



EUROPEAN CENTRAL BANK

EUROSYSTEM

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**TRUSTING THE
BANKERS**

**A NEW LOOK AT
THE CREDIT
CHANNEL OF
MONETARY
POLICY**

by Matteo Ciccarelli,
Angela Maddaloni
and José-Luis Peydró



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A NEW LOOK AT THE CREDIT CHANNEL OF MONETARY POLICY¹

by Matteo Ciccarelli², Angela Maddaloni³
and José-Luis Peydró⁴



In 2010 all ECB publications feature a motif taken from the €500 banknote.

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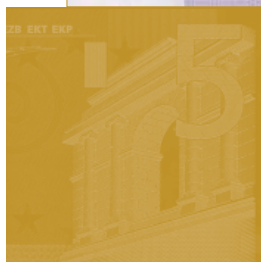
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Abstract

Any empirical analysis of the credit channel faces a key identification challenge: changes in credit supply and demand are difficult to disentangle. To address this issue, we use the detailed answers from the US and the confidential and unique Euro area bank lending surveys. Embedding this information within a standard VAR model, we find that: (1) the credit channel is active through the balance-sheets of households, firms and banks; (2) the credit channel amplifies the impact of a monetary policy shock on GDP and inflation; (3) for business loans, the impact through the (supply) bank lending channel is higher than through the demand and balance-sheet channels. For household loans the demand channel is the strongest; (4) during the crisis, credit supply restrictions to firms in the Euro area and tighter standards for mortgage loans in the US contributed significantly to the reduction in GDP.

JEL classification: E32, E44, E5, G01, G21

Keywords: Non-financial borrower balance-sheet channel, Bank lending channel, Credit channel, Credit crunch, Lending standards, Monetary policy

Non-technical summary

The events unfolding in the global economy over the last few years suggests that the financial sector, and the banking sector in particular, is a key determinant of business cycle fluctuations. Most European countries and the US have experienced the worst financial crisis since the Great Depression. The global recession that has followed also appears to be the most severe of this era.

The role played by the banking sector in affecting the economy at large, in particular through the supply of credit to the private sector, has become a central issue of concerns for academics and policy makers alike. The provisions of credit to the private sector to fund investment and consumption may be impaired in periods of financial distress. During these time credit restrictions may be the reflection of banks' solvency and liquidity problems, which constrain their *ability* and *incentive* to provide credit. At the same time, the worsened financial position of firms and households may restrict their *capacity* to borrow, because of their increased riskiness. Finally, the grim economic outlook may also weaken the demand for loans.

During the recent financial crisis, the actions undertaken by central banks in most developed countries were aimed at supporting aggregate demand, but also at countervailing the reduction of credit to the private sector by banks. Therefore, identifying and quantifying the mechanisms linking monetary policy, credit provision and the macroeconomy becomes even more relevant.

In this paper, we address empirically a number of related questions on the impact of credit channels on GDP growth and inflation and how changes in monetary policy are transmitted through these channels. We also focus on the period of the recent financial crisis and look at the role played by bank balance sheet constraints in reducing GDP through tighter credit provision.

We separate credit supply and demand by using a novel dataset based on the detailed information from the US and from the unique and confidential Euro area bank lending survey, where we observe loan demand changes, changes in lending standards due to firm (or household) changes in net worth/risk, and changes in lending standards due to changes in bank balance sheet capacity (capital and liquidity).

Three sets of results emerge from the analysis. First, the credit channel of monetary policy transmission is operational. Changes in overnight interest rates affect credit availability, which in turn impacts output and inflation. These results hold for all type of loans (business, mortgages and consumer) and economic regions, albeit with differences in the size and timing of the impacts. Moreover, both changes in bank balance sheet capacity and changes in borrowers' financial position have an impact on GDP and prices through credit availability.

Second, we quantify the different channels and find that the credit channel significantly amplifies the impact of a monetary policy shock on GDP and inflation. Moreover, for firms, the impact through the (supply) bank lending channel is higher than through the demand and firm balance-sheet channels. For household loans, instead, the demand channel is the strongest.

Finally, focusing the analysis during the period of the financial crisis, we find that, in the Euro area, a reduction of credit supply to firms significantly contributed to the decline in GDP growth – i.e. there has been a credit crunch with real effects. At the same time, the actions of the European Central Bank and of the Eurosystem – both monetary policy rate cuts and non-standard measures of liquidity provisions – gave a significant support to the real economy. In the US, restrictions to credit availability for mortgage loans were more important in explaining the GDP decline.

These latest results may therefore give some indications on actions to be pursued by central banks in response to financial crises. Our analysis shows that when a financial crisis affects the provision of credit (for example because it affects in particular bank balance sheet capacity), both policies of aiming at relaxing balance sheet constraints of banks and of lower policy rates may be beneficial and help to sustain economic growth and employment.

“Extremely important outstanding questions for research. One is the [...] role of the credit channel in our understanding of economic fluctuations and monetary policy. The literature in this area remains thin, and this thinness reflects difficulty in specifying the relevant mechanisms and finding the supporting empirical evidence.” Boivin, Kiley and Mishkin (2010), *Handbook of Monetary Economics*

“Much of the earlier macroeconomics literature with financial frictions emphasized credit market constraints on non-financial borrowers and treated intermediaries largely as a veil (see, e.g. BGG).” Gertler and Kiyotaki (2010), *Handbook of Monetary Economics*

“Fluctuations in the supply of credit arise from how much slack there is in financial intermediary balance sheet capacity [...]. Variations in the policy target determine short term interest rates, and have a direct impact on the profitability of intermediaries.” Adrian and Shin (2010), *Handbook of Monetary Economics*

1 Introduction

The events unfolding in the global economy over the last few years suggests that the financial sector – the banking sector in particular – is a key determinant of business cycle fluctuations. Most European countries and the US have experienced the worst financial crisis since the Great Depression. The global recession that has followed also appears to be the most severe of this era.

Banks affect the economy at large through several channels. One of the most important mechanisms concerns the provision of credit to the private sector. Bank balance-sheet capacity affects the provision of credit to the private sector that will use it to fund investment and consumption. During the recent financial crisis, for instance, credit restrictions may have been the reflection of banks’ solvency and liquidity problems. At the same time, the worsened financial position of firms and households may have constrained their capacity to borrow, because of their increased riskiness. In addition, the grim economic outlook may have induced weaker demand for loans. Consequently, the actions undertaken by central banks in most developed countries were aimed at supporting aggregate demand, but also at countervailing the reduction of credit to the private sector by banks. Therefore, identifying and quantifying the mechanisms linking monetary policy, credit provision and the macroeconomy is particularly relevant.

In this paper, we address empirically a number of related questions: (i) Does monetary policy affect GDP and inflation through the (broad) credit channel? (ii) What is the relative importance of the loan demand channel, the (non-financial borrower) balance-sheet channel, and the (narrow) banking lending supply channel? Is the impact of monetary policy different for loans to households and firms? (iii) Finally, focusing on the recent

financial crisis, did constraints on bank capital and liquidity significantly reduce GDP through a reduction of credit supply?¹

Any empirical study of the credit channel of monetary policy faces a key challenge and the literature has not succeeded so far in defining a clean identification strategy to address it. Changes in the demand for credit and in credit supply conditions are in general unobserved variables. A restrictive monetary policy shock may reduce *at the same time* credit demand and supply. When the policy interest rate increases, the cost of the loan (lending rate) raises, possibly dampening loan demand. At the same time, also the external finance premia faced by both non-financial borrowers and banks increase, therefore affecting credit. Observable credit macro-aggregates (quantities and prices) do not convey enough information to isolate changes in credit supply. In fact, following a monetary tightening, both the classical interest rate channel (through loan demand) and the credit channel would predict a decline in the volume of new loans granted.² Concerning the price of loans, average loan spreads may not even significantly increase in the aftermath of a monetary tightening because of *flight to quality* of banks to the best borrowers (Bernanke, Gertler and Gilchrist, 1996). Hence, the composition of bank loans' portfolio changes as well, thus implying that average loan spreads and volumes are insufficient measures to identify the credit channel.

The literature has tried to solve this identification problem with the help of micro data, such as firm and bank level data (see Bernanke and Gertler, 1995). However, as pointed out by Kashyap and Stein (2000), the micro identification cannot analyze the *total* effect of a monetary policy shock on aggregate credit and output, but only a difference-in-difference effect by comparing banks (see e.g. Kashyap and Stein, 2000) or non-financial borrowers (see e.g. Gertler and Gilchrist, 1994) with different degree of sensitivity to a monetary policy shock. In addition, constrained borrowers may borrow from constrained banks

¹For the definitions of the different channels see Bernanke and Gertler (1987 and 1995), Bernanke (2007), and Gertler and Kiyotaki (2010). As suggested by Holmstrom and Tirole (1997), Stein (1998), Diamond and Rajan (2001), and Freixas and Rochet (2008), bank loan supply is shaped by the frictions stemming from the agency costs of borrowing between banks and their non-financial borrowers (firms and households), but also between banks and their providers of funds (retail and wholesale depositors, and equity-holders). Monetary policy influences the severity of these frictions via changes in net worth and external finance premia of both non-financial and financial borrowers. Therefore it may affect loan supply and, as a consequence, aggregate output and prices (Bernanke and Blinder, 1988, 1992; Diamond and Rajan, 2006, 2009; Gertler and Karadi, 2010; Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997, 2008; Bernanke, Gertler, Gilchrist, 1996, 1999; Matsuyama, 2007; Fostel and Geanakoplos, 2009; Adrian and Shin, 2008, 2009; and, Stiglitz and Greenwald, 2003; Stiglitz and Weiss, 1981; and Stiglitz, 2001).

²Loan volume, in addition, is also affected by previously committed loans and credit lines (no *new* lending). Furthermore, bank loan demand may increase after a monetary tightening to finance working capital and inventory or because of a restricted access to market financing for borrowers (see Bernanke and Gertler, 1995; Friedman and Kuttner, 1993).

which make balance-sheet and bank lending channels correlated (Gertler and Gilchrist, 1994) and hence difficult to disentangle. Moreover, analyses based on micro data generally use actual credit granted (i.e. there is not an observed direct measure of loan demand), and therefore, the micro-identification has been forced to make restrictive assumptions on loan demand changes. Kashyap and Stein (2000), for instance, assume that banks with different liquidity levels face similar changes in loan demand as a response to a monetary policy shock.³ As a consequence, the identification using micro data cannot quantify the relative impact on the real activity of the loan supply, demand and non-financial balance-sheet channels.⁴

In this paper, we identify shocks to loan supply and to loan demand by using the detailed answers of the confidential and unique Bank Lending Survey (BLS) for the Euro area and the US Senior Loan Officer (SLO) Survey. Euro area national central banks and regional Feds request from banks quarterly information on the lending standards that banks apply to customers and on the loan demand that they receive from firms and households. The information refers to the actual lending standards that banks apply to the pool of all borrowers (not only to accepted loans). Moreover, the surveys – especially the BLS – contain information on the *factors* affecting banks' lending standard decisions – factors related to bank balance-sheet capacity and borrowers' outlook, quality and risk (for firms and households).⁵ This combined information is therefore crucial to identify loan supply shocks, and also to disentangle the effect of the (supply) bank lending, the (non-financial borrower) balance-sheet, and the loan demand channel.

Since lending standards and loan demand may react to – but also influence – business cycle fluctuations (Bernanke and Gertler, 1995), we embed this rich information on lending

³An exception is Jiménez, Ongena, Peydró and Saurina (2010) who use loan applications and bank-firm level data.

⁴On the bank lending channel, the available empirical evidence is not conclusive, and comprises both analysis supporting the existence of the bank lending channel (e.g., Kashyap and Stein, 2000; Peek and Rosengren, 1995, 1997, 2009) and evidence in favour of a more conventional transmission mechanism (Romer and Romer 1990; Ramey 1993). A key issue is not only to identify but also to quantify the different sub-channels (Boivin, Kiley and Mishkin, 2010).

⁵The information gathered from the BLS is better than from the SLO under different aspects. The responses related to the factors affecting banks' decisions to change lending standards is much more comprehensive in the Euro area BLS than in the US SLO - a key information to identify the supply channel. In addition, loan demand and lending standards are significantly less correlated in the Euro area than in US. Moreover, lending standards on mortgage loans have significantly more variability in the Euro area than in the U.S., probably because in Europe banks are by far the main providers of mortgages, as opposed to the US. Also, in the Euro area there is a common monetary policy but some cross-country heterogeneity of the business and credit cycles. Finally, the Euro area is a bank dominated system as compared to U.S., which is more market dominated (see Allen et al., 2004). All this makes the *bank* lending survey from the Euro area *unique*.

standards and loan demand into an otherwise standard VAR methodology to account for the linkages between the credit and the business cycle (see Christiano, Eichenbaum and Evans, 1999). For the Euro area we use a panel VAR including lending standards and loan demand from the BLS for each of the 12 countries which comprised the Euro area in 2002, the year when the BLS was launched. This framework takes into account the common monetary policy and some degree of cross-country heterogeneity in the business and credit cycles. For the US we estimate a one-country VAR. Data availability dictate the time span estimation in both economies: 2002:Q4–2009:Q4 for the Euro area and 1992:Q3–2009:Q4 for the US.

For the identification of monetary policy shocks, we follow Christiano, Eichenbaum and Evans (1999) and Angeloni et al. (2003) and use the overnight rate as the monetary policy instrument. In response to the financial crisis, in October 2008 the ECB significantly relaxed its policy stance by reducing the policy rate and by introducing a measure of credit enhancement. In this framework the Eurosystem has been lending to banks through fixed-rate full-allotment liquidity auctions. The implementation of this policy brought the overnight rate (EONIA) significantly below the policy rate (Trichet, 2009, and ECB, 2009). Based on this observation, we believe that the EONIA rate is a sensible measure of monetary policy even during the crisis time. For the sake of symmetry we consider the Federal Funds Rate as the measure of monetary policy for the US, though the actions by the Federal Reserve during the crisis were directed towards several markets and implemented through different mechanisms (Bernanke, 2009, and ECB, 2009). Hence, for the US the overnight rates may not be a comprehensive measure of monetary policy stance during the crisis. Nonetheless, the main results of the paper (both for the Euro area and for the US) are robust to a shorter sample, ending in 2008:Q3 (the time of Lehman Brothers' failure).

For the identification of the credit shocks, *we trust the bankers* and interpret their assessment as truthfully reflecting conditions in the bank credit markets. Consequently, we interpret an innovation to the answers related to demand for loans as a shock to credit demand, and an innovation to changes in total lending standards as a shock to credit availability (*broad credit channel*). Changes in total lending standards can be further decomposed in two variables using the answers related to the factors affecting these changes. We interpret an innovation to changes of credit standards due to banks' changes in balance-sheet strength and competition as a measure of credit supply (*bank lending channel*), and an innovation to change of credit standards due to firms' (households') changes in balance-sheet strength as a measure of borrower's quality (*firm/household balance-sheet channel*). A visual inspection of the credit availability shocks estimated from the model suggest that they are consistent with episodes of restrictions in the credit markets both in the Euro area and in the US. Shocks to credit supply in the Euro area are also in line with periods

of interbank market impairment during the recent financial crisis.

Our paper makes a key contribution to the literature on monetary policy transmission. We disentangle loan supply from demand in a novel and direct way by using unique, confidential information from banks on the lending standards applied to and on the loan demand received from firms and households, and, importantly, on the reasons behind banks' decisions to change their lending standards (borrower or bank change in net worth).⁶ This strategy allows to identify the impact of a monetary policy shock on aggregate output and prices through loan demand, supply and the non-financial borrower balance-sheet channel (Bernanke and Gertler, 1987, 1989, 1995; Diamond and Rajan, 2006; Gertler and Kiyotaki, 2009, Boivin, Kiley and Mishkin, 2010; Adrian and Shin, 2010). Following up on Den Haan et al. (2007), we also show the differential effects of monetary policy shocks on different lending markets (business, mortgage and consumer loans) and assess the importance of bank loan portfolio composition effects for the monetary policy transmission. Finally, we also contribute to the emerging literature on the current crisis. By building up on the methodology used to analyze the transmission channels, we study how the different shocks have impacted aggregate output during the crisis by analyzing potential credit crunches, their real implications, and the effect of monetary policy (Diamond and Rajan, 2009; Gertler and Karadi, 2009). Our results may help to shed light on theories linking the business cycle and the financial sector. At the same time, they also have important policy implications for central banks and governments.

Three sets of results emerge from the analysis. First, the (broad) credit channel is operational. A monetary policy shock affects credit availability, and a credit availability shock affects GDP growth and inflation. Results are significant for business, mortgage, and consumer loans, but there are differences in the size and timing of the impact across borrowers and economic regions. Once we disentangle the effect of changes in lending standards due to bank balance-sheet capacity and competition pressures from changes due to borrower quality, we find that both the bank lending channel and the firm and household balance-sheet channels are operational.

⁶Lown and Morgan (2006) analyze the information content of the US SLO. However, they use only the answers from one of the questions of the survey on lending standards – namely changes in credit standards applied to C&I loans – and proxy loan demand with the macro variables commonly used by the previous literature. In fact, since they aim at analyzing the predictive power of lending standards, their priority is to use the whole history of the SLO survey and, therefore, cannot include the answers to questions related to the loan demand, which only started in 1991. They find that the credit standards predict future output and credit growth. Our work is different in aim and scope, as we test the credit channel of monetary policy and use several answers from the bank lending survey to fully exploit its information content. The surveys – the BLS in particular – include questions on the factors behind the decision to change lending standards. We exploit this information together with the answers related to the loan demand to identify the credit channels of monetary policy.



Second, we quantify the relative importance of the channels for different types of borrowers by analyzing the economic significance of the different impacts through appropriately designed counterfactuals. We find that the (broad) credit channel amplifies the impact of a monetary policy shock on GDP and inflation. For business loans, this impact is higher through the supply bank lending channel than through the demand and balance-sheet channels. For household loans, the demand channel is the strongest. Nonetheless, the impact of a monetary policy shock on GDP through the firm and the household balance sheet channels are still economically significant.

Finally, we implement a shock decomposition of GDP growth during the period of the financial crisis in the Euro area and in the US. In the Euro area the shock decomposition of GDP growth suggests that a reduction of credit supply to firms due to bank balance sheet constraints significantly contributed to the decline of GDP growth – i.e., there has been a credit crunch for firms in turn leading to a significant reduction in GDP (see Bernanke and Lown, 1991). The current expansionary monetary policy, at least in the Euro area, seems to have supported GDP growth, both aiming at relaxing balance sheet constraints of banks and at lowering short-term interest rates (see Gertler and Karadi, 2009). In the US, restrictions in credit availability for mortgage loans are among the most important shocks to explain changes in GDP growth during the crisis period. In the US case, unfortunately, one cannot distinguish the impact of restrictions due to lower net worth of US households vis-a-vis problems in bank capital and liquidity.

The rest of the paper is structured as follows. Section 2 describes the data used in the analysis focusing on the details of the Euro area BLS and the US SLO Survey, and reviews the empirical identification and the methodology. Section 3 presents and discusses the results. Section 4 summarizes the paper, discusses the policy implications, and concludes.

2 Data, identification and methodology

As explained above, the key testable hypotheses from the theory of the credit channel of monetary policy transmission are the following:

1. A contractive monetary policy shock reduces bank loan supply, reducing in turn aggregate output and prices.
2. The monetary policy shock is transmitted through changes to the net worth of the non-financial borrower (firm and household) and of the bank - the balance sheet and the bank lending channel.

The main identification challenges, as explained above, are:

1. Disentangle the impact of shocks to loan demand and to loan supply.
2. Disentangle the effect of the (non-financial borrower) firm and household balance-sheet channel from the bank lending channel.

In this section we explain how we deal with the two main testable predictions from the theory, focusing in particular on the data which helps us to address the identification challenges.

Our identification strategy relies on the use of the answers reported in the Euro area BLS and in the US SLO. National central banks of the euro area and regional Feds request from banks quarterly information on the lending standards banks apply (including the reasons for changing them), and on the loan demand they receive from firms and households. The fact that the survey is carried out by the central banks – often also supervisory authorities – contributes to the reliability of the information received and to the overall credibility of the survey. The economic interpretation of the answers reported in the surveys in terms of supply of and demand for credit follows naturally from the questions formulated. Therefore, *we trust the bankers* in their assessment of the lending standards applied to firms and households, the reasons (banks argue) for changing these standards (due to changes in borrowers' balance sheets and in banks' balance-sheet positions), and the loan demand that banks received.⁷ Our empirical strategy consists in embedding, within an otherwise standard VAR model, the rich information from the bank lending surveys – the panel of confidential answers aggregated by country for 12 Euro area countries and the publicly available aggregate answers for the US.

The following sub-sections describe in detail the data used in the analysis and the empirical methodology. In particular, Section 2.1 summarizes the setup of the Euro area BLS. Section 2.2 describes briefly the main characteristics of the US survey that has already been used in the literature (Lown and Morgan, 2006). Section 2.3 describes the aggregate variables we use from the BLS and SLO. Section 2.4 describes the other macroeconomic series used for the analysis. Finally, in Section 2.5 we illustrate our empirical methodology. The identification strategy is common for all the countries of the Euro area. However, some differences are present between Euro area and US due to the availability of data (see also the Appendix).

⁷Lown and Morgan (2006) and De Bondt et al. (2010) show that the surveys have predictive power for output and credit growth in the US and in the Euro area respectively. A recent paper based on Italian data at the level of individual banks investigates also the link between the BLS answers and credit data and find indeed that the answers from the surveys are reliable indicators of developments in the markets for bank loans (see Del Giovane, Ginette and Nobili, 2009).

2.1 The Euro area BLS

The national central banks of the Eurosystem request a representative sample of banks in each country to provide quarterly information on the lending standards that banks apply to customers and on the loan demand that banks receive.⁸ The survey contains 18 specific questions on past and expected (bank) credit market developments. Past developments refer to lending standards applied and to loan demand received over the past three months, while expected developments focus on what it is expected in the following quarter. Two borrower sectors are the focus of the survey: firms and households. Loans to households are further disentangled in loans for house purchase and for consumer credit, consistently with the classification of loans in the official statistics of the Euro area.⁹

The questions imply only qualitative answers and no figures are required. The answers are collected by the national central banks of the Euro area countries. Typically the questionnaire is sent to senior loan officers, such as the chairperson of the bank's credit committee. The sample of banks is representative of the banking sector in each country. Therefore it comprises banks of different size, although some preference was given to the inclusion of large banks.¹⁰ The analysis reported in this paper is based on the aggregate answers received from a sample of around 90 banks.¹¹ The response rate has been 100% almost all the time.

The scope and the coverage of the Survey have changed little since its inception. Concerning the questionnaire, the regular questions have been kept fixed throughout the sample. A number of ad-hoc questions were added at times to shed light on specific issues. We do not use the answers to these questions since they are available only for few quarters.

The questionnaire covers both supply of and demand for bank loans. Concerning supply of loans, which are addressed in ten different questions, attention is given to changes in lending standards, to the factors responsible for these changes, and to credit conditions and terms applied to customers – i.e., *whether*, *why* and *how* banks change lending stan-

⁸Berg, van Rixtel, Ferrando, de Bondt and Scopel (2005) describe in detail the setup of the survey. Sauer (2009) and Hempell, Köhler-Ulbrich and Sauer (2009) provide an update including the most recent developments and the few changes implemented (request of additional information via ad-hoc questions). The survey was first used for research purposes in Maddaloni and Peydró (2009) and Maddaloni, Peydró and Scopel (2009).

⁹This classification is somewhat different from the classification used in the US for the Senior Loan Officer Survey where mortgage loans are further disentangled in prime and subprime loans.

¹⁰As we have access to information on banks' size, an interesting hypothesis stemming from the bank lending channel is that the credit channel may be stronger for small banks. We postpone this analysis to future investigation.

¹¹At the start, there were 87 banks answering the survey. This figure remained almost fixed until 2007, when Slovenia entered the euro area and Slovenian banks entered in the survey. Successively, in 2008, this figure reached 112 with the inclusion of Cyprus, Malta and an enlarged sample for Italy and Germany.

dards. Concerning demand for loans, there are mainly two questions, one related to the demand received from each type of borrower, and the other related to the factors affecting loan demand (investment needs, access to other sources of finance, etc.).¹²

The first set of questions ask about changes in lending standards for each type of borrower (firms and households, for house purchase and for consumption). Lending standards are the internal guidelines or criteria for a bank's loan policy (see Loan and Morgan, 2006, and Freixas and Rochet, 2008). Two different questions, referring to firms and households, ask if banks changed lending standards over the previous quarter (or they expect to change them in the following quarter).¹³ The successive set of questions give banks the opportunity to assess how specific factors affected their credit standards. In particular, whether the changes in standards were due to changes in bank balance-sheet capacity, to changes in competitive pressures, or to changes in borrowers' creditworthiness and net worth. Finally, the last set of questions concerns changes in the terms and conditions of loans – the contractual obligations agreed upon by banks and borrowers, such as the interest rate, the loan collateral, size, maturity and covenants.

The Euro area results of the survey (which are a weighted average of the results obtained for each Euro area country) are published every quarter on the website of the ECB (<http://www.ecb.europa.eu/stats/money/surveys/lend/html/index.en.html>). In very few countries the aggregate answers of the domestic samples are published by the respective national central banks. However, the overall sample including all the answers at the country and bank level is confidential.

For the purpose of this paper we concentrate only on few questions from the BLS that we describe in detail in the Appendix. Since we aim at identifying shocks to credit supply and demand – bank and borrowers' balance-sheet channels – we concentrate on the questions related to whether lending standards have changed, which factors have affected the decision, and on the loan demand received by banks. Moreover, since we are interested in actual lending decisions by banks and we are also comparing the results of the analysis in the Euro area and in the US (see section 2.2), we analyze the answers related to actual changes in lending standards over the previous three months and we do not use answers related to expected changes.¹⁴

¹²The factors that change loan demand also contain some useful information. An interesting hypothesis to check in the future is whether the economic impact of the credit channel is higher when loan demand increases, due to limited access to other financing sources.

¹³In cases when foreign banks are part of the sample, the credit standards refer to the loans' policy in the domestic market which may differ from guidelines established for the headquarter bank.

¹⁴The answers related to the factors which induced changes in the lending standards applied by banks (i.e. why banks have tightened lending standards) further strengthen the identification of loan supply restrictions. These factors can be categorized in two main groups: (1) factors linked to the ability of banks to lend in relation with their balance sheet constraints and the competitive pressures; (2) factors linked to

To use a balanced panel, we restrict the analysis to the 12 countries which comprised the Euro area at the inception of the survey (2002:Q4). The answers cover the period from 2002:Q4 to 2009:Q4. Over this period we consistently have quarterly data for 12 Euro area countries (Austria, Belgium, France, Finland, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain).

2.2 The Senior Loan Officer Survey

The Federal Reserve publishes every quarter the results of a survey on bank lending standards, the Senior Loan Officer Opinion Survey on Bank Lending Practices (SLO). The Survey covers both business and household loans.

The questionnaire focuses on supply of and demand for bank loans, but the focus is on past developments and there are no regular questions on expectations. Since 1990 the officers are reporting separately on lending standards for small and large firms (as well as demand). We generally use in our benchmark analysis the answers related to large enterprises.¹⁵

The current sample is composed of around 60 banks, usually the largest in each of the 12 Federal Reserve Districts. The Survey is conducted by the district Federal Reserve Banks involved. The response rate is virtually 100%. More information on the setup of the survey is in Lown and Morgan (2006).¹⁶ The results of the survey are available at <http://www.federalreserve.gov/boarddocs/SnLoanSurvey>.

Similar to the questions in the BLS, for business (C&I) loans, the SLO asks about changes in lending standards and also the factors that have determined these decisions. These factors are broadly related to bank balance-sheet positions, banking competition factors, and borrower risk/outlook. Notably, the SLO contains a specific question on how bank tolerance for risk has affected lending standards decision, an information that is not reported in the BLS.¹⁷ Unfortunately, and differently from the Euro area BLS, the SLO changes in borrowers' risk and net worth. In our setting the answers related to the first group of factors identifies "pure" credit supply restrictions and, therefore, the bank lending channel. This information is useful not only to disentangle the bank lending channel from the firm/household balance-sheet channel, but also to strengthen the credit supply identification (the effect over and above changes in loan demand and borrower's quality).

¹⁵The series on lending standards for large and small enterprises have a correlation of 96%. The series on demand for loans from large and small enterprises have a correlation of 93%. For the Euro Area the general question on firms refers to all firms, but then there are also questions referring to lending standards applied to large and SME firms that we do not use in this paper.

¹⁶See also Lown, Morgan and Rohatgi (2000) and Lown and Morgan (2002).

¹⁷This information can be interpreted as a direct measure of banks' appetite for risk in lending behaviour in the US. While the BLS for the Euro Area does not provide a direct measure of banks' risk appetite, the richness of the survey information allow to extract this measure indirectly by controlling for the other

information on factors affecting changes in lending standards is not available for mortgage and consumer loans but only for C&I loans.¹⁸

The survey was introduced for the first time in 1967. Since then, however, the basic structure of the Survey has changed several times. Therefore, the time series that can be used for a comprehensive econometric analysis with consistent information of the survey is considerably shorter. The questions related to the demand for business and households loans, moreover, were included in the survey in 1992:Q3. Therefore, this is the starting point of our analysis.¹⁹ For the purpose of this paper we concentrate only on few questions from the SLO that we describe in detail in the Appendix.

2.3 Aggregate statistics for the BLS and the SLO

The questions asked in the Euro area BLS and in the US SLO allow for five possible replies ranging from “eased considerably” to “tightened considerably” for the questions related to changes in lending standards and from “decreased considerably” to “increased considerably” for the questions related to the demand for loans.

Following for instance Lown and Morgan (2006), we quantify the different answers by using *net percentages*.²⁰ When measuring *credit availability*, the net percentage is the difference between the percentage of banks reporting a tightening of lending standards and the percentage of banks reporting a softening of standards in each country. The net percentage of banks that have changed standards due to factors linked to balance sheet capacity provides a measure of (*pure*) *credit supply*. In both cases a positive value implies that there has been a *net* tightening of standards.

For changes in the demand for loans, the net percentage is the difference between the percentage of banks reporting an increase in the demand for loans and the percentage of banks reporting a decrease. In this case, a positive figure indicates a *net* increase in the factors and by analysing the terms and conditions of the loans (see Maddaloni and Peydró, 2009).

¹⁸In addition, some of the questions about the factors affecting changes in lending standards in the SLO were added only in recent years, which further restrict the use of these answers over the entire time period that we are using for the US.

¹⁹Questions related to the demand for consumer loans were included only in 1995Q4.

²⁰The use of this statistic implies that no distinction is made for the degree of tightening (easing) of lending standards in the replies (similarly on the degree of increase in the demand for loans). This issue can be addressed using diffusion indexes. A simple way of calculating these indexes consists for example in weighting by 0.5 the percentage of banks answering that they have tightened somewhat (eased somewhat) and in weighting by 1 the percentage of banks that have tightened considerably (eased considerably). A similar weighting scheme can be applied to the answers concerning demand for loans. The results obtained using diffusion indexes do not differ qualitatively from the results obtained with net percentages and, therefore, we do not report them since they also imply a certain level of discretion when choosing the weights.

demand for loans. Figures 1 and 2 (Panel A) plot the euro area aggregate and the US figures respectively for total demand, lending standards, “(pure) credit supply” (i.e. the sum of bank balance-sheet constraints and competitive pressures) and borrower’s quality.

The respondents of the survey assess at the same time supply and demand conditions in the banking market and, therefore, their answers may be highly (negatively) correlated. However, a simple correlation analysis of the answers related to supply and demand of credit at the country level show that they are not perfectly correlated and the correlation is significantly low when the answers refer to “pure supply” channels. Figure A in the appendix clarify this issue. The three graphs report the correlation between total loan demand and (i) total credit availability (changes in overall lending standards for firms), (ii) supply factors related to borrowers’ quality (economic conditions and risk/outlook of firms) and (iii) “pure credit supply” (factors related to banks’ balance-sheet strength and to competitive pressures). Both for the US and for the Euro area the correlation between loan demand and supply of credit identified through the survey answers significantly decreases when supply is identified via “pure” supply factors – stemming from the bank lending channel. In these cases the correlations are never higher than 40 percent.²¹

2.4 Macroeconomic data

In addition to the loan information from central banks, we include in the analysis three macroeconomic variables: aggregate output, prices and monetary policy rates. The output variable is the four-quarter growth rate of real GDP for each Euro area country and for the US. Developments in prices are proxied by the four-quarter growth rate of the GDP deflator. Finally, the monetary policy interest rate is the overnight money market rate (EONIA) for the Euro area and the effective Federal Funds Rate for the US. In the US the Fed Funds Rate has been extensively used as an indicator of the stance of monetary policy (see for example Bernanke and Blinder (1992), Bernanke and Mihov (1997), Christiano, Eichenbaum and Evans (1999) and den Haan et al. (2007)). In the Euro area the Governing Council of the ECB determines a corridor within which the EONIA rate fluctuates (between a deposit facility rate and a marginal lending facility rate). Therefore, this rate proxies for the stance of Euro area monetary policy.

In October 2008 the ECB has reduced the policy rate and also introduced a *credit enhancement measure*, providing liquidity to banks through fixed-rate full allotment auctions. This policy has made the overnight rate (EONIA) significantly lower than the policy rate (ECB, 2009). Therefore, we consider EONIA as the measure of monetary policy in

²¹Results are similar if correlations are computed with loans to households in the euro area. The same detailed information is not available for the US SLO.

the Euro area for the whole period, even after September 2008.²² For the sake of symmetry we consider the Federal Funds Rate as the measure of monetary policy for the US, even though the Fed implemented a variety of actions during the crisis (Bernanke, 2009, and ECB, 2009), thus making the US overnight rate a possibly incomplete measure of the monetary policy stance. Our main results remain however robust to a sample ending in September 2008.

At first instance, we have also included in the VAR the volume of loans as in Lown and Morgan (2006) or den Haan et al. (2007). However, the use of both loan demand and supply answers from the lending surveys with their detailed classification and richness of information makes the volume and prices (lending rates) of loans redundant in the specification. In these (non-reported) estimations, shocks to what we identify as loan demand and supply for all categories have always the correct impact on the respective actual loan variables without substantially modifying the results for the other variables.

2.5 Empirical methodology

We embed the rich information on lending standards and demand within an otherwise standard vector autoregressive (VAR) model:

$$Y_t = A(L)Y_{t-1} + \varepsilon_t \quad (1)$$

where $t = 1, \dots, T$ denotes time, Y_t is an m -dimensional vector of endogenous variables, $A(L)$ is a matrix polynomial of order p in the lag operator L , and ε_t is a vector of white noise residuals. As in Christiano, Eichenbaum and Evans (1999), we assume $Y_t = [Y'_{1t}, r_t, Y'_{2t}]'$ where Y_{1t} is a $(k_1 \times 1)$ vector with elements whose contemporaneous values are in the information set of central bank, r_t is the monetary policy rate, i.e. the Federal Funds rate for the US and the EONIA rate for the Euro area, and Y_{2t} is a $(k_2 \times 1)$ vector with elements whose contemporaneous values are not in the information set of the central bank.

While for the US the available time series cover almost twenty years of quarterly observations (1992:3-2009:4), for the Euro area the sample is rather short (2002:4-2009:4). Therefore, for the Euro area we estimate a VAR on a panel data set from the 12 countries comprising the Euro area in 2002, with a fixed-effects approach. This allows to pool

²²As a robustness check, in non-reported analysis we have also used the 3-month Euribor rate and the overnight interest swap rate on EONIA (OIS). These measures carry additional information compared with the overnight rates and, therefore, the results obtained may be more difficult to interpret. The 3-month Euribor is an interbank rate and therefore reflects also a component of credit risk. On the other hand, the OIS rate is a proxy of expectations of monetary policy, but it may also be affected by liquidity in the swap market.

diverse information from all countries, while controlling for heterogeneity in the constant term.²³ The estimation of the VAR is Bayesian, assuming a flat prior on the parameters and normality of the error terms (see e.g. Kadiyala and Karlsson, 1997).

In all specifications, the vector Y_t is composed of three sets of variables: the macroeconomic variables (GDP growth and inflation), the credit variables and the monetary policy rate. We structure the analysis using four different specifications. In this way we take into account the availability of data for the euro and for the US (across time and borrowers) and provide results to be seen against the available evidence on the credit channel. In particular, we consider the following specifications:

- Model 1: the credit variables include only changes in total demand and total supply of business loans
- Model 2: the credit variables include total demand and total credit availability for all loan categories, i.e. non-financial corporations, mortgages and consumer credit
- Model 3: the credit variables include total demand, “pure” credit supply (bank lending channel) and borrower risks relative only to firms (firm balance-sheet channel)
- Model 4: the credit variables include total demand, “pure” credit supply (bank lending channel) and borrower risks relative to all loan categories (firm and household balance-sheet channel)

The specification in Model 1 is used for the sake of comparability with the previous literature (see, in particular, Lown and Morgan, 2006). The remaining models help qualify the various components of the credit channel and, in particular, Model 3 and 4 truly isolate the credit supply channel. However, because of lack of data, they are restricted either to business loans (Model 3) or to Euro area data (Model 4). All VAR specifications include one lag for each variable.

For the identification of the monetary policy shock, we follow a standard approach (see for example Christiano, Eichenbaum and Evans, 1999). Unlike the previous literature, however, which typically orders the credit variables after the policy rates in the VAR and includes the credit variables in the Y_{2t} vector, we assume that the monetary authority responds to all contemporaneous (i.e. quarterly) information. This identification of the monetary policy shock takes into account the forward looking character of the survey.

²³Even though there is no official CEPR dating of the Euro area business cycle after the 1990s, the Euro area four-quarter growth rates of GDP shows the features of a complete cycle from 2002 to 2009. Heterogeneity across countries are nevertheless sufficient to ensure reliable estimates from a panel strategy, while ex-post tests do not reject our common slope assumption in the panel. Hence, there is enough heterogeneity in the Euro area to exploit a panel but not so much that prevents pooling.

It assumes that central banks observe not only current output and prices, but also the current responses of loan officers when deciding on the policy rate. Therefore, all these variables do not change at time t in response to a time t policy shock, and the policy rate is ordered after both the macro and the credit variables. In other words, in our setup the subset Y_{2t} is empty.²⁴ Nevertheless, we conduct several robustness checks using different ordering of variables in Y_t and the results obtained are robust to the different specifications.

For the identification of the credit shocks, as already remarked above, we *trust the bankers* and interpret their assessment as truthfully reflecting conditions in the bank credit markets. Consequently, we interpret an innovation to the answers related to demand for loans as a shock to credit demand, and an innovation to total lending standards as a shock to credit availability (*broad credit channel*). Furthermore, we interpret an innovation to change of credit standards due to banks' changes in balance-sheet strength and competition as a measure of credit supply (*bank lending channel*), and an innovation to change of credit standards due to firms' (households') changes in balance-sheet strength as a measure of borrower's quality (*firm/household balance-sheet channel*). All the results are quite robust and generally invariant to different ordering of the credit variables.²⁵

Figures 1B and 2B plot the shocks to *pure supply* as estimated from the model and the actual pure credit supply from the surveys (average of the responses related to bank balance sheet constraints and competition factors). It is important to note that shocks to *pure supply* mimic well over time the developments in related lending standards in the Euro area. In particular, the years 2004 to 2006 in which lending standards were relaxed due mainly to competition pressures, and the period starting in August 2007 when lending standards were tightened because of bank liquidity and capital problems (see Figure 1B). Conversely, in the US, shocks to *pure supply* do not mimic well lending standards related to pure credit supply suggesting that the available data from the SLO are not sufficient to disentangle the sub-channels of the broad credit channel (bank lending and borrower balance sheet channel) (see Figure 2B).

²⁴The choice of this ordering is especially justifiable in the Euro Area, where the monetary policy strategy is based on a two-pillar approach and explicitly takes into account information from credit aggregates.

²⁵Similar definitions have been also used in a recent paper by Ivashina and Scharfstein (2010) who consider as loan supply both subchannels of the credit channel. However, it may still be argued that the firm or household balance sheet channels are due to changes in the quality of loan applications and, therefore, they are part of the demand channel. A measure of (pure) credit supply is therefore preferable to better disentangle the various channels.

3 Results

We present the results in three main subsections. First, we analyze the full dynamics of the credit channel. We discuss the responses of the system to three shocks – monetary policy, loan demand and *total* credit availability. Moreover, we perform some counterfactual experiments to validate the existence and strength of the credit channel of monetary policy transmission, and quantify the relative importance of loan demand and supply. Second, we focus on the existence and relevance of the sub-channels of the credit channel: the bank-lending (“pure” credit supply) and the (non-financial) borrower balance-sheet channels (firms and households). Also in this case we run counterfactual experiments to quantify the relative contribution of the sub-channels. Finally, building on the methodology developed, we perform a shock decomposition of GDP growth during the crisis period (2007Q3-2009Q4). Based on this analysis we can assess the implications of monetary policy interventions and credit supply constraints on the real economy during the latest crisis.

To address the issues outlined above, the analysis is performed using four specifications of the VAR model including different credit variables (see Section 2.5). The results are presented by means of impulse response functions. All the responses shown are normalized by dividing for their innovation variances. Therefore they can be compared on a single scale. We show the median response along with 68 (dark blue) and 90 (light blue) percent Bayesian credible intervals, computed by estimating the VAR with a flat prior on the parameters and assuming normality of the error terms (see e.g. Kadiyala and Karlsson, 1997). The panel VAR for the Euro area is estimated assuming fixed effects, slope homogeneity and the same identification assumptions for each country.

3.1 The dynamics of the credit channel

In this section we discuss the existence of a credit channel of monetary policy and its importance for the transmission of shocks. First, we look at the impact of a monetary policy shock on loan supply and demand. Next, we assess the effect of a credit availability shock on aggregate output and prices. Finally, we quantify the size of the credit channel and report the amplification impact of a monetary policy shock on GDP growth and inflation due to credit variables by means of appropriately designed counterfactual experiments. In the counterfactual analysis we report the 68 percent Bayesian credible intervals of the impulse responses computed in the full system and the median responses under the counterfactual experiment.

3.1.1 Loans to non-financial corporations (Model 1)

We start by considering only information from the banking surveys related to business loans and we use only the answers related to total loan demand and total lending standards (*broad credit channel*). This is Model 1, as described in Section 2.5. The results obtained with this model specification can be compared directly to most of the available evidence on the credit channel which has focused mainly on business loans (see Bernanke and Gertler, 1995; and Bernanke, Gertler and Gilchrist, 1996, and the references cited therein). The results can also be compared with what Lown and Morgan (2006) report, using lending standards from the SLO in a VAR model.

Figure 3A shows the response of the demand for and of the (broad) supply of business loans – as proxied by the correspondent responses from the BLS and the SLO – to a one-standard deviation monetary policy shock. Demand for loans declines in response to an increase of the short-term interest rate in both economies. Loan supply is restricted when monetary policy is tightened (a higher value for loan supply means tighter credit standards).²⁶ In the Euro area the restriction to loan supply due to a monetary policy shock is significantly higher than the decline in loan demand, suggesting that monetary policy affects loan supply more than loan demand at least business loans. In the US, the opposite happens and loan demand is affected more than loan supply. Another important finding is that loan supply restrictions in response to a monetary policy shock are significantly higher in the Euro area than in the US, despite the size of the increase in the short-term interest rate is larger in the US.²⁷

Figure 3B shows the responses of GDP growth and inflation to a shock to the bank credit variables (demand for and supply of business loans). A positive shock to credit availability (net tightening) implies lower GDP growth and lower inflation in Euro area. A negative shock to demand has similar effects. In the US the direction of the impacts is similar, but only a tightening of credit availability to firms has a significant effect on GDP growth and inflation, whereas the impacts from a loan demand shock are not statistically significant. However, the reduction of GDP growth due to a shock to credit availability is significantly higher in the US than in the Euro area. All in all these results suggest that a credit channel of monetary policy transmission is active in both economies. Tighter monetary policy restricts bank loan supply to firms. In turn, lower credit availability reduces both output growth and inflation.

We take a next step and quantify the relevance of the credit channel for the transmission mechanism. In particular we would like to address the following questions: (i) Do credit

²⁶ These results for the US are similar to what reported by Lown and Morgan (2006).

²⁷ A one-standard deviation shock corresponds to an increase of the short-term interest rate of around 60 basis points in the U.S. and of 30 basis points in the Euro area.

variables amplify the effect of a monetary policy shock on GDP growth and inflation? (ii) If yes, what is the mechanism through which the amplification works? In other words, is the amplification due to induced changes in loan demand, in loan supply or in both?

We answer these questions with simple counterfactual experiments. In Figure 3C we compare the response of GDP growth and inflation to a monetary policy shock when both the loan demand and the broad loan supply channels are activated (grey interval) with the median responses obtained when the channels are closed down (black line).²⁸

Credit availability is important in amplifying the transmission of a monetary policy shock on output and prices in both economic areas. The impacts on the variables of interest (GDP growth and inflation) in a system where the loan supply has been closed down (the counterfactuals) are significantly different in magnitude and timing from the responses obtained in a full system, particularly in the Euro area. The impact of a shock of monetary policy on GDP growth when the credit channel is active is also higher in the Euro area. This result underlines the importance of bank loans for the financing of the private sector in the Euro area, as opposed to the US, where other financial intermediaries (for mortgage loans in particular) and financial markets (for business loans) play an important role (see Allen et al., 2004).

The results when the credit channel is shut down are quantitatively in line with the previous literature analyzing the impact of monetary policy shocks on macroeconomic variables. The GDP response is significantly negative and remains negative for almost four years (the x-axis measures quarters). It displays the usual hump-shaped dynamics with a peak occurring between one and two years in both economic areas. The response of inflation shows a short-lived but not significant (in size) price puzzle, a result common to most related literature (see Christiano et al., 1999; or den Haan et al., 2007; Altavilla and Ciccarelli, 2009). Hence, the results suggest that when the credit channel is active monetary policy shocks have a significantly higher impact on aggregate output and prices. Note finally that the results are robust to the exclusion of the crisis period from the estimation sample. We have performed the same analysis over a shorter sample (up until the third quarter of 2008) so to exclude the period following the bankruptcy of Lehman Brothers, and results do not point to a weaker credit channel.

²⁸We report responses to a 100 basis points monetary policy shock. The Bayesian credible intervals in grey represent the responses in a system where all the channels are active. The black lines are the median responses computed from a system where the supply or the demand channel has been closed down. We perform the exercise by choosing a sequence of supply or demand shocks which exactly neutralizes the impact of the monetary policy shock on the supply or demand variables.

3.1.2 NFC, mortgage and consumer loans (Model 2)

Business loans are only a fraction of bank loans and, as already pointed out by Bernanke et al. (1996), there are reasons to believe that the transmission through the credit channel may be more relevant for mortgage and consumer loans than for business loans. In addition, Den Haan et al. (2007) point out the importance of the whole portfolio allocation of bank loans when analyzing a monetary tightening, as the volume of loans to different borrowers (business, consumer and real estate) may react differently to a short-term interest rate shock because banks strategically decide to reallocate their loan portfolio in response to changes in monetary conditions.

To take these issues into consideration, we include in the VAR model the demand and the supply for the different types of loans (business, mortgage and consumer loans) as in the specification of Model 2 (see Section 2.5). The information on consumer loans is available in the US SLO only since 1996, which greatly reduces the time series available for the analysis. As a result, the estimation results obtained tend to be less robust when including the answers relative to consumer loans. Therefore for the US we show the impulse responses obtained when including only business and mortgage loans.

Figure 4A shows the responses of loan demand and supply to a monetary policy shock for all types of loans in the Euro area and in the US. The level and timing of credit availability reduction is significant and similar across different type of loans, whereas there are differences in the responses of loan demand. In the Euro area the reaction of loan demand for mortgages is stronger than for other loans, whereas in the US the response is not statistically significant. This may, at least in part, reflect different institutional characteristics of the mortgage credit markets. For instance, other (non commercial bank) financial intermediaries are important providers of mortgage loans in the US while this is not the case in (most) Euro area countries; the ratio of fixed to variable loan rates is different in the two economies; conditions for refinancing mortgage loans tend to be more favorable in the US compared to (most) Euro area countries.²⁹

These results suggest that the responses to a monetary policy shock of volumes of different kind of loans as reported in den Haan et al. (2007) with US data may reflect changes in loan demand more than in loan supply. In the results of den Haan et al. (2007), a monetary tightening has a dampening impact only on real estate and consumer loans.

²⁹Over the past two decades institutional changes in the US mortgage market have made particularly efficient the refinancing process with the growth of the refinancing business. This has made it easier for homeowners to refinance their mortgage to take advantage of declining interest rates. While the information from bank lending surveys refer to new loans - therefore not directly related to refinancing activity - it is likely that the flexibility offered to homeowners has weakened the link between the demand for loans and the level of interest rates. For a recent discussion on the characteristics of the US mortgage market see for example Khandani, Lo and Merton (2009).

Our results, instead, suggest that while the responses to a monetary policy shock across different type of borrowers differ somewhat in size and in timing, the direction of the shock is the same for all type of loans. These differences are likely to reflect the different identification strategy for loan demand and supply that we use in our study.

The next step is to analyze the impact of shocks to credit variables on GDP growth and inflation. Figure 4B plots the responses of these variables to a tightening of credit in the Euro area and in the US. A shock to credit availability dampens GDP growth in both economies, with responses to business and mortgage loans restrictions being more significant than those to consumers' credit, possibly as a consequence of the relatively low importance of this segment of the credit market in most Euro area countries. Response of GDP growth is higher to shocks to the supply of business loans in the Euro area and to mortgage loans in the US. On the other hand, shocks to demand for mortgage loans have higher impact on GDP growth in both areas. The impact on inflation is more subdued. In the US this may be related to the high uncertainty surrounding the estimates in this specification. In the Euro area a shock to credit availability for mortgage loans dampens inflation almost immediately, whereas a restriction to the supply of business loans to firms has a higher but more delayed impact.

Counterfactual analysis All in all the results presented so far show that tighter monetary policy restricts credit availability to all type of borrowers both in the US and in the Euro area, albeit with some differences in the intensity and in the timing of the impacts. In turn, restrictions to credit significantly reduce output growth and inflation. This first evidence, therefore, suggests that a credit channel of monetary policy transmission is active and works through all the lending channels (loans to different borrowers).

As we have done for Model 1, we now quantify the relevance of the credit channel in a framework where all the different classes of borrowers are taken into account. In addition to the questions we have addressed using Model 1, the specification of Model 2 raises two additional issues. First, we can check which borrower category is more relevant for the transmission of monetary policy shocks. Second, as restrictions to loan supply may affect GDP growth and inflation by dampening loan demand (which in turn amplifies the impact on the economy), we can also check the relevance of this *indirect* channel.³⁰

³⁰ An anonymous referee has rightly pointed out that movements along the demand curve should not be confused with shifts of the demand curve. Clearly a restriction to loan supply will result in an equilibrium with higher rates and lower demand and not necessarily in a shift of the demand curve. A movement along the demand curve (an equilibrium with lower demand and higher lending rate) should be included in the response of demand to a monetary policy shock. On the other hand, loan supply may be restricted by tightening terms and conditions of loans other than the price of the loans (collateral requirements, loan-to-value ratio, size and maturity). These conditions would be translated in a shift of the demand

The analysis is carried out using counterfactual experiments. We address the first question by looking at the impact on GDP growth and inflation of a monetary policy shock when the demand and the supply channels for each type of loans are closed down. The results are shown in Figure 4C, where we compare the dynamics of the responses of output growth and inflation to a monetary policy shock (grey interval) with counterfactual of responses of the same variables obtained when closing down either the loan supply or the loan demand for each type of loans (black line).³¹

The figures show that in the Euro area a monetary policy shock has a high impact on GDP growth by changing demand and supply for mortgage loans and loan supply for business loans, whereas in the US results are not statistically conclusive, although in median terms supply (of both business and mortgage loans) seems to matter more than demand. In the Euro area, when considering the effect on inflation, demand more than supply seem to be important across all loan categories. Demand for consumer loans, which do not matter for the transmission of a monetary policy shock to GDP growth, are somewhat relevant for the transmission of the shock to inflation.

Finally, in Figure 4D we check the *indirect* channel of monetary transmission. The figures show the results of counterfactual experiments where the full-system impact of a credit tightening (shock to credit availability) on output growth and inflation is compared with the responses of the same variables when closing down the demand channel. The evidence indicates that the tightening of bank loan supply has a significant direct impact on GDP growth, and that the indirect effect working through demand is only somewhat significant on both GDP growth and inflation for mortgage loans in the Euro area, and slightly modifies the dynamics of inflation in US for business loans.

3.2 Firm and household balance-sheet versus bank-lending channel

In this subsection we disentangle the two main sub-channels of the credit channel of the transmission of monetary policy. In particular, we assess the relative importance of the mechanisms of transmission of monetary policy shocks through the balance sheets of banks and borrowers (the bank lending channel and the non-financial borrower balance sheet channel).

To identify these channels we use the rich information provided by the surveys, in particular the answers related to the *factors* (reasons) inducing banks to change their lending standards to firms and households. We categorize these factors in two broad sets. curve (lower demand at the same level of lending rate). However, more than discriminate between these two effects, our aim here is only to assess how much of the supply shock is dynamically transmitted to the GDP growth through demand, regardless of whether demand itself has shifted or not.

³¹See footnote 29.

The *pure supply* factors are related to the capital and liquidity positions of the banks, their ability to access market financing and to the competitive pressures in the banking sector (stemming also from non-bank intermediaries). These factors affect the *ability* and *incentives* of banks to grant loans given a certain quality of the borrowers. Therefore, these factors provide a measure of the importance of the bank lending channel. The latest financial crises has emphasized the need to understand deeply these mechanisms in light also of the policies put in place to support the banking sector (see e.g. the forthcoming chapters in the Handbook of Monetary Policy, in particular Adrian and Shin, 2009; Boivin et al., 2009; and Gertler and Kiyotaki, 2009).

The factors related to the *borrowers' quality* are instead linked to the outlook for firms and households and to the quality of their collateral. Therefore, they are more related to the *willingness* of banks to lend to borrowers with different risk profiles, hence reflecting different agency problems (see Bernanke, Gertler and Gilchrist 1996 and 1999). We use these factors as indicators of the relevance of the (non-financial borrower) balance sheet channels.

Note that in this context there is an important difference between the two bank lending surveys. In the Euro area BLS there is information on the reasons why banks have changed lending standards both for business and household loans, whereas in the US SLO this information is available only for business loans. As a consequence, we can analyze the household balance-sheet channel only for the Euro area. In the next subsections, first we analyze the firm balance-sheet channel and the bank lending channel for both the US and the Euro area (Model 3). Next, we analyze the household and firm balance-sheet channels for the Euro area and we compare their strength with the bank lending channel (Model 4).

3.2.1 Firm balance-sheet channel and bank lending channel (Model 3)

Figure 5A shows the responses to a monetary policy shock of demand and supply for business loans in the Euro area and in the US. The response of loan supply is further disentangled between the effect working through the bank lending channel and the firm balance-sheet channel. In the Euro area a monetary tightening reduces loan supply through the bank lending channel (*pure supply*, banks tighten the standards because of bank balance sheet constraints and competitive pressures) and the firm balance-sheet channel (*borrower's quality*, banks tighten their standards because of higher firm risk, worsened outlook and/or less valuable collateral). The responses are significantly estimated and show a comparable positive impact (tightened credit standards) but a somewhat different timing (the impact peaks around one quarter earlier for the transmission through the pure credit supply channel). In the US, responses are subject to a higher degree of uncertainty. Nev-

ertheless the estimates show that the impact of a monetary tightening affects significantly the bank lending channel at 68% of confidence, while the response of factors related to firms' quality is generally not significant.

Figure 5B plots the responses of GDP growth and inflation to a shock to bank pure supply and firms' quality factors for the Euro area and for the US. In the Euro area the two loan supply channels are significantly affecting GDP growth and – to a lesser extent – inflation, with a comparable lag: the responses of output growth peak between three and four quarters, whereas the responses of inflation reach a maximum approximately after five to six quarters. In terms of magnitude, the impact on GDP growth and inflation of shocks to the pure supply (bank lending) channel is on average twice as big as the effect of shocks to firm's quality.

In the US only shocks to the firm's quality (firm balance sheet channel) have a significant impact on GDP, while the responses to pure credit supply shocks are not significant. This difference between the responses in the Euro area and in the US may reflect differences in the banking structure of the two economies. In particular, the corporate sector in the US is less reliant on bank loans, and thus restrictions of firms' access to bank credit may have a lower impact on GDP growth (see Allen et al., 2004).

Overall, these results confirm that both a firm balance-sheet and a bank-lending channel play a significant role in the transmission mechanism in the Euro area and in the US at least concerning the impact on GDP growth. To further investigate and better quantify the relative importance of the two channels, we use counterfactual experiments, similar to the ones performed in the previous sections. We analyze which factors amplify more the responses of output growth and inflation to a monetary policy shock. Figure 5C shows the results of this analysis. In the Euro area the effect on GDP growth of a monetary policy shock is amplified by credit supply changes (the bank lending channel) slightly more than by the effect working through firm's quality (balance-sheet channel). The effect on inflation is also higher through the pure supply channel and through the loan demand channel. On the other hand, in the US the firm balance-sheet and the loan demand channels seem on average important for both GDP and inflation.

Our assessment on the importance of the bank lending channel in the US and in the Euro area provide some support to the different policies that were implemented during the financial crisis. In the US the central bank has implemented policies directed to support both banks and firms (for example by intervening in the commercial paper market), whereas in the Euro area interventions have mainly targeted banks – the credit enhancement implemented by the ECB.

3.2.2 All subchannels including the household balance-sheet channel (Model 4)

In the last VAR specification considered, we include loan demand, pure supply and borrower's quality channels for all borrowers: firms, mortgages and consumer loans. This specification (Model 4 in section 2.5) is used to analyze the importance of the transmission channels working through the balance sheet of banks and non-financial borrowers (banks, firms and households, respectively). As observed earlier, we can do this analysis only for the Euro area since we have information from the BLS on whether changes in lending standards for households (either for house purchase or for consumption) are due to changes in pure credit supply factors (bank balance sheet constraints and competitive pressures) or to changes in households' quality (outlook and risk of collateral).

Figure 6A shows the responses to a monetary tightening of loan demand and loan supply to firms and households through the bank lending and the non-financial borrower balance-sheet channels. A monetary tightening reduces loan supply through the bank lending channel (pure supply) and also through the firm and household balance-sheet channels. The responses are significant and show a comparable positive impact (tightened credit standards) with peaks around four to five quarters and similar magnitudes. The responses are broadly similar across type of loans.

Figure 6B shows the responses of GDP growth and inflation to shocks to loan supply for firms and households (through the bank lending and the borrower balance-sheet channels). Concerning the impact on GDP growth, the results relative to the bank lending channel for firms (pure credit supply restrictions for loans to firms) are similar to what shown in Figures 5B. The restrictions to supply for consumer loans is not very relevant. For loans for house purchase the household balance-sheet channel is more important than the (household) bank lending channel. This implies that shocks to the supply of mortgages are relevant for GDP growth because of mechanisms working through households' quality channels. This is consistent with arguments put forward in Bernanke et al. (1996), who point out that households may be more financially constrained due to human capital inalienability (see also Hart and Moore 1994), implying that monetary policy has stronger effects through household loans.

The results for inflation suggest also a difference across lending markets. The impact on inflation is more significant for business loans through the bank lending channel. On the other hand, credit to households affects inflation by channels working through borrower's quality and demand. These results may have interesting policy implications. Policies aimed at sustaining aggregate demand and improving balance sheet of non-financial borrowers may be more effective in supporting the credit markets for mortgages. However,

they may also have more impact on inflation.

To assess the relevance of the different channels of transmission of credit supply we run a counterfactual analysis as done in the previous sections (Figure 6C). All in all the results confirm that in terms of impact on GDP growth, the bank lending channel is more important for business loans and the household balance-sheet channel is more important for mortgage loans. It is interesting to note that in Figure 5C the difference between the impact on GDP growth of restrictions to supply stemming from the bank lending and the borrower balance sheet channel was less than what shown in Figure 6C. These latest results therefore suggest that an unbiased assessment of the relative importance of the transmission channels can be performed only considering all type of loans in the model. Finally, demand for all type of loans and pure supply channel for business loans generate significant effects on inflation.

3.3 The financial crisis

In this section, we use the VAR specification to analyze the relative importance of different shocks during the financial crises and to shed some light on the relationship between the financial sector and the macroeconomy (in crises periods). Specifically, we assess the role played by the impairment of the financial sector and the consequent credit crunch on the real economy and also the effectiveness of monetary policy interventions – primarily reduction of policy rates.

We report in Figure 7A a shock decomposition for both economies using the specification of Model 2. The bars in the charts represent the effects at time t of innovations to other variables which explain movements in GDP growth.³²

In the Euro area, apart from the own shocks, changes in GDP growth were mostly affected by restrictions of bank loan supply to business loans, in particular during the financial crisis. Therefore, the impairment of the financial sector due to the crisis has affected credit availability to firms (loans with average shorter maturity) and this, in turn, had a negative impact on GDP growth. In the last quarters also the decline in demand for mortgage loans reduced significantly output growth. This is consistent with a deteriorating outlook for the real economy which dampens demand for loans from the household sector. At the same time, monetary policy shocks (primarily policy rate cuts but also indirectly the full allotment policy implemented by the Eurosystem) have supported GDP growth, which presumably would have been lower if an accommodative monetary policy stance had

³²The decomposition at each time t is technically performed by estimating the VAR, projecting the variables of interest over the crisis sample (2007Q3-2009Q4), and decomposing the difference between the realised and the projected values in the sum of the innovations to all variables between 2007Q3 and t . See, e.g. Doan (2009) for more details.

not been put in place.³³ The policies aimed at sustaining bank's liquidity may have partly relaxed liquidity constraints of banks and been conducive to less tight lending standards than otherwise.

The same analysis for the US yields qualitatively different results. Apart from “own shocks”, restrictions to the supply of mortgage loans are among the most important shocks to explain changes in GDP growth over the period 2007Q3-2009Q4. Restrictions to the supply of business loans are also important. At the same time, monetary policy shocks play an almost neutral role. Concerning this result, the Fed has engaged in a diversified and multifaceted strategy of non-conventional monetary policy measures, aimed at supporting not only the financial sector (by increasing the number of financial institutions which could draw on central bank liquidity and relaxing requirements on the quality of collateral) but also the corporate sector, for example by buying commercial papers. This may partly explain why restrictions to business loans play a minor role than in the Euro area, and why shocks to the Fed Funds rate during the crisis period may not be able to capture fully the importance of a monetary policy shock.

Finally, we investigate the relative importance of all the channels of loan supply. Figure 7B shows the shock decomposition using Model 4 for the Euro area (no comparable data are available for the US). Apart from the own shock, the most important shock affecting negatively GDP growth are credit supply restrictions to firms due to banks' balance-sheet constraints, i.e. the bank lending channel. This suggests that problems in bank capital and liquidity and access to market financing significantly reduced GDP growth during the financial crisis, contributing to the economic recession.

4 Concluding remarks

Most developed countries around the world have experienced the worst banking crisis of the post-war period. The global economic recession that has followed also appears to be the most severe of this era. The role played by the banking sector in affecting the macroeconomy, in particular through the supply of credit to the private sector, has become a central issue of concerns for academics and policy makers alike. The issues of interest revolve around three main questions: (i) whether balance sheet positions of banks affect their lending decisions; (ii) whether this, in turn, has an impact on aggregate output and inflation; and (iii) whether and how monetary policy impulses are transmitted to the rest of the economy, in particular through banks. Our objective in this paper is to test the credit channel of monetary transmission and to explore the dynamics of credit during the current crisis.

³³ As explained in Section 3.4 the level of EONIA rate embeds also the effect of the full allotment policy.

There is a key identification problem that the empirical literature on the credit channel has to face: disentangling the effects of changes in loan demand and in loan supply, in particular the separation of the mechanisms related to the bank lending, the (non-financial borrower) balance-sheet, and the loan demand channels. Our identification strategy is based on the use of the answers from the confidential Euro area Bank Lending Survey and the US Senior Loan Officer Survey. National central banks of the Eurosystem and regional Feds carry out these surveys to gather quarterly information on the loan demand that banks receive and on the lending standards that banks apply to firms and households, including the *factors* affecting banks' decisions – bank balance sheet constraints and borrowers' quality factors.

Our results suggest that the credit channel is broadly operational for all type of channels and loans. In fact, the impact of a monetary policy shock on GDP is significantly stronger if the credit channel is accounted for in the model. Moreover, for the impact of monetary policy on GDP, the bank lending channel is stronger than the loan demand and the balance-sheet channel for firms, whereas the household balance-sheet channel and the demand channels are stronger for households. Therefore, these findings imply that bank loan supply should be included explicitly when modelling the linkages between monetary policy, credit provision and the real economy. In turn, this is likely to amplify the mechanisms of the financial accelerator (see Gertler and Kiyotaki, 2010, vis-a-vis Bernanke, Gertler, and Gilchrist, 1999). At the same time, our results also stress the importance of an accurate calibration of the models, taking into account differences across financial systems (we find important differences between the effects in the Euro area and in the US), as well as different lending markets (to firms and to households).

In the last part of the paper we also analyze whether the strong evidence we find for the credit channel is due to the occurrence of the financial crisis. Our results are qualitatively similar if we estimate the model until 2008:Q3, therefore taking out the period after the bankruptcy of Lehman Brothers. In addition, a shock decomposition of Euro area GDP growth over the crisis period suggests that the restrictions of credit supply to firms due to bank balance sheet constraints – a credit crunch (Bernanke and Lown, 1991) – played an important role in reducing output growth. In the US, restrictions to credit availability for mortgages are among the most important shocks to explain changes in GDP growth during the crisis period. Finally, our analysis suggests that the policies of the central banks based on very low interest rates and measures aimed at relaxing bank capital and liquidity constraints have been providing a significant support to the real economy.

These latest results may therefore give some indications on actions to be pursued by central banks in response to financial crises. Our analysis shows that when a financial crisis affects the provision of credit (for example because it affects in particular bank

balance sheet capacity), policies aiming at relaxing balance sheet constraints of financial intermediaries may be beneficial and help to sustain economic growth.

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Appendix

Bank Lending Survey

1. Questions on supply and demand for loans

QUESTION	MARKET SEGMENT	VARIABLE	DEFINITION
<i>Supply of loans</i>			
Over the past three months, how have your bank's credit standards as applied to the approval of loans...	or credit lines to enterprises changed? (Q1)	Net percentage of banks reporting a tightening of credit standards	Difference between the sum of banks answering "tightened considerably" and "tightened somewhat" and the sum of banks answering "eased somewhat" and "eased considerably" in percentage of the total number of banks.
	to households changed? (Q8)		
<i>Demand for loans</i>			
Over the past three months, how has the demand for loans or credit lines to [...] changed at your bank, apart from normal seasonal fluctuations?	enterprises (Q4)	Net percentage of banks reporting an increase of the demand for loans	Difference between the sum of banks answering "increased considerably" and "increased somewhat" and the sum of banks answering "decreased somewhat" and "decreased considerably" in percentage of the total number of banks.
	households (Q13)		

2. Questions on factors affecting the supply of loans

QUESTION	FACTORS	VARIABLE	DEFINITION
Q2 Over the past three months, how have the following factors affected your bank's credit standards as applied to the approval of loans or credit lines to enterprises?	A. Costs of funds and balance sheet constraints Costs related to your bank's capital position Your bank's ability to access market financing Your bank's liquidity position	Net percentage of banks reporting that each of these factors has contributed to the tightening of standards to enterprises.	Difference between the sum of the banks answering "contributed considerably to tightening" and "contributed somewhat to tightening" and the sum of the banks answering "contributed somewhat to easing" and "contributed considerably to easing" in percentage of the total number of banks.
	B. Pressure from competition Competition from other banks Competition from non-banks Competition from market financing		
	C. Perception of risk Expectations regarding general economic activity Industry or firm-specific outlook Risk on the collateral demanded		
Q9 Over the past three months, how have the following factors affected your bank's credit standards as applied to the approval of loans to households for house purchase?	A. Costs of funds and balance sheet constraints	Net percentage of banks reporting that each of these factors has contributed to the tightening of standards to enterprises.	Difference between the sum of the banks answering "contributed considerably to tightening" and "contributed somewhat to tightening" and the sum of the banks answering "contributed somewhat to easing" and "contributed considerably to easing" in percentage of the total number of banks.
	B. Pressure from competition Competition from other banks Competition from non-banks		
	C. Perception of risk Expectations regarding general economic activity Housing market prospects		
Q11 Over the past three months, how have the following factors affected your bank's credit standards as applied to the approval of consumer credit and other lending to households?	A. Costs of funds and balance sheet constraints	Net percentage of banks reporting that each of these factors has contributed to the tightening of standards to enterprises.	Difference between the sum of the banks answering "contributed considerably to tightening" and "contributed somewhat to tightening" and the sum of the banks answering "contributed somewhat to easing" and "contributed considerably to easing" in percentage of the total number of banks.
	B. Pressure from competition Competition from other banks Competition from non-banks		
	C. Perception of risk Expectations regarding general economic activity Creditworthiness of consumers Risk on the collateral demanded		

Note: Q* indicates the number of the question in the survey

Source: European Central Bank

Appendix

Senior Loan Officer Survey

1. Questions on supply and demand for loans

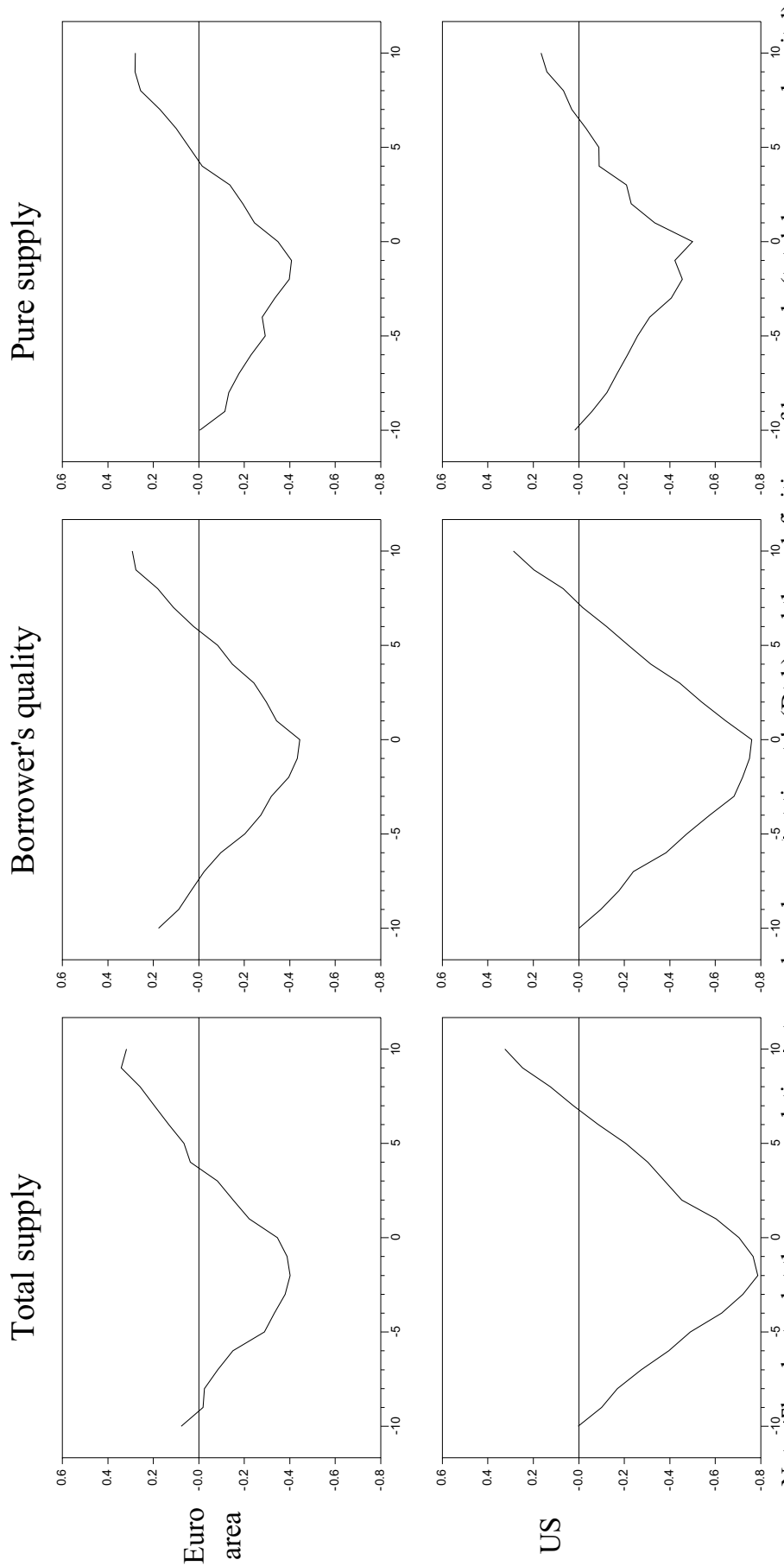
QUESTION	MARKET SEGMENT	VARIABLE	DEFINITION
Supply of loans			
Over the past three months, how have your bank's credit standards for ...	approving applications for C&I loans or credit lines - other than those to be used to finance mergers and acquisitions - to large and middle-market firms changed? Q1	Net percentage of banks reporting a tightened of credit standards	Difference between the sum of banks answering "tightened considerably" and "tightened somewhat" and the sum of banks answering "eased somewhat" and "eased considerably" in percentage of the total number of banks
	from individuals for mortgage loans to purchase homes changed? (Q9)		
	for consumer loans other than credit card loans changed? (Q15)		
Demand for loans			
Apart from normal seasonal variation, how has demand for...	C&I loans changed over the past three months? (Q4)	Net percentage of banks reporting an increased of the demand for loans.	Difference between the sum of banks answering "increased considerably" and "increased somewhat" and the sum of banks answering "decreased somewhat" and "decreased considerably" in percentage of the total number of banks.
	mortgage to purchase homes changed over the past three months? (Q10)		
	consumer loans of all types changed over the past three months? (Q18)		

2. Questions on factors affecting the supply of loans

QUESTION	FACTORS	VARIABLE	DEFINITION
Q3 if your bank has tightened or eased its credit standards or its terms for C&I loans or credit lines over the past three months, how important have been the following possible reasons for the change?	A. Current or expected capital position	<i>Pure supply</i> = responses to A	Difference between the sum of the banks answering "contributed considerably to tightening" and "contributed somewhat to tightening" and the sum of the banks answering "contributed somewhat to easing" and "contributed considerably to easing" in percentage of the total number of banks.
	B. Economic outlook and its uncertainty		
	C. Industry specific problems		
		<i>Borrower quality</i> = average of the responses to B and C	

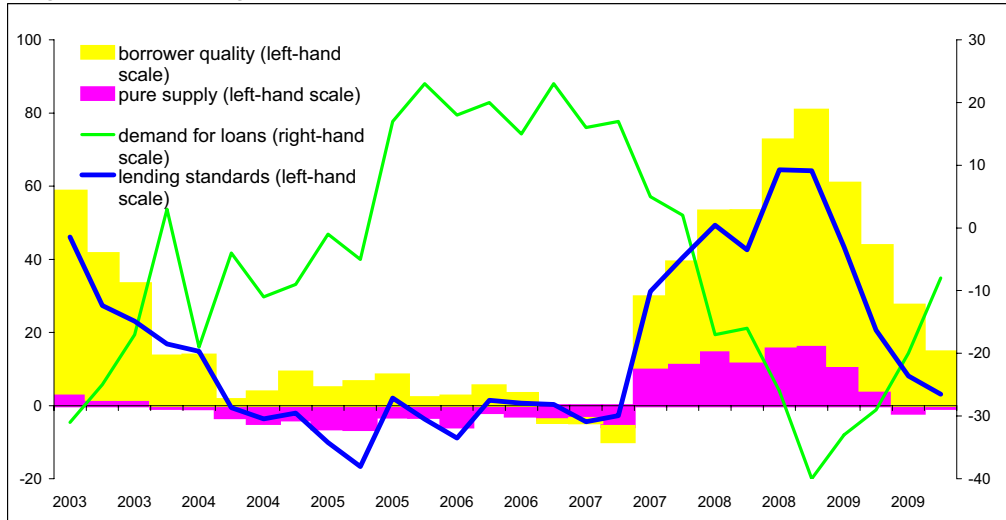
Note: Q* indicates the number of the question in the survey
Source: Federal Reserve Board

Figure A. Cross-correlations between loan demand and supply



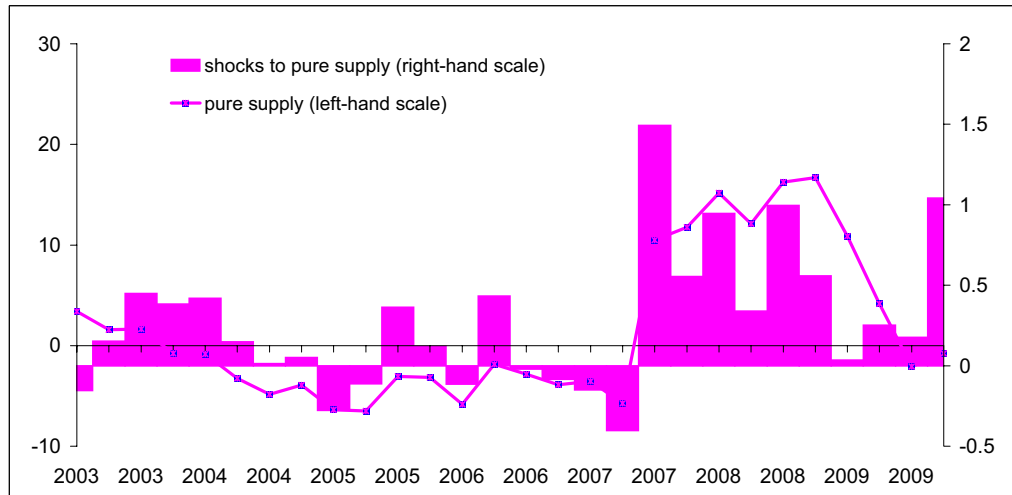
Note: The charts plot the cross-correlation between loan demand at time $t-k$ (Dt-k) and three definitions of loan supply (total, borrower and capital) at time t (S_t), for $k=-10, \dots, -1, 0, 1, \dots, 10$. Supply and demand refer only to business loans (loans to non-financial corporations in the Euro area and C&I loans in the US). See Section 2 and the Appendix for the definition of the variables.

Figure 1A. Lending standards and demand for loans in the Euro area



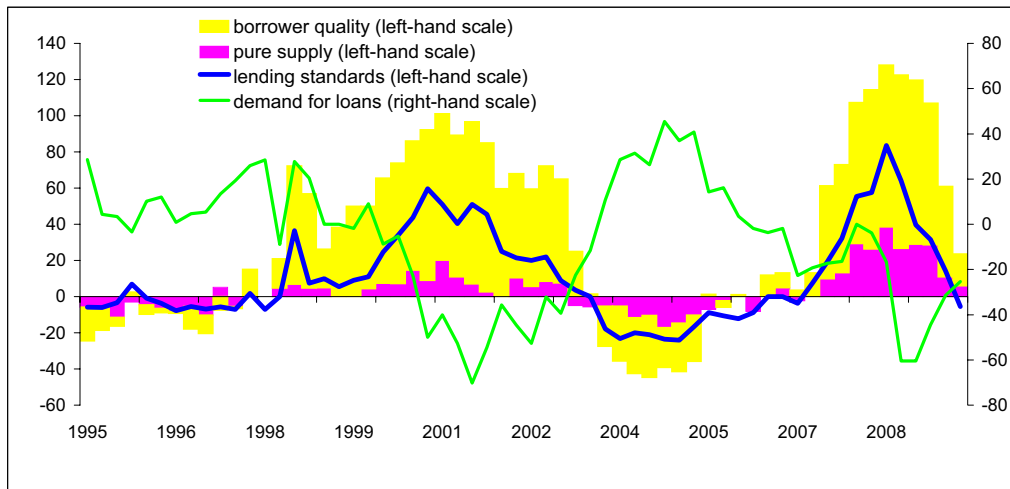
Note: These graphs plot the lending standards and the demand for loans in the Euro area as reported in the BLS. The responses refer to business (non-financial corporations) loans. *Pure supply* is the average of the responses to the questions referring to balance sheet constraints and competition. *Borrower quality* is the average of the responses referring to the economic outlook and borrower specific risks. See Section 2 and the Appendix for a detailed definition of the variables.
Source: European Central Bank

Figure 1B. Lending standards and credit supply shocks in the Euro area



Note: These graphs plot the supply for loans in the Euro area as reported in the BLS and the shocks derived from the VAR model. The responses refer to business (non-financial corporations) loans. *Pure supply* is equal to the average of the responses to the questions referring to balance sheet constraints and competition. See Section 2 and the Appendix for a detailed definition of the variables.
Source: European Central Bank and authors' calculations

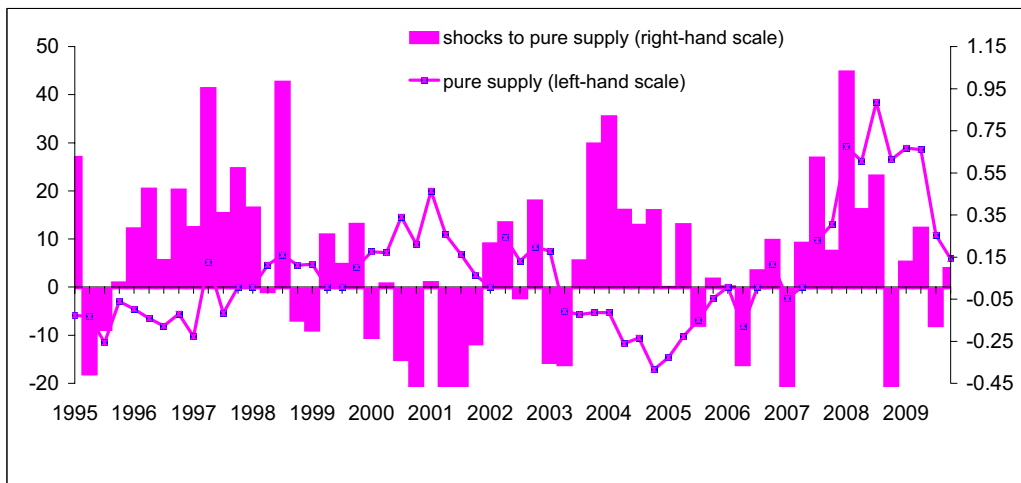
Figure 2A. Lending standards and demand for loans in the US



Note: These graphs plot the lending standards and the demand for loans in the US as reported in the SLO. The responses refer to business (C&I) loans. *Pure supply* is equal to the responses to the questions referring to capital position. *Borrower quality* is the average of the responses referring to the economic outlook and to industry specific problems. See Section 2 and the Appendix for a detailed definition of the variables.

Source: Federal Reserve Board

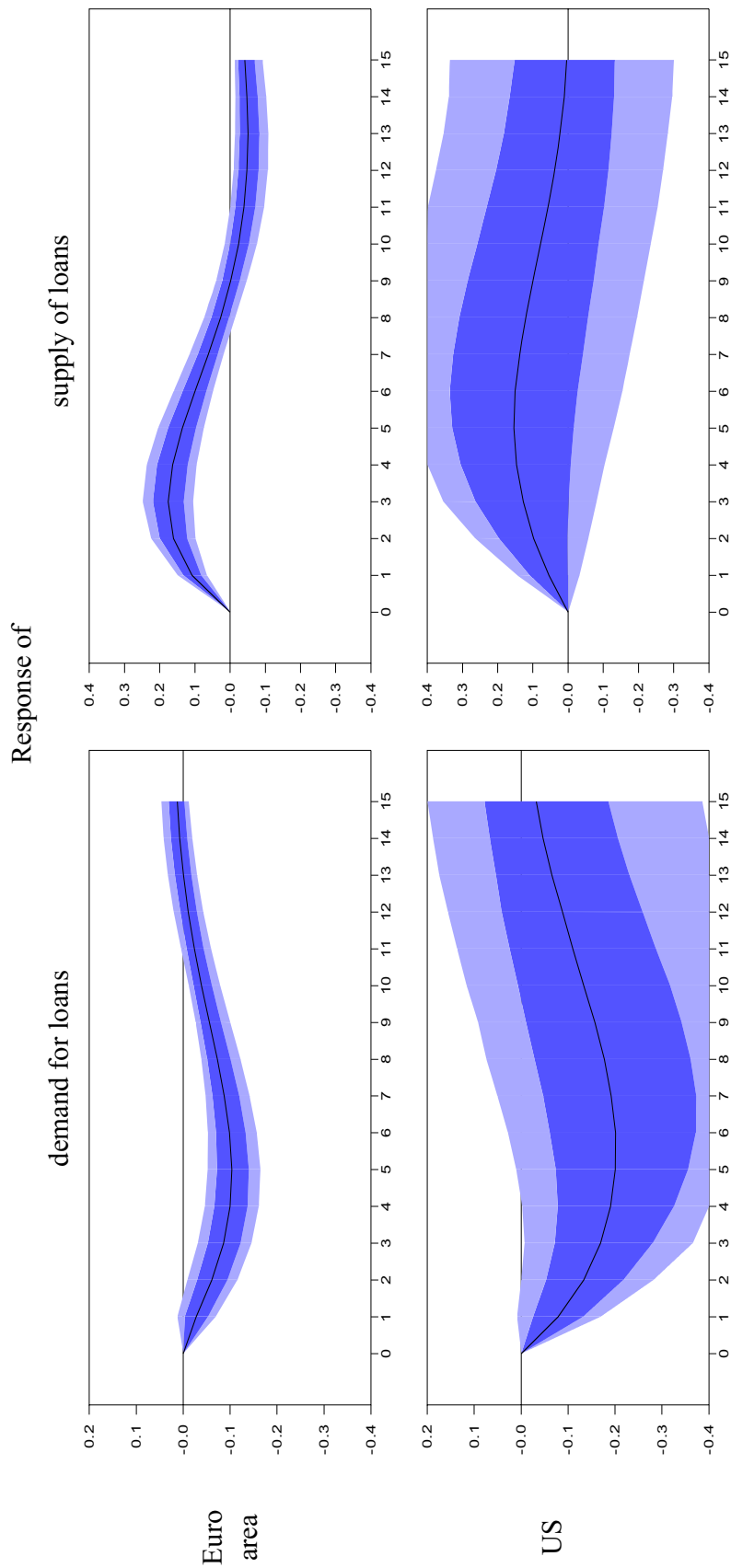
Figure 2B. Lending standards and credit supply shocks in the US



Note: These graphs plot the supply for loans in the US as reported in the SLO and the shocks derived from the VAR model. The responses refer to business (C&I) loans. *Pure supply* is equal to the responses to the questions referring to capital position. See Section 2 and the Appendix for a detailed definition of the variables.

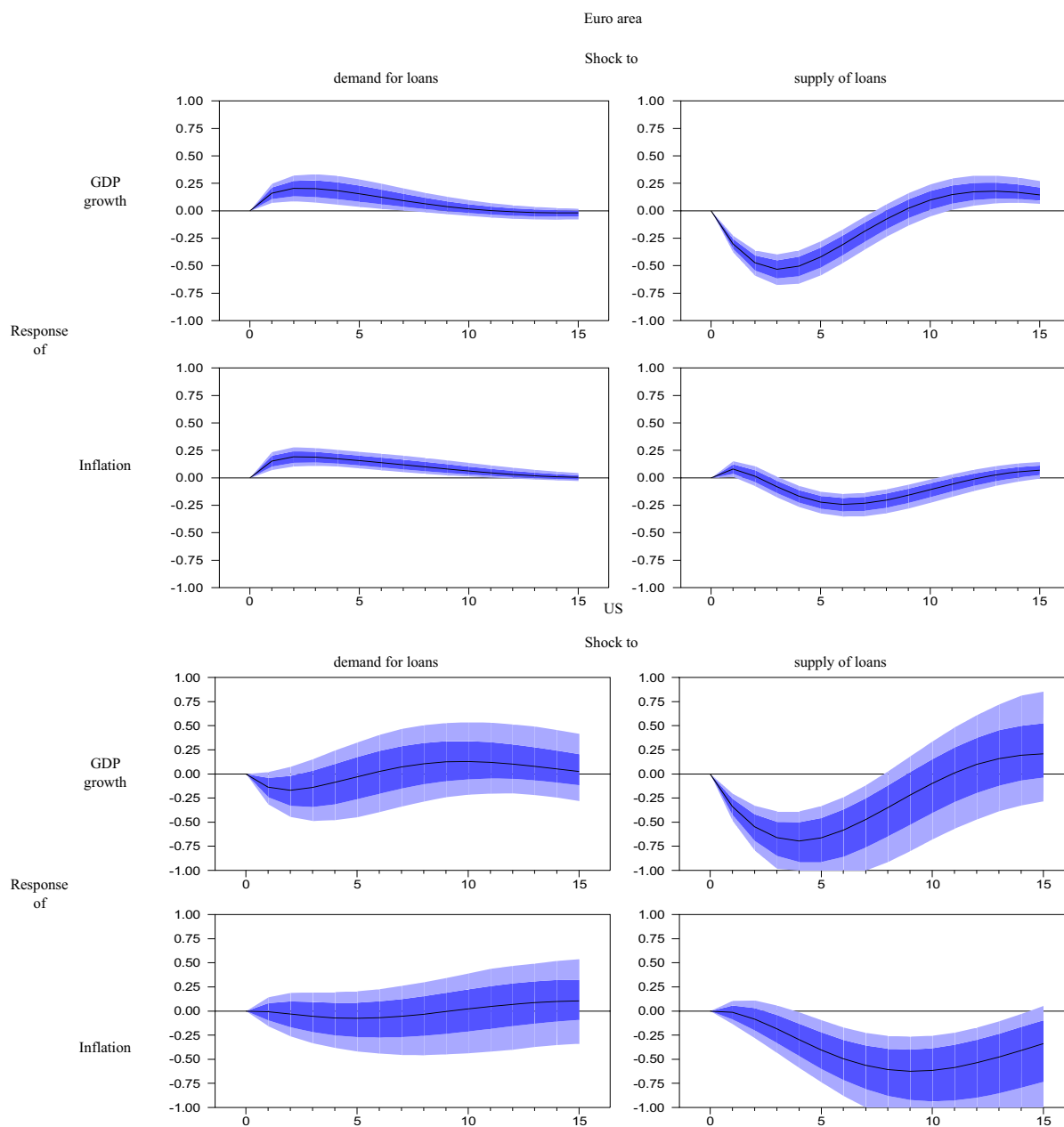
Source: Federal Reserve Board and authors' calculations

Figure 3A. Responses of demand and supply of business loans to a monetary policy shock



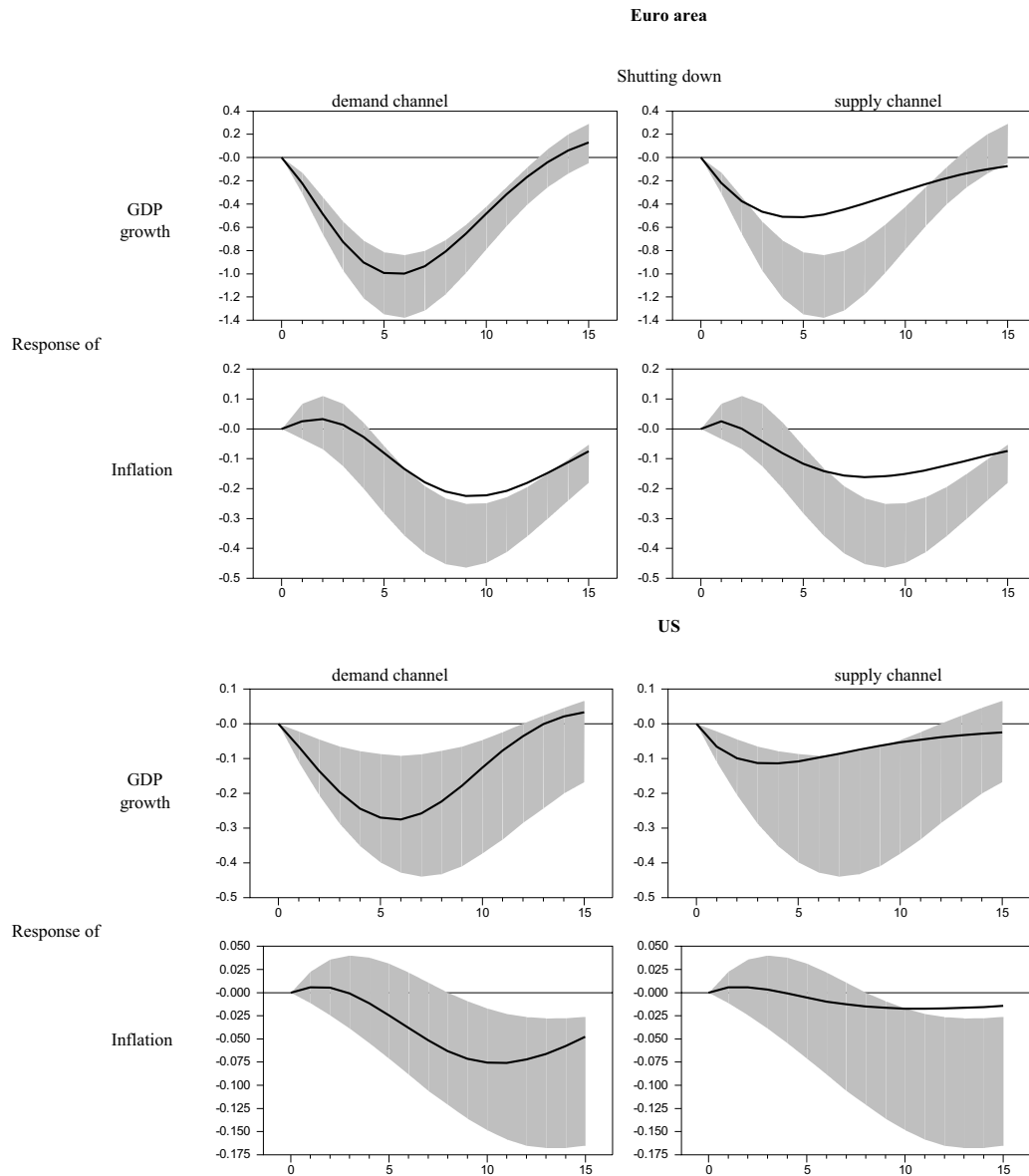
Note: These graphs plot the responses of loan demand and loan supply to a one-standard deviation shock to the overnight rate. Only business loans (loans to non-financial corporations in the Euro area and C&I loans in the US) are considered. Responses of the series are normalised and divided by their innovation variances so that all responses to a shock are comparable on a single scale. The median response is shown along with 68 (dark blue) and 90 (light blue) percent Bayesian credible intervals, computed by estimating the VAR with a flat prior on the parameters and assuming normality of the error terms. The graphs on the first row refer to the Euro area, while the second row shows the responses for the United States (US). The panel VAR for the Euro Area is estimated assuming fixed effects, slope homogeneity and the country identification strategy as explained in Section 2. The specification of the VAR includes 5 variables: GDP growth, inflation, total demand of loans from firms and total lending standards of loans to firms (see specification of MODEL 1 in Section 2.5.) See Section 2 and the Appendix for a detailed definition of the variables.

Figure 3B. Responses of GDP growth and inflation to shocks to demand and supply (credit availability) of business loans



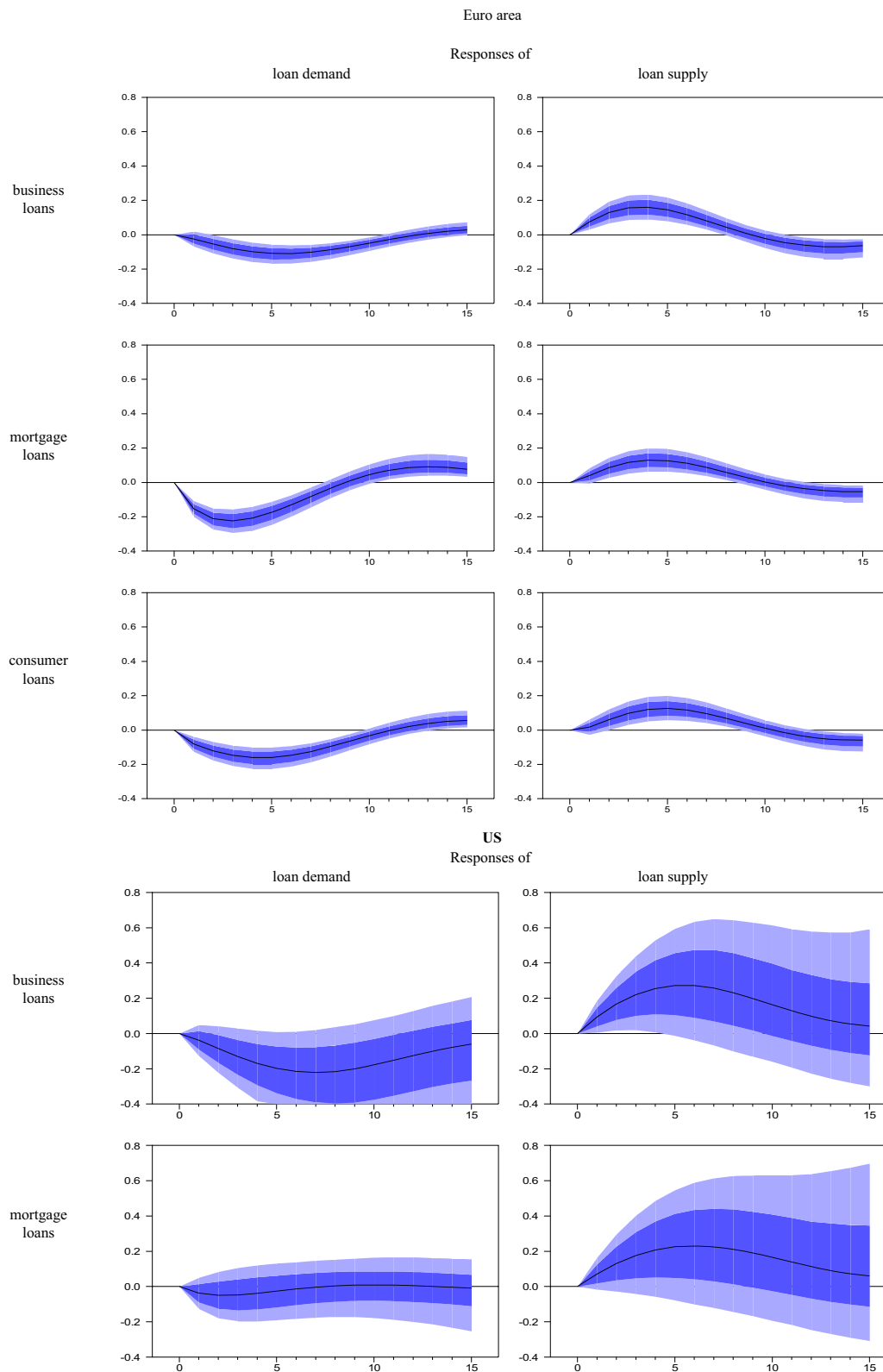
Note: These graphs plot the responses of GDP growth and inflation to a one-standard deviation shock to demand for and supply of loans. Only business loans (loans to non-financial corporations in the Euro area and C&I loans in the US) are considered. Responses of the series are normalised and divided by their innovation variances so that all responses to a shock are comparable on a single scale. The median response is shown along with 68 (dark blue) and 90 (light blue) percent Bayesian credible intervals, computed by estimating the VAR with a flat prior on the parameters and assuming normality of the error terms. The graphs on the first two rows refer to the Euro area, while the others show the responses for the United States (US). The panel VAR for the Euro Area is estimated assuming fixed effects, slope homogeneity and the country identification strategy as explained in Section 2. The specification of the VAR includes 5 variables: GDP growth, inflation, total demand of loans from firms and total lending standards of loans to firms (see specification of MODEL 1 in Section 2.5.) See Section 2 and the Appendix for a detailed definition of the variables.

Figure 3C. Counterfactual analysis. Responses of GDP growth and inflation to a monetary policy shock with and without credit channels (for business loans)



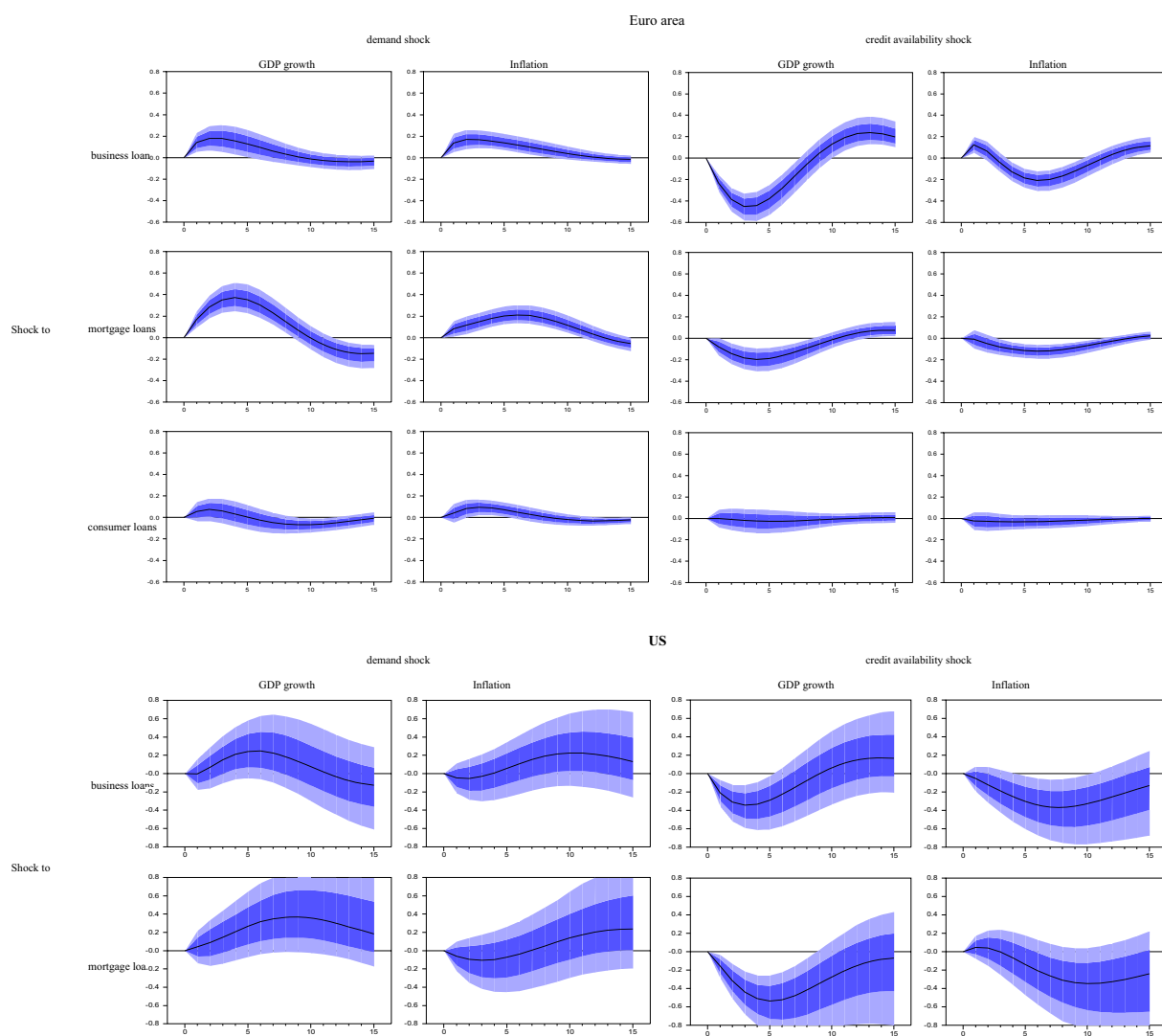
Note: These graphs report the results of counterfactual experiments. The responses of GDP growth and inflation to a one-standard deviation monetary policy shock in a full model are compared with the responses obtained when closing down the supply (supply channel) or the demand (demand channel) of business loans in the system. The black lines are computed from a system where the supply or demand channel has been closed down. The areas in grey are the confidence bands of the responses for the system where all the channels are active. Responses of the series are normalised and divided by their innovation variances so that all responses to a shock are comparable on a single scale. The graphs on the first two rows refer to the Euro area, while the others show the responses for the US. The panel VAR for the Euro Area is estimated assuming fixed effects, slope homogeneity and the country identification strategy as explained in Section 2. The specification of the VAR includes 5 variables: GDP growth, inflation, total demand of loans from firms and total lending standards for firms (see specification of MODEL 1 in Section 2.5.) See Section 2 and the Appendix for a detailed definition of the variables.

Figure 4A. Responses of loan demand and supply to a monetary policy shock



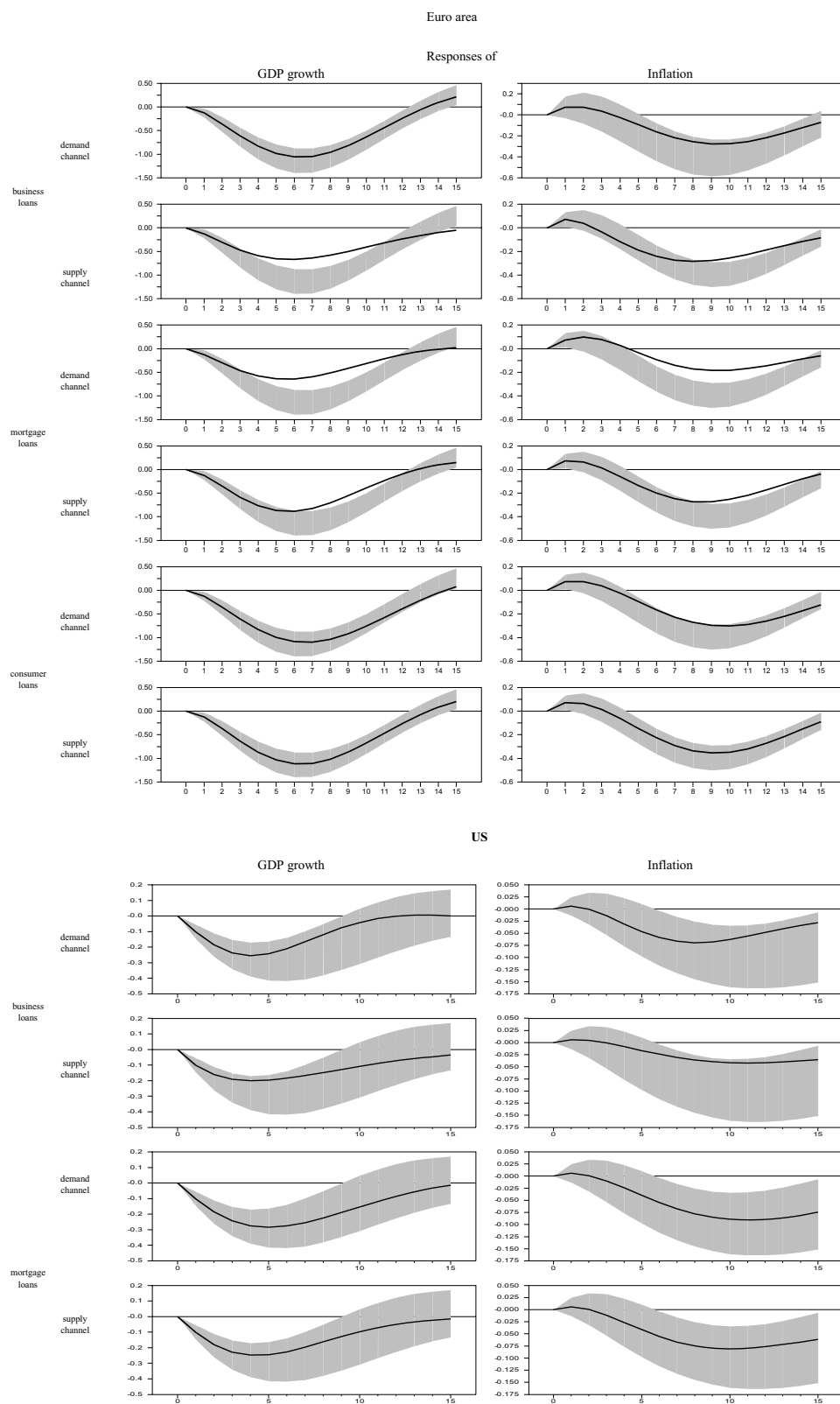
Note: These graphs plot the responses of loan demand and loan supply to a one-standard deviation monetary policy shock. Responses of the series are normalised and divided by their innovation variances so that all responses to a shock are comparable on a single scale. The median response is shown along with 68 (dark blue) and 90 (light blue) percent Bayesian credible intervals, computed by estimating the VAR with a flat prior on the parameters and assuming normality of the error terms. The graphs on the first three rows refer to the Euro area, for which business, mortgage and consumer loans are considered. The last two rows show the responses for the United States (US), where only business and mortgage loans are considered. The panel VAR for the Euro Area is estimated assuming fixed effects, slope homogeneity and the country identification strategy as explained in Section 2. The specification of the VAR includes 9 variables: GDP growth, inflation, overnight rates, demand and total lending standards for business, mortgages and consumer credit (see MODEL 2 in Section 2.5.) See Section 2 and the Appendix for a detailed definition of the variables.

Figure 4B. Responses of GDP growth and inflation to loan demand and supply shocks



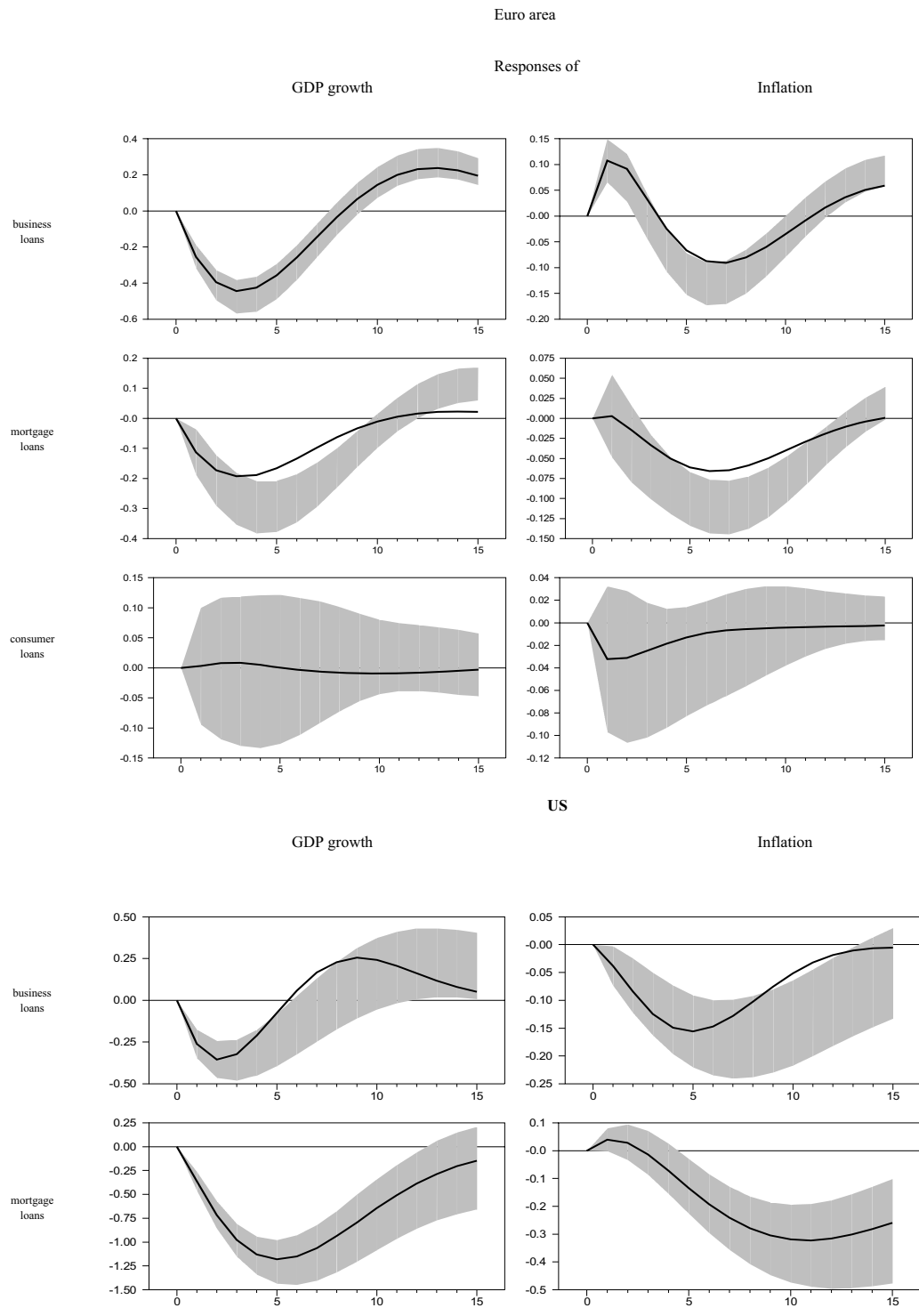
Note: These graphs plot the responses of GDP growth and inflation to a one-standard deviation shock to loan supply. Responses of the series are normalised and divided by their innovation variances so that all responses to a shock are comparable on a single scale. The median response is shown along with 68 (dark blue) and 90 (light blue) percent Bayesian credible intervals, computed by estimating the VAR with a flat prior on the parameters and assuming normality of the error terms. The graphs on the first three rows refer to the Euro area, for which business, mortgage and consumer loans are considered. The last two rows show the responses for the US, where only business and mortgage loans are considered. The panel VAR for the Euro Area is estimated assuming fixed effects, slope homogeneity and the country identification strategy as explained in Section 2. The specification of the VAR includes 9 variables: GDP growth, inflation, overnight rates, demand and total lending standards for business, mortgages and consumer credit (see MODEL 2 in Section 2.5.) See Section 2 and the Appendix for a detailed definition of the variables.

Figure 4C. Counterfactual analysis. Responses of GDP growth and inflation to a monetary policy shock with and without loan demand and supply channels and for specific borrower categories



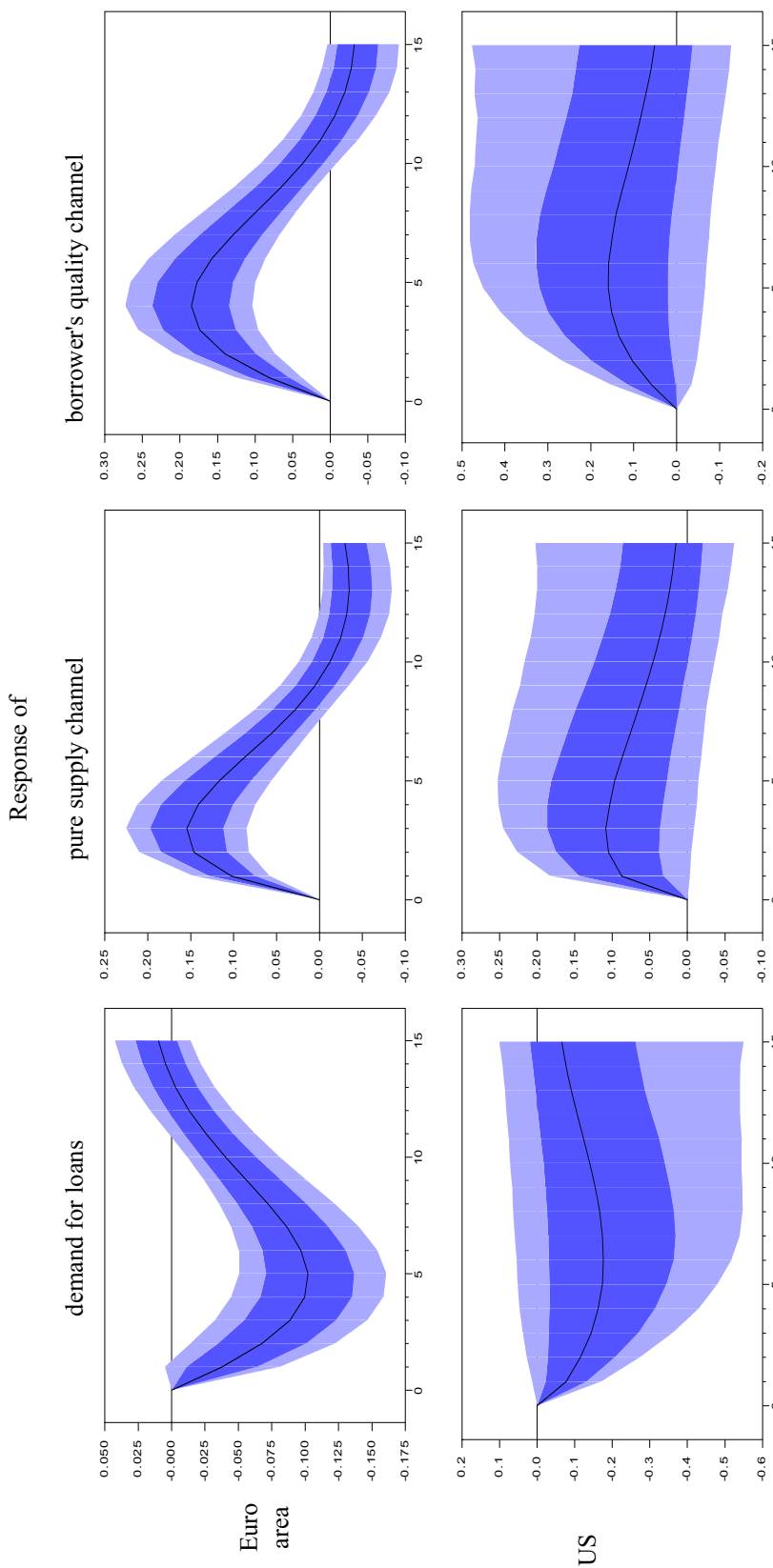
Note: These graphs report counterfactual experiments. The responses of output growth and inflation to a one-standard deviation monetary policy shock in a full model (grey shaded areas) are compared with the responses obtained when closing down the credit channels (demand or supply, black lines). All types of loans are considered. Responses of the series are normalised and divided by their innovation variances so that all responses to a shock are comparable on a single scale. The graphs on the first six rows refer to the Euro area. The last four rows show the responses for the US. The panel VAR for the Euro Area is estimated assuming fixed effects, slope homogeneity and the country identification strategy as explained in Section 2. The specification of the VAR includes 9 variables: GDP growth, inflation, overnight rates, demand and supply (two channels) for each type of loans (see MODEL 2 in Section 2.5). See Section 2 and the Appendix for a detailed definition of the variables.

Figure 4D. Counterfactual analysis. Responses of GDP growth and inflation to a credit availability shock with and without loan demand channels (for a specific borrower category)



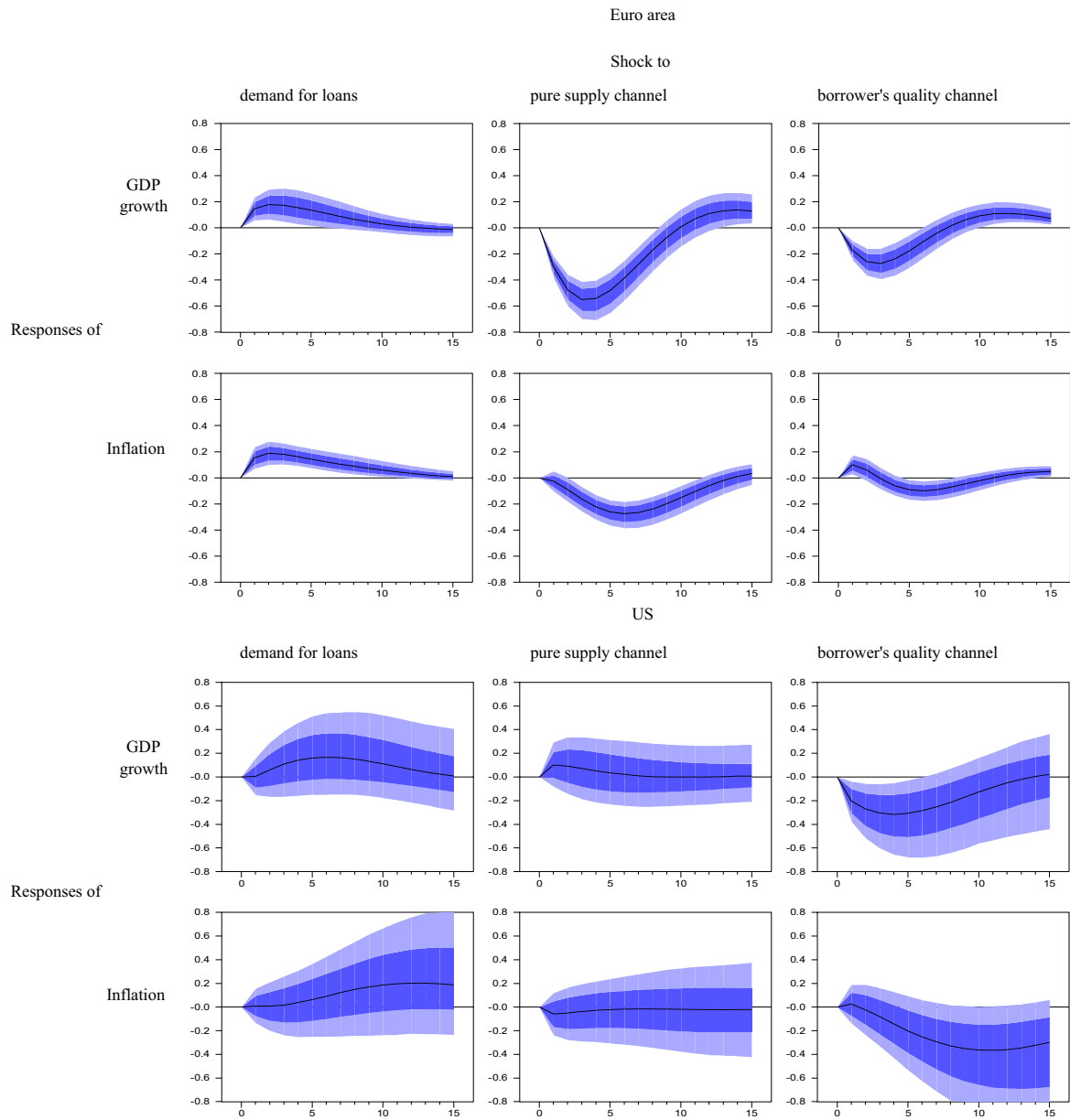
Note: These graphs report counterfactual experiments. The responses of output growth and inflation to a credit supply shock are compared with the responses obtained when closing down the demand channel. All types of loans are considered. Responses of the series are normalised and divided by their innovation variances so that all responses to a shock are comparable on a single scale. The graphs on the first six rows refer to the Euro area. The last four rows show the responses for the US. The panel VAR for the Euro Area is estimated assuming fixed effects, slope homogeneity and the country identification strategy as explained in Section 2. The specification of the VAR includes 9 variables: GDP growth, inflation, overnight rates, demand and total lending standards for each type of loans (see MODEL 2 in Section 2.5). See Section 2 and the Appendix for a detailed definition of the variables.

Figure 5A. Firm balance-sheet and bank lending channel. Responses of demand and supply of business loans to a monetary policy shock



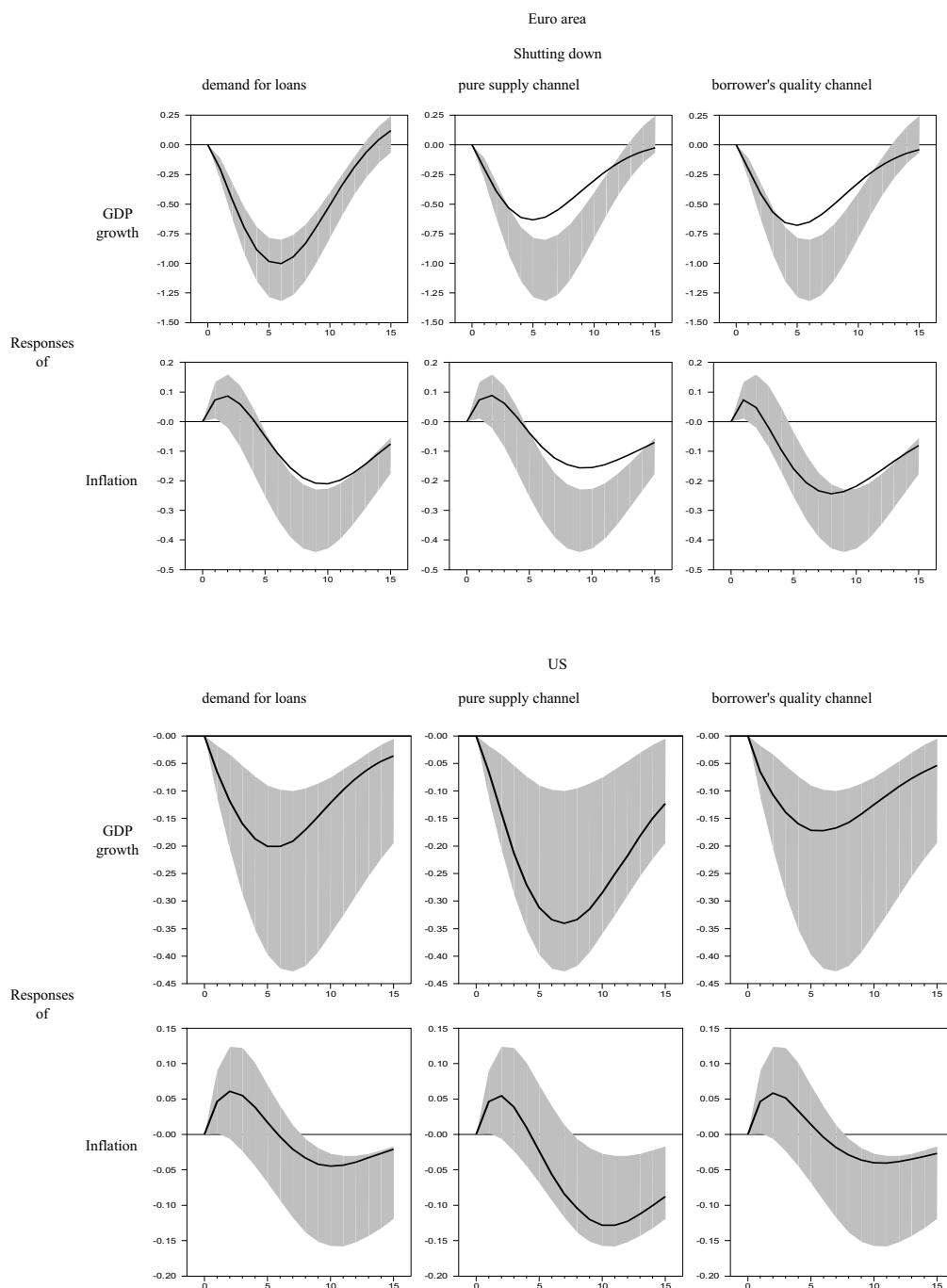
Note: These graphs plot the responses of loan demand and loan supply to a one-standard deviation monetary policy shock. Only business loans (loans to non-financial corporations) are considered. Loan supply is represented by two different channels: the pure supply and the borrower's quality channel (proxy for the bank lending and the firm balance-sheet channel). Responses of the series are normalised and divided by their innovation variances so that all responses to a shock are comparable on a single scale. The median response is shown along with 68 (dark blue) and 90 (light blue) percent Bayesian credible intervals, computed by estimating the VAR with a flat prior on the parameters and assuming normality of the error terms. The graphs on the first row refer to the Euro area, while the second row shows the responses for the United States (US). The panel VAR for the Euro Area is estimated assuming fixed effects, slope homogeneity and the country identification strategy as explained in Section 2. The specification of the VAR includes 6 variables for the euro area: GDP growth, inflation, demand for loans, *pure* supply lending standards and borrower's quality lending standards (see MODEL 2 in Section 2.5.). See Section 2 and the Appendix for a detailed definition of the variables.

Figure 5B. Firm balance-sheet and bank lending channel. Responses of GDP growth and inflation to a shock to demand and credit supply



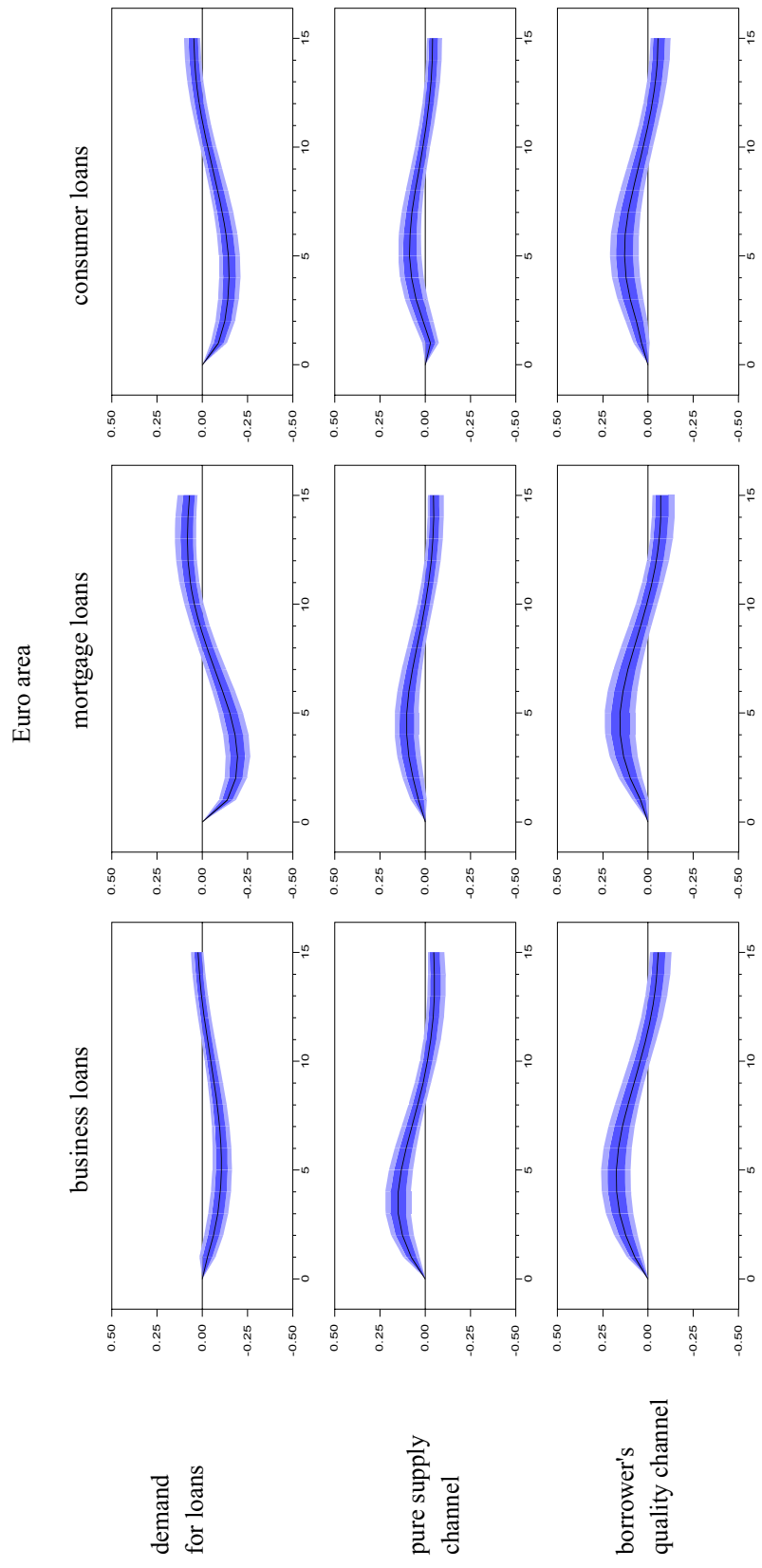
Note: These graphs plot the responses of GDP growth and inflation to a one-standard deviation shock of loan demand and loan supply. Only business loans (loans to non-financial corporations) are considered. Loan supply is represented by two different channels: the pure supply and the borrower's quality channel (proxy for the bank lending and the firm balance-sheet channel). Responses of the series are normalised and divided by their innovation variances so that all responses to a shock are comparable on a single scale. The median response is shown along with 68 (dark blue) and 90 (light blue) percent Bayesian credible intervals, computed by estimating the VAR with a flat prior on the parameters and assuming normality of the error terms. The graphs on the first two rows refer to the Euro area (EA), while the other rows show the responses for the US. The panel VAR for the Euro Area is estimated assuming fixed effects, slope homogeneity and the country identification strategy as explained in Section 2. The specification of the VAR includes 6 variables for the euro area: GDP growth, inflation, demand, pure supply lending standards and borrower's quality lending standards for business loans (see MODEL 2 in Section 2.5.). See Section 2 and the Appendix for a detailed definition of the variables.

Figure 5C. Counterfactual analysis. Firm balance-sheet and bank lending channel. Responses of GDP growth and inflation to a monetary policy shock.



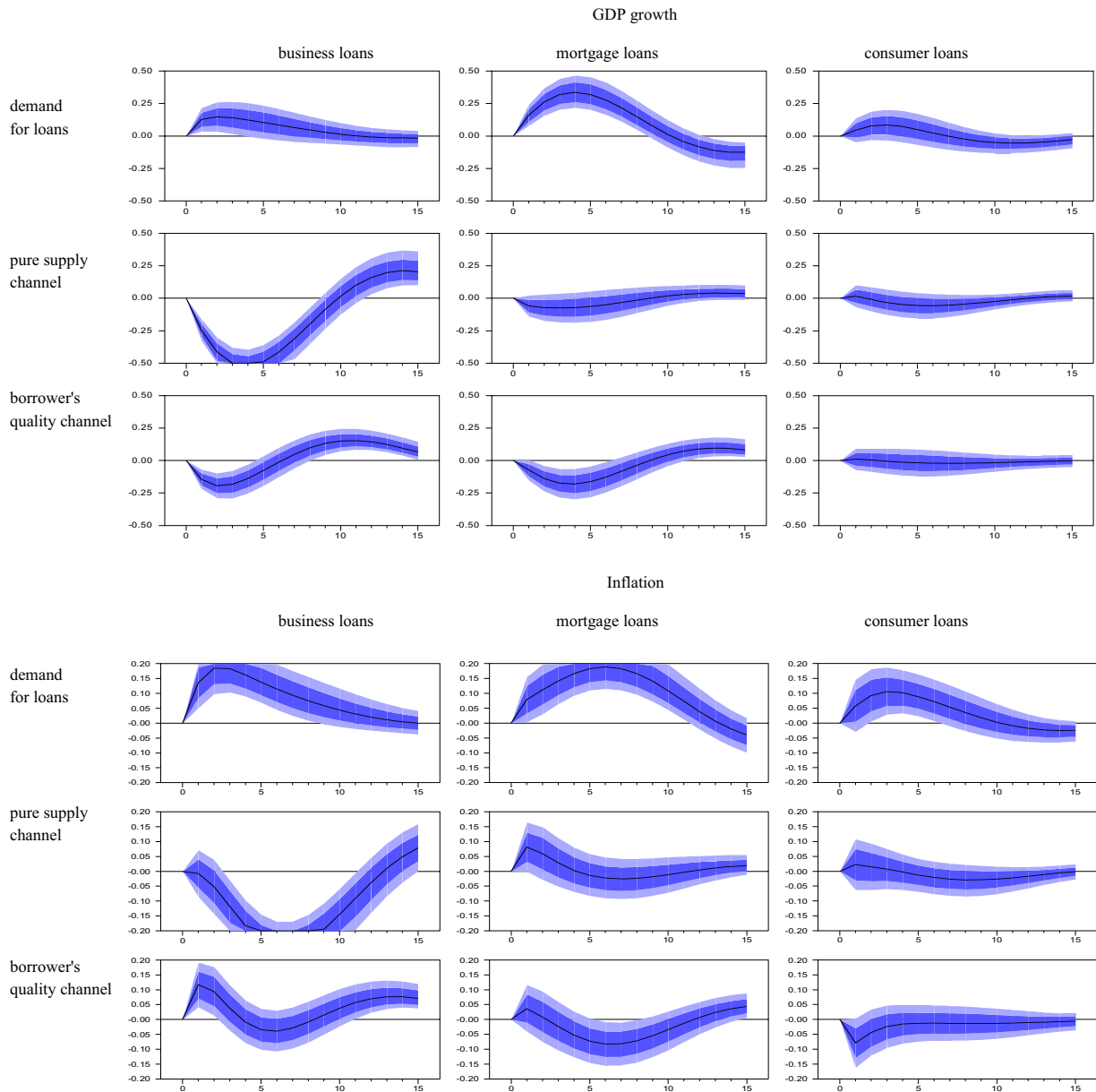
Note: These graphs report counterfactual experiments. The responses of output growth and inflation to a one-standard deviation monetary policy shock in a full model (grey shaded areas) are compared with the responses obtained when closing down the credit channels (one demand channel and two supply channels, black lines). Only business loans are considered. Responses of the series are normalised and divided by their innovation variances so that all responses to a shock are comparable on a single scale. The graphs on the first two rows refer to the Euro area. The last two rows show the responses for the US. The panel VAR for the Euro Area is estimated assuming fixed effects, slope homogeneity and the country identification strategy as explained in Section 2. The specification of the VAR includes 6 variables: GDP growth, inflation, overnight rates, demand, pure supply lending standards and borrower's quality lending standards for business loans (see MODEL 2 in Section 2.5.) See Section 2 and Appendix for a detailed definition of the variables.

Figure 6A. Responses of loan demand and supply (bank lending and borrower's bank lending channels) to a monetary policy shock (all category of borrowers).



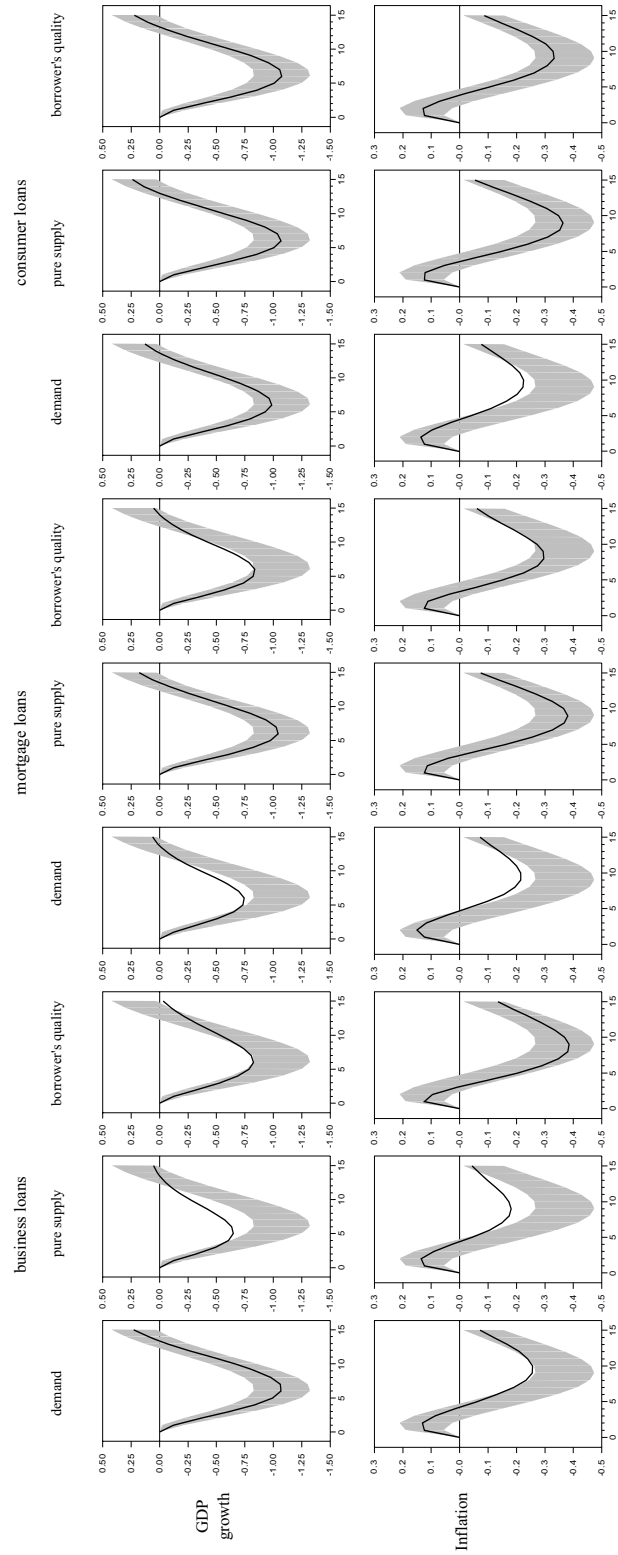
Note: These graphs report the responses of loan demand and loan supply (via bank lending and borrower's balance sheet channels) to a monetary policy shock for all borrower's category. Responses of the series are normalised and divided by their innovation variances so that all responses to a shock are comparable on a single scale. The median response is shown along with 68 (dark blue) and 90 (light blue) percent Bayesian credible intervals, computed by estimating the VAR with a flat prior on the parameters and assuming normality of the error terms. The graphs refer to the Euro area. The panel VAR for the Euro Area is estimated assuming fixed effects, slope homogeneity and the country identification strategy as explained in Section 2. The specification of the VAR includes 9 variables: GDP growth, inflation, overnight rates, demand, pure supply lending standards and borrower's quality lending standards for all type of loans (see MODEL 4 in Section 2.5.) See Section 2 and the Appendix for a detailed definition of the variables.

Figure 6B. Responses of Euro area GDP growth and inflation to a shock to loan demand and loan supply (bank lending and borrower's balance sheet channel), all category of borrowers.



Note: These graphs report the responses of GDP growth and inflation to a shock to loan demand and loan supply (via bank lending and borrower's balance sheet channels) for all category of borrowers (business, mortgage and consumer loans). Responses of the series are normalised and divided by their innovation variances so that all responses to a shock are comparable on a single scale. The median response is shown along with 68 (dark blue) and 90 (light blue) percent Bayesian credible intervals, computed by estimating the VAR with a flat prior on the parameters and assuming normality of the error terms. The graphs refer to the Euro area. The panel VAR for the Euro Area is estimated assuming fixed effects, slope homogeneity and the country identification strategy as explained in Section 2. The specification of the VAR includes 9 variables: GDP growth, inflation, overnight rates, demand, pure supply lending standards and borrower's quality lending standards for all type of loans (see MODEL 4 in Section 2.5.) See Section 2 and the Appendix for a detailed definition of the variables.

Figure 6C. Counterfactual analysis. Firm, household and bank balance-sheet channels in the Euro area. Responses of GDP growth and inflation to a monetary policy shock when closing down loan demand and loan supply (pure supply and borrower's quality) channels for each category of loans at a time.



Note: These graphs report counterfactual experiments. The responses of output growth and inflation to a one-standard deviation monetary policy shock in a full model are compared with the response obtained when closing down the credit channels (demand and supply channels) for each type of loan at a time. The results of the full system (grey shaded area) are compared with the results of the system where the corresponding channel has been closed down (black line). Responses of the model are calculated and displayed for the first 15 periods after the shock. All 12 impulse responses are for the Euro area. The panel VAR for the Euro Area is estimated assuming fixed effects, slope homogeneity and the country identification strategy as explained in Section 2. The specification of the VAR includes 12 variables: GDP growth, inflation, overnight rates, demand, pure supply lending standards and borrower's quality lending standards for all type of loans (see MODEL 4 in Section 2.5.) See Section 2 and the Appendix for a detailed definition of the variables.

Figure 7A. Historical decomposition. The impact of different shocks during the financial crisis

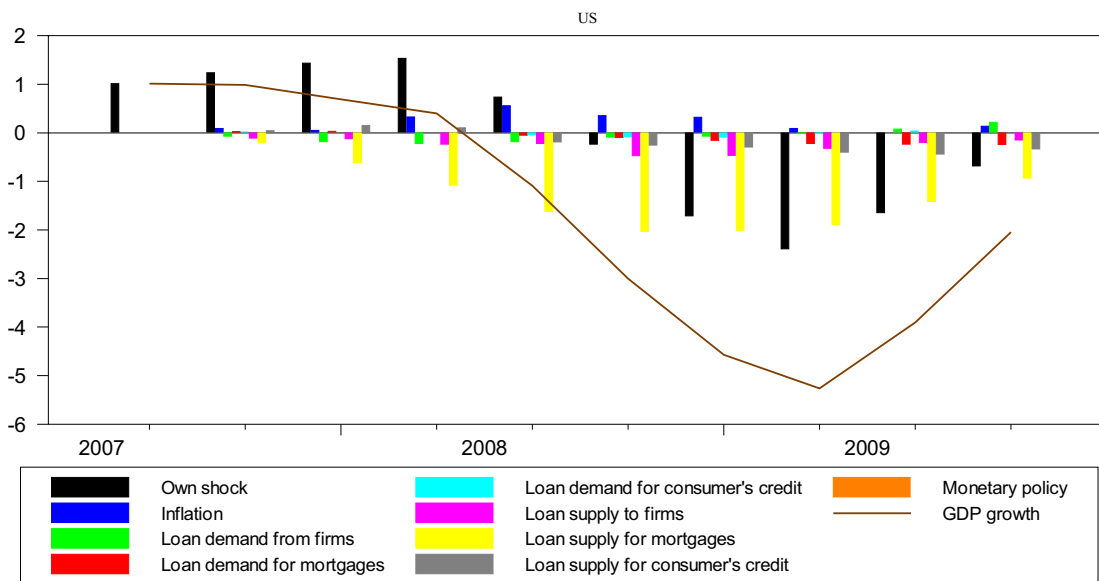
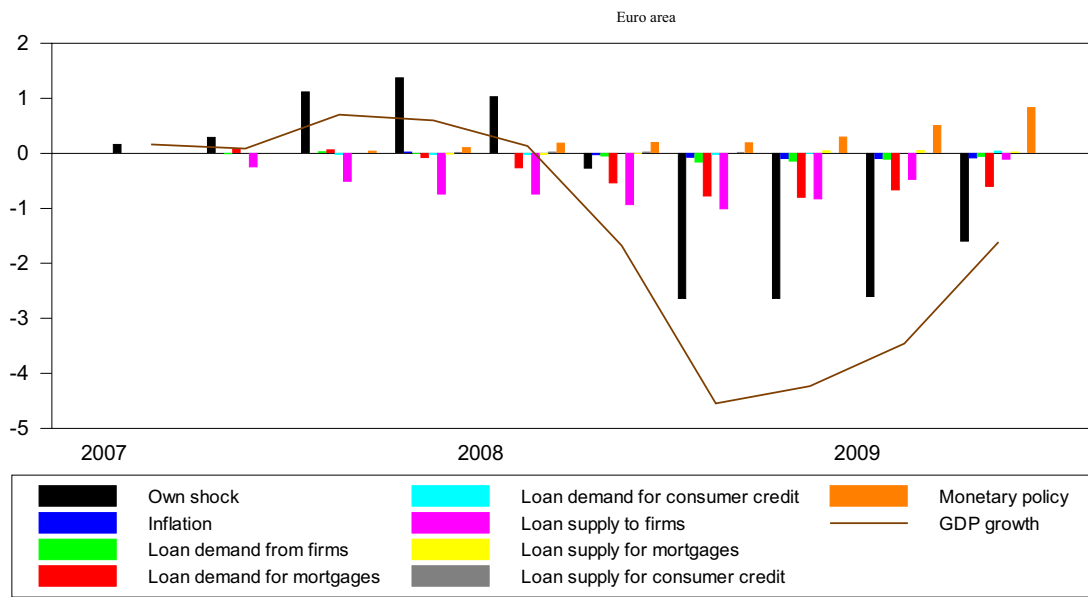


Figure 7B. Historical decomposition. The impact of different shocks during the financial crisis in the Euro area (pure credit supply and borrower's quality shocks)

