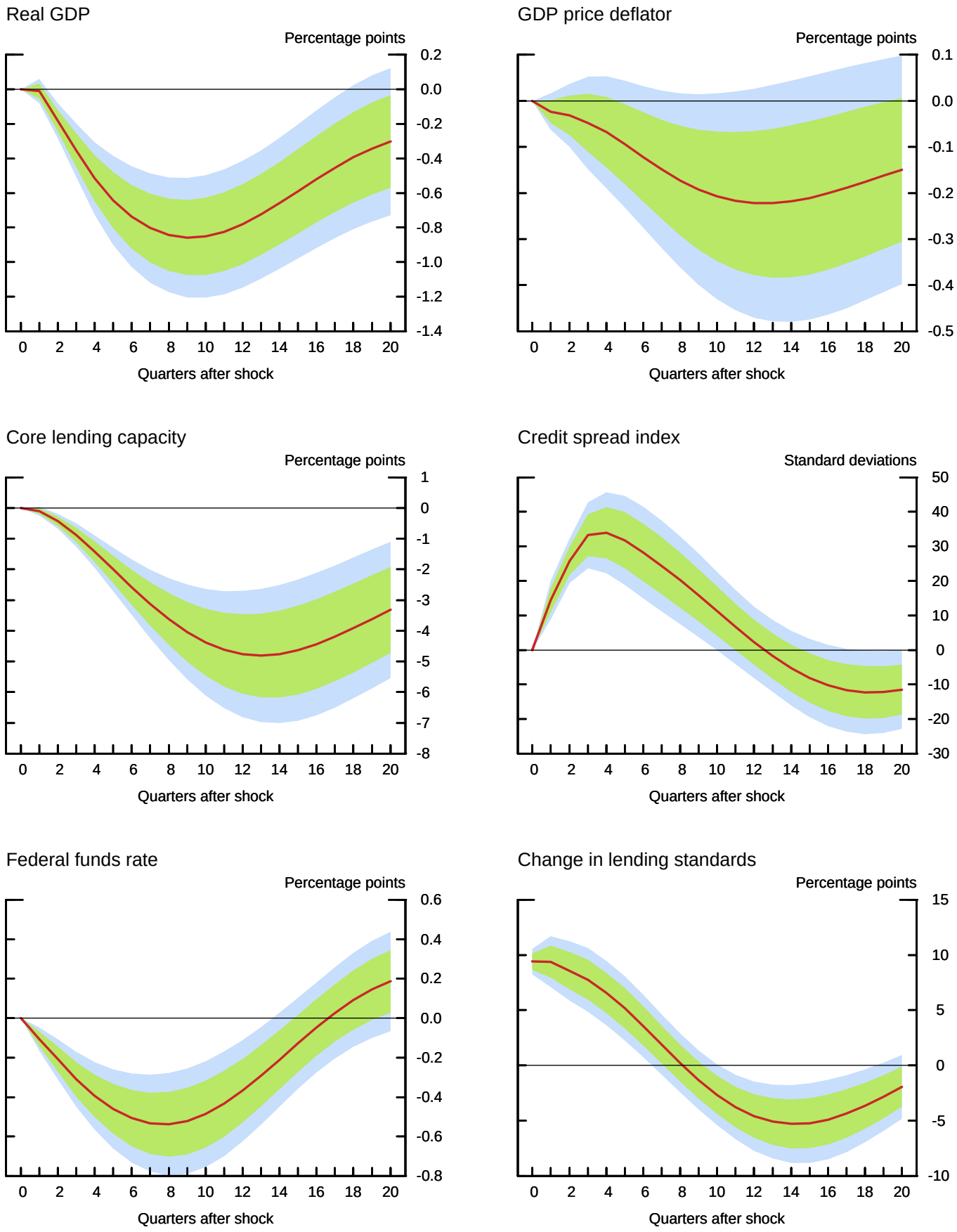
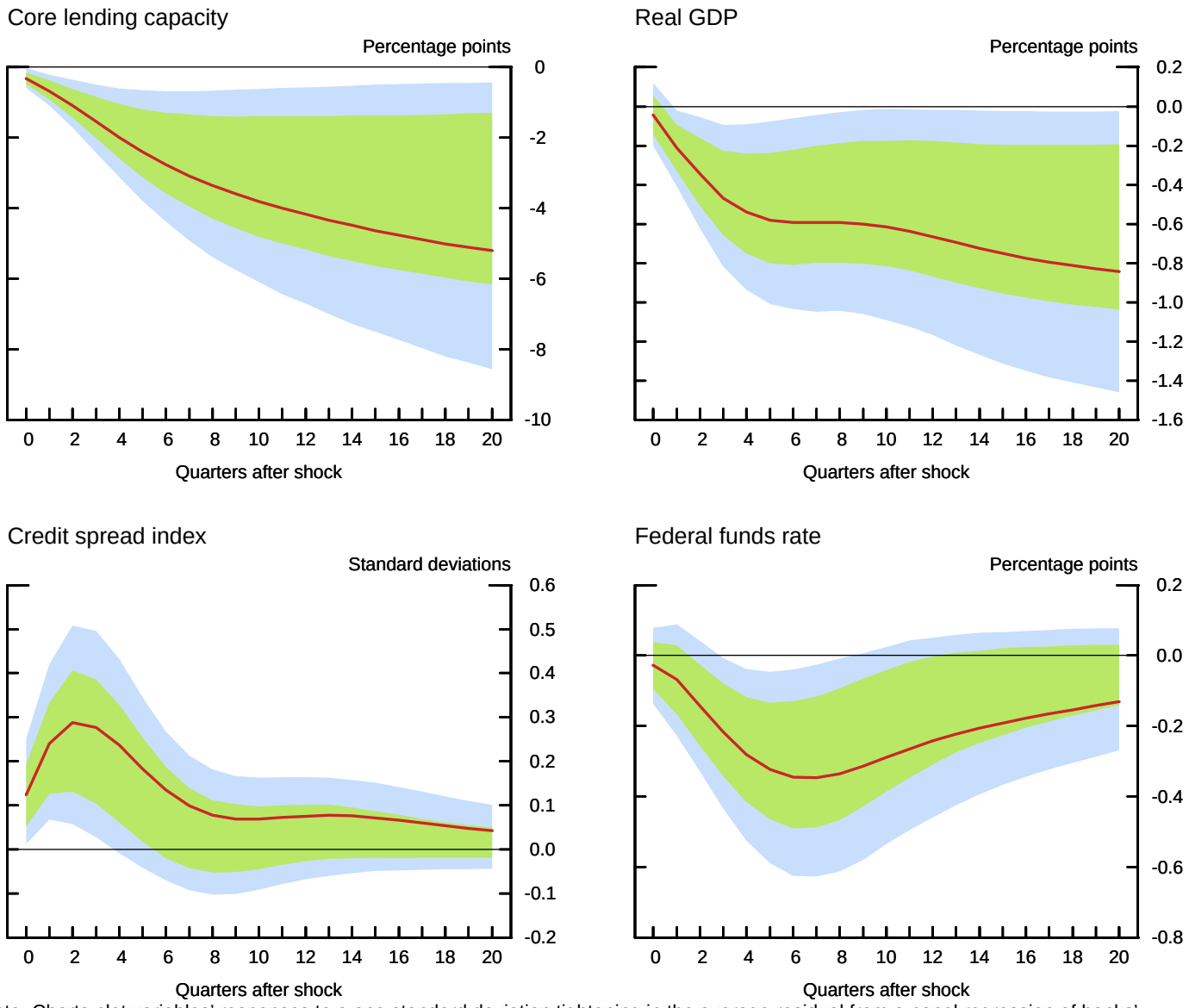
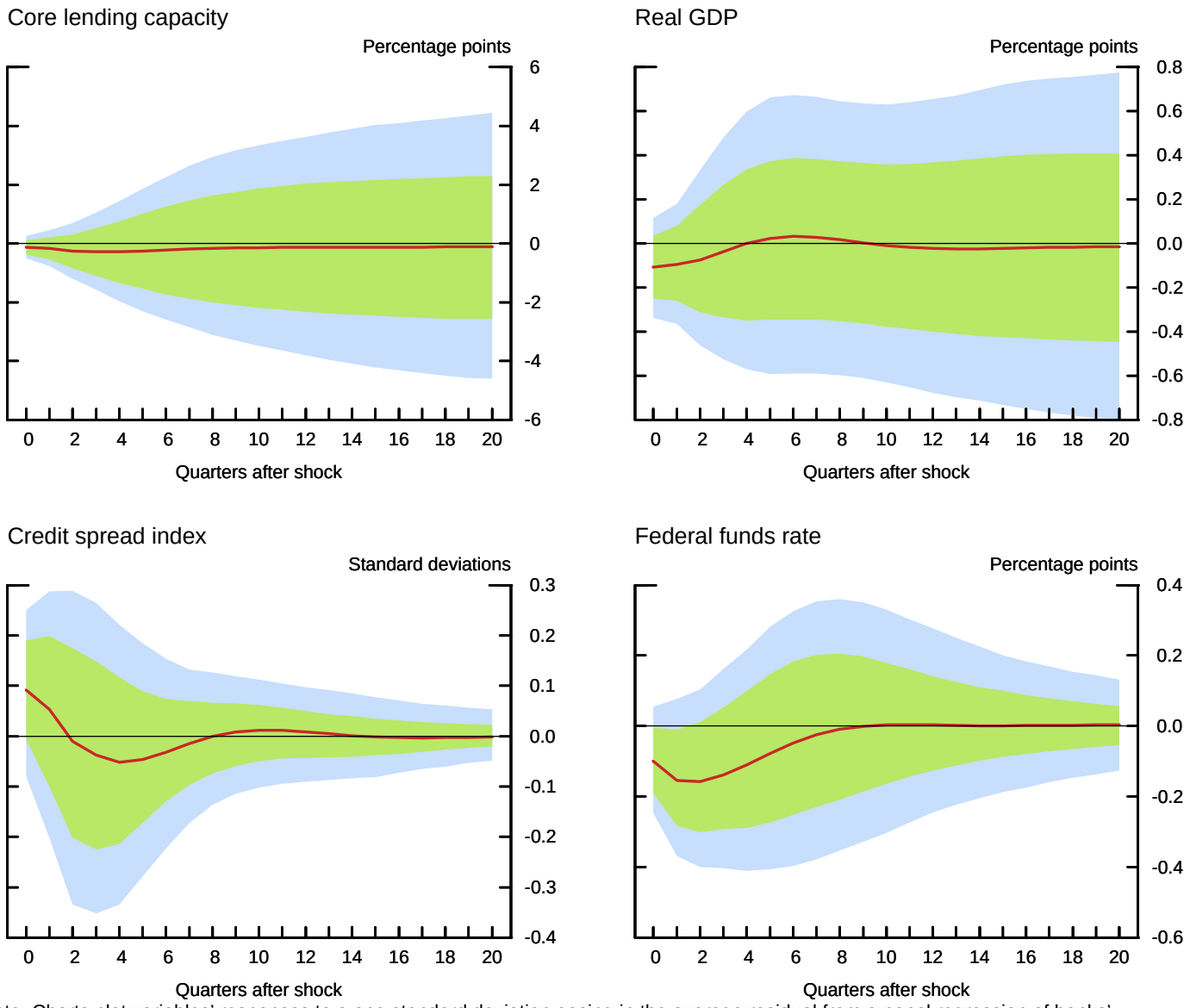


Figure 9: Implications of a tightening in lending standards (Allowing separate effects for tightening and easing)



Note: Charts plot variables' responses to a one standard deviation tightening in the average residual from a panel regression of banks' tightening indexes on macroeconomic and bank-specific explanatory variables.

Figure 10: Implications of an easing in lending standards (Allowing separate effects for tightening and easing)



Note: Charts plot variables' responses to a one standard deviation easing in the average residual from a panel regression of banks' tightening indexes on macroeconomic and bank-specific explanatory variables.