A Non-Standard Monetary Policy Shock: The ECB's 3-Year LTROs and the Shift in Credit Supply*

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Abstract

We study the macroeconomic effects of the 3-year long-term refinancing operations (LTROs) introduced by the ECB in December 2011 with the aim of reducing the obstacles to credit supply through the mitigation of liquidity and funding risks in the euro area banking system. Therefore, we interpret the measure as a credit supply shock, which is identified both recursively and with sign restriction methods using the euro area Bank Lending Survey (BLS). The size of the shock due to the LTROs is computed using both the April 2012 BLS and the special ad-hoc questions on the LTROs conducted in February 2012. The counterfactual exercises suggest that the 3-year LTROs lifted prospects for real GDP and loan provision to non-financial corporations over the next two-to-three years, thereby avoiding a major credit crunch.

Keywords: Non-standard monetary policy measures, panel VAR.

JEL classification: C23, E52.

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1 Introduction

The European Central Bank (ECB) implemented the 3-year long-term refinancing operations (LTROs) in December 2011 and February 2012. On 21 December 2011, the ECB allotted EUR 489 billion (USD 644 billion) in three-year loans to 523 banks; on 29 February 2012, the ECB allotted EUR 530 billion (USD 713 billion) in similar loans to 800 lenders. This liquidity provision at 1% interest rate amounts to 10.8% of euro area nominal GDP in 2011, 330% of the weekly main refinancing operations before the crisis started in 2007 and about 400% of the weekly main refinancing operations before the 3-year LTROs. The aim of this paper is to address the macroeconomic implications of such measure, facilitated by the fact that the ECB key interest rate was not at its zero lower bound (ZLB).

The identification of non-standard monetary policy shocks is still in uncharted territory. Identifying non-standard monetary policy shocks is a key challenge for econometricians, not least as these measures are largely unprecedented in central banking history and as the instruments vary widely across the various non-standard measures. An extensive theoretical literature has discussed the various policy alternatives, which are available when the policy rate hits the zero lower bound. By contrast, the empirical literature is only gradually emerging as data are collected and solutions to identification issues are found.

Bernanke et al. (2004) and Cecioni, et al. (2011) provide an extensive survey of the theoretical and empirical literature before and after the collapse of Lehman Brothers, respectively. In normal circumstances, conventional monetary policy acts by setting a target for the overnight interest rate in the interbank money market. During downturns, a monetary stimulus is provided, but this increases the spread between various forms of external finance and the short-term interbank rate owing to a pass-through price elasticity, which is lower than one particularly in the short term (Sander and Kleimeier, 2004; Kleimeier and Sander, 2006; ECB, 2009; Kwapil and Scharler, 2010; Hristov et al., 2012).

Conversely, unconventional measures directly target the cost and availability of external finance to banks, households and non-financial corporations, such that the spread between the external finance premium and the short-term interest rates declines (Bini Smaghi, 2009; Curdia and Woodford, 2009 and 2010; Woodford, 2010). Specifically, credit easing – such as the 3-years LTROs – aims at relaxing banks' collateral and funding liquidity constraint, so that banks can expand credit supply.

The 3-year LTROs, therefore, cannot be studied via the traditional bank lending channel, because the latter requires a rise in credit spreads, which contradicts the aim of the unconventional measure. We argue that the 3-year LTROs reduced the obstacles

to credit supply and should be interpreted as a credit supply shock, (i) through a change in the banking sectors' liquidity positions, which would loosen leverage constraints, and/or (ii) through a change in the banking sectors' risk perception about the overall economy or other intermediaries' assets, and/or (iii) through a change in financial regulations given the enlarged pool of the collateral accepted for the refinancing operation with the central bank. Such interpretation is consistent with the aim of the unconventional measures in reducing credit spreads and expanding credit supply.

We identify such shock through the Bank Lending Survey (BLS) conducted in March and published in April 2012, reporting actual survey information for the first quarter of 2012 and expected values for the second quarter of 2012. Clearly, there were many other events over this 6-month period that might have affected credit supply. Therefore, we also make use of an ad-hoc BLS questionnaire collected between 9 and 14 February 2012, which provides the commercial banks' direct answers on the effect of the 3-year LTROs over the first half of 2012. In other words, we restrict the potential spurious events to a 8-week window (from 21 December 2011 to 14 February 2012) and there is no doubt compelling to assume that the LTROs were the only driver of credit supply over this period. Both surveys show that this non-standard measure has been successful in making less tight credit standards to both households and non-financial corporations in the euro area.

We employ the euro area BLS demand and supply factors to non-financial corporations to identify credit supply shocks.[1] Specifically, we estimate a panel VAR using Generalized Method of Moments (GMM) and the Arellano-Bond estimator to overcome the Nickell (1981) bias in dynamic panels. De Santis and Surico (2013) highlight that the transmission of monetary policy over bank lending in the euro area is heterogenous. Therefore, the model is estimated using quarterly series over the period 2003Q1-2011Q4 for the largest eleven euro area countries or for eight countries excluding Greece, Ireland and Portugal, which are under the European financial assistance program, in order to investigate the potential implications of slopes' heterogeneity across groups of countries; namely of a group-specific transmission mechanism of the credit supply.

Based on the estimated panel-VAR, the macroeconomic impact of the 3-year

[1] Lown and Morgan (2006) for the United States and Ciccarelli, et al. (2010) for the euro area have also suggested to use the BLS to identify the credit supply shock. However, Ciccarelli, et al. (2010 and 2013) have focused their analysis on the bank lending channel, namely the impact of the standard monetary policy rate transmitted through credit.

LTROs is computed as follows. First, regarding the identification of credit supply shocks, we use two alternative methods based on short-run restrictions: the recursive (Sims, 1980) and the sign restriction (Uhlig, 2005; Rubio-Ramirez, Waggoner, Zha, 2010). The two identification schemes implemented in the paper deliver comparable macroeconomic propagation of credit supply disturbances and similar explanatory power on euro area economic developments through the crisis. Such similarities are worth emphasizing given the strong conceptual and technical differences between the two identification strategies.

Second, the effect of the 3-year LTROs is assumed to be exclusively attributed to the credit supply shocks estimated for the first half of 2012 either using the unpublished ad-hoc questionnaire of the BLS in February 2012, which directly provides the size of the credit supply shocks, or the published April 2012 survey round,[2] which is exploited to estimate econometrically the size of the credit supply shocks. The results based on both surveys and alternative identification schemes turn out to be strikingly similar. The counterfactual experiment points to a hump-shaped response of euro area real GDP in level reaching a peak by mid-2013 at 0.5-0.8 percentage points depending on data used to identify the shock and identification methods. The effects on inflation materialize with some lag with the annual inflation rate increasing by 0.15-0.25 percentage points at the peak in the beginning of 2014. Turning to credit variables, the outstanding amount of bank loans to non-financial corporations responds very gradually with maximum effects recorded in the second half of 2014, almost two years later than for GDP, at around 1.7-2.5 percentage points above baseline. At the same time, the lending rate spread declines by 10-20 basis points in the first quarters, reverting back to zero by mid-2014. As for the monetary policy rate, it would decline by about 40 basis points from 1%. Therefore, the ZLB issue does not impinge on the validity of the results.

The empirical analysis on the impact of the 3-year LTROs assumes that this non-standard monetary policy measure works through the mitigation of liquidity and funding risks in the euro area banking system, which ultimately contributes to relax bank lending standards and supports the financing of the economy at large. The moderate narrowing of lending rate spreads compared with the improvement of economic activity and loan provision suggests that the relaxation of credit standards due to the 3-year LTROs is more related to a quantitative easing of loan supply. The broadly similar outcomes obtained regardless of the data and identification methods

[2] To minimize any stigma associated with banks borrowing from the ECB through the LTROs, it was agreed not to publish the survey.

used reinforce the plausibility of our interpretation that 3-year LTROs acted as a favorable credit supply shock.

We also provide alternative counterfactual experiments in order to assess the robustness of the mentioned results. We replace in the panel-VAR the BLS variable on credit standards by the aggregation of three factors explaining credit standards in the BLS questionnaire: banks' liquidity position, banks' capital position and banks' ability to access market financing. Focusing the credit supply indicators on the most acute sources of bank vulnerabilities during the financial crisis is supportive of the qualitative results mentioned previously, even increasing our measurement of the effectiveness of ECB's non-standard measures.

We also broaden the impact assessment of the 3-year LTRO beyond its effect on the credit standards by incorporating in the panel-VAR financial variables likely to capture factors related to economic risk perception and risk aversion. A popular indicator used in the macro-financial empirical literature is the implied volatility of S&P 500 index options (VIX). This exercise shows that the quantitative assessment would not significantly change by controlling for financial variables in the panel-VAR system or broadening the transmission channel of the 3-year LTROs to investors' risk aversion and uncertainty.

Finally, we conduct a large number of exercises to show that the identified credit supply shock is truly exogenous.

Turning to the closely related literature, the effects of the non-standard measures introduced by the ECB on macroeconomic variables computed using VAR methods are also studied by Lenza, et al. (2010), Peersman (2011), Giannone, et al. (2012) and Gambacorta, et al. (2012). Lenza, et al. (2010) and Giannone, et al. (2012) study the impact of the non-standard measures by employing counterfactual simulations, which resemble generalized impulse response functions. Peersman (2011) and Gambacorta, et al. (2012) instead make use of structural VARs with sign restrictions.[3]

[3] Lenza, et al. (2010) identify the non-standard measure shock indirectly assuming that the reduction in the spread between unsecured and secured money market rates observed between November 2008 and August 2009 was entirely due to the non-standard measures. Giannone, et al. (2012) instead makes use of the ECB bank balance sheet. By comparing the forecasts of the main macro variables conditional to the observed path of the ECB bank balance sheet and a no-policy scenario in which the ECB balance sheet is projected to develop conditional to the macroeconomic environment, they conclude that in the absence of the ECB intervention, the macroeconomic activity in the euro area would have been more depressed. This identification scheme has two shortcomings: (1) the forecast of the ECB balance sheet is conditional to a macroeconomic environment that has already been affected by the policy measure; (2) the comparison of the two scenarios is comparable to a

Specifically, Peersman (2011) suggests to identify the non-standard measures using bank loans. The non-standard monetary policy shock is identified as the innovation to credit supply (i.e. higher bank loans with lower lending rates) orthogonal to the policy rate innovations. Such shock has the same transmission mechanism of Peersman's credit multiplier shock, which is an innovation that shifts the supply of bank loans, and our credit supply shock estimated using the BLS credit tightening information.

Gambacorta, et al. (2012), following the approach used by Peersman (2011), identify the non-standard measure using directly the central bank balance sheets and estimating a panel of eight advanced economies since the onset of the global financial crisis. To identify the shock, they assume that an unexpected increase in central banks' liquidity supply is associated with unexpectedly lower aggregate financial market volatility measured by the VIX. By means of such identification scheme, they show that an exogenous increase in central bank balance sheet at the zero lower bound is expansionary, but this is also because a lower VIX is generally associated with better economic perspectives.

The rest of the paper is structured as follows. Section 2 describes shortly the BLS for the euro area. In Section 3, we discuss the method and the data. Section 4 shows the relative importance of the credit supply shock on the euro area macroeconomic variables under alternative identification strategies. Section 5 discusses the key results focusing on the macroeconomic impact of the identified non-standard 3-years LTROs shock. Section 6 shows that the identified credit supply shock is truly exogenous. Section 7 concludes.

2 The Euro Area Bank Lending Survey (BLS)

The euro area BLS is addressed to senior loan officers of a representative sample of euro area banks and is conducted four times a year. The sample group participating in the survey comprises around 90-100 banks from all euro area countries and takes into account the characteristics of their respective national banking structures. The survey contains 17 specific questions on past and expected credit market developments. The former covers developments over the past three months, while the latter focus on the next three months. Questions are classified according to the two borrower sectors that are the central focus of the survey, i.e. enterprises and households. Specifically, seven questions refer to loans or credit lines to enterprises, eight questions refer to loans to households for house purchase and two questions refer to loans to households

generalized impulse response function rather than an impulse from an identified structural shock.

for consumer credit. To identify the credit supply shock, we use the answers of banks to loans or credit lines to enterprises (see Appendix A).

The definitions and classifications used in the survey are consistent with other ECB statistics. For both enterprises - i.e. non-financial corporations - and households, the questionnaire covers both loan demand and loan supply factors. Among the supply factors, attention is given to credit standards and credit conditions and terms, as well as to the various factors that may be responsible for their changes. Credit standards are the internal guidelines or criteria that guide a bank's loan policy. The terms and conditions of a loan refer to the specific obligations agreed upon by the lender and the borrower, such as the interest rate, collateral required and maturity.

The questions used to identify the credit supply and demand factors are those for loans or credit lines to enterprises:

- 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 (Question 1 in Appendix A)?

- Over the past three months, how has the demand for loans or credit lines to enterprises changed at your bank, apart from normal seasonal fluctuations (Question 4 in Appendix A)?

Of the questions on credit standards, three refer to banks' liquidity position, access to market funding and capital position, which are the most acute sources of bank vulnerabilities during the financial crisis affecting credit supply:

- 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 (as described in question 1)? a1 - Costs related to your bank's capital position; a2 - Your bank's ability to access market financing (e.g. money or bond market financing, including true-sale securitisation); a3 - Your bank's liquidity position (Question 2 in Appendix A).

We will also make use of this more restrictive definition of BLS credit supply factor, which is closely related to cost of funds and balance sheet constraints.

Finally, we make use of an ad-hoc BLS to assess the impact of the 3-year LTROs, which took place between 8 and 14 February 2012 and which the ECB Governing Council agreed not to publish. The questions used to identify the credit supply shocks are the following:

- Did your bank participate in the three-year LTRO of December 2011? Does your bank intend to participate in the three-year LTRO of February 2012? Explain the reasons behind your decisions for both LTROs.
- Did the three-year LTRO of December 2011 improve your financial situation in the following areas and did this have an impact on your lending behaviour from 21 December up to now? Will the two three-year LTRO operations (December 2011 and February 2012) improve your financial situation in the following areas and will this have an impact on your lending behaviour over the next six months? Areas: your liquidity position; your market financing conditions (prices); your ability to raise funds in wholesale markets (quantities); your ability to improve your profitability; your ability to improve your capital position (via retained earnings).

The 3-year LTROs was announced on 8 December 2011 and the first allotment was conducted on 21 December 2011. The regular BLS, describing developments for 2011Q4, was conducted between 19 December 2011 and 9 January 2012 and, therefore in the middle of the first allotment. The ad-hoc BLS on the 3-years LTROs was conducted between 8 and 14 February 2012 before the second allotment on 29 February 2012. Finally, the regular BLS, describing developments for 2012Q1, was conducted between 23 March and 5 April 2012:

Activity	Dates
3-yr LTROs announcement	8 Dec. 2011
First 3-yr LTROs allotment	21 Dec. 2011
Regular BLS (Jan. 2012)	19 Dec. 2011 - 9 Jan. 2012
Ad-hoc BLS on 3-yr LTROs	8 - 14 Feb. 2012
Second 3-yr LTROs allotment	29 Feb. 2012
Regular BLS (Apr. 2012)	23 Mar. - 5 Apr. 2012

The BLS demand and supply factors to NFCs for the euro area as a whole as well as for the individual countries that have allowed publication are plotted in Figure 1. The net percentage for the questions on supply of loans refers to the difference between the sum of the percentages for "tightened considerably" and "tightened somewhat" and the sum of the percentages for "eased somewhat" and "eased considerably". The net percentages for the questions on demand for loans are defined as the difference between the sum of the percentages for "increased considerably" and "increased somewhat" and the sum of the percentages for "decreased somewhat" and "decreased considerably". The BLS credit standards were tightened twice in the 2007-2008 period

and in the 2010-2011 period with the build-up of the euro area sovereign debt crisis. The results of the BLS disaggregated at the level of individual countries suggest that credit conditions in 2011 were particularly tight in Italy and Portugal. The 3-year LTROs policy introduced by the ECB in December 2011 and February 2012 was very effective: according to the April 2012 BLS, the net tightening of credit standards by Italian and Portuguese banks declined substantially in 2012Q1, both for loans to non-financial corporations and for loans to households. Similarly, the lending rates to NFCs stabilized after the introduction of the 3-year LTROs policy. This change mainly reflected milder pressures from cost of funds and balance sheet constraints, especially banks' access to funding and their liquidity position.

[insert Figure 1 here]

3 A panel-VAR using the euro area BLS information

The model can be written as

$$y_{i,t} = \alpha_i + B(L)\, y_{i,t-1} + \varepsilon_{i,t}, \qquad t = 1, ..., T, \tag{1}$$

where $y_{i,t}$ is a $k \times 1$ vector of variables of each of the i countries, $i = 1, ...I$, α_i is an country-specific, unobservable, fixed effect and $B(L)$ is a lag polynomial with the VAR coefficients. The disturbances, $\varepsilon_{i,t}$, have zero means and variance, $\Sigma = \mathbf{E}\left[\varepsilon_{i,t}, \varepsilon'_{i,t}\right]$.

The presence of α_i and $y_{i,t-1}$ make least square estimation of equation (1) inconsistent, even if the disturbances, $\varepsilon_{i,t}$, are uncorrelated, particularly when the time span is small (Nickell, 1981). In such cases, the instrumental variable (IV) estimator (Anderson and Hsiao, 1981) and generalized method of moments (GMM) estimator (Arellano and Bond, 1991) are both widely used. As noted by Blundell and Bond (1998), these estimators suffer from a weak instrument problem when the dynamic panel autoregressive coefficient approaches unity. This is not the case in our VAR specification in growth rates (see next sub-section).

The standard fixed effect estimator is biased in VAR with panel data (Holtz-Eakin, et al., 1988). Therefore, we estimate the panel assuming fixed effects and common slopes and adopting the Arellano-Bond GMM estimator. Equation (1) is estimated in first differences, using as instrument lagged levels of the dependent variable:

$$E\left[y_{i,t-s}\left(\Delta y_{i,t} - B(L)\, \Delta y_{i,t-1}\right)\right] = 0, \qquad s = 2, 3, ..., t.$$

It is important to stress that variables lagged twice are used as instrument for the first-differenced equation.

An alternative approach is to model heterogeneity in the slopes, but this would increase sharply the number of coefficients to estimate. A complementary approach is estimating the potential different transmission mechanism of the structural shocks across an alternative group of countries. This is the reason why one of the models excludes Greece, Ireland and Portugal from the estimation. Needless to say that the results remain broadly similar.

3.1 The data set

We bring the model to the data by considering historical series of quarterly data for the euro area over the period 2003Q1 to 2011Q4 for the largest eleven euro area countries. The size of T depends on BLS data availability, as the survey was conducted for the first time in 2003Q1. The size of N depends on the number of countries that joined the euro area as of 2003Q1 with the exclusion of Luxemburg: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain.

Economic activity is measured by quarter-on-quarter real GDP growth, while inflation is measured by quarter-on-quarter GDP deflator inflation. As for the monetary policy stance, it is common to employ the EONIA (Euro OverNight Index Average) rate (see Ciccarelli, et al., 2010 and 2013).[4] The EONIA is a weighted average of overnight Euro Interbank Offer Rates for interbank loans and it suffers from sharp movements due to technical reasons. In mid-2011, for example, the EONIA rate was above the 3-month EURIBOR, which is the rate at which euro area banks lend to each other on an unsecured basis. Conversely, the 3-month OIS (Overnight Index Swap) rate, which is an interest rate swap whose floating leg is tied to an overnight rate remained below the 3-month EURIBOR. Therefore, it is a preferable rate to measure the monetary policy stance (see Figure 2).

[insert Figure 2 here]

As for bank intermediation, given that the BLS credit conditions to NFCs, are used to identify the credit supply shock, we employ BLS demand and supply factors to NFCs as well as quarter-on-quarter loan growth to NFCs and the spread between the lending rate to NFCs and the 3-month OIS. Note that the answers to the BLS refer to changes relative to the previous quarter. This implies that the BLS answers

[4] Ciccarelli et al. (2010 and 2013) used four-quarter sum real GDP growth and inflation. This approach, however, generates more persistence in the impulse response functions and, as a result, in the historical decomposition of shocks.

are a flow measure which is consistent with macro-variables, such as GDP, prices and loans in growth rates.

The average correlation among the variables is in most cases strongly statistically significant (see Table 1), which suggests that the VAR methodology is needed to extract the expected correlations useful to identify the "surprises". As for the lag length, the Schwarz information criterion suggests the use of one lag.

[insert Table 1 here]

3.2 Panel unit root tests

Given that the traditional GMM estimator works very badly if the variables are I(1), we report in Table 2 a battery of unit root tests. For the purpose of testing, there are two natural assumptions that we can make about the autoregressive coefficient. First, one can assume that the persistence parameters are common across cross-sections, as employed by Breitung (2000), Hadri (2000) and Levin, et al. (2002). Alternatively, one can allow the unit root processes to vary freely across cross-sections, as suggested by Maddala and Wu (1999), Choi (2001) and Im, et al. (2003). All tests, but Hadri (2000), employ a null hypothesis of a unit root, while the Hadri test uses a null of no unit root. Except for the 3-month OIS and the lending rate spread, the unit root hypothesis is highly rejected. The non-stationarity of the policy rate and the lending rate spread is simply due to the very high persistence of both time series (see Figure 1). Therefore, we can assume them stationary. It would be unrealistic to believe that such rates were non-stationary.

[insert Table 2 here]

4 Credit supply shocks and economic fluctuations

In this section, we identify credit supply shocks in the panel-VAR and analyze the macroeconomic propagation mechanism of such economic disturbances together with their contribution to euro area cyclical developments over the last decade.

4.1 Impulse response function of a credit supply shock

Structural interpretation of VAR models requires additional identifying assumptions. We use thereafter two alternative short-run exclusion restriction methods: a traditional recursive identification scheme and one based on sign restrictions.

4.1.1 Recursive identification

Error terms of a VAR are typically correlated across equations. By computing the Cholesky factorization of the reduced form VAR covariance matrix $\mathbf{\Sigma} = AA'$, we "orthogonalize" the reduced-form innovations and estimate the structural shocks (Sims, 1980). Specifically, once estimated $\mathbf{B}(L)$, we can recover the disturbances, $\varepsilon_{i,t}$, and identify the structural shocks $\eta_{i,t}$ as follows: $\eta_{i,t} = \mathbf{A}^{-1}\varepsilon_{i,t}$, where $\mathbf{A}$ is the lower triangular Cholesky factor of the residual variance-covariance matrix.

The variables are ordered as follows: Real GDP growth, GDP deflator inflation, BLS demand factor, BLS supply factor, lending rate to NFCs-3-month OIS, 3-month OIS, loan growth to NFCs, with the first three variables capturing potential technology shocks, but most importantly aggregate demand and credit demand shocks. The results are qualitatively similar even if the BLS supply factor is ordered last (see Section 6).

The impulse response functions of the credit supply shock are presented in Figure 3. The results suggests that real GDP declines for about 3 years with a loss amounting to 0.6 percentage points at the peak if the panel is estimated using 8 countries and 0.7 percentage points if the panel also included Greece, Ireland and Portugal. The impact on prices is also negative, but small ranging between 15 basis points after 2 years if the panel is formed by 8 countries and 25 basis points after 2 years and half if the panel included Greece, Ireland and Portugal. All in all, an unanticipated credit tightening has a temporary negative impact on output and prices, with responses that are generally more persistent when the panel included also Greece, Ireland and Portugal.

[insert Figure 3 here]

Regarding all other variables related to credit intermediation, the credit supply shock shifts on impact the BLS answer on credit standards. The tightening of bank lending policy leads to higher bank lending rate spreads and lower outstanding amount of loans.

More specifically, the following features of the credit supply transmission mechanism should be emphasized. First, the maximum effect of output is reached after 5 quarters reverting back to baseline after 14 quarters while the impact on loans peaks after 10 quarters and is more persistent. The obtained impulse response functions are qualitatively very similar to Peersman (2012). The lagged impact of credit standards on bank loans is also confirmed by Hempell and Kok Sørensen (2010), who employ panel fixed effects methods.[5] Second, the relative magnitude of output and loan re-

[5] Hempell and Kok Sørensen (2010) find a significant impact of credit supply factors on bank

sponse shows that after credit supply disturbances the peak effect on loans is much stronger than on GDP. The maximum impact on real GDP is around 0.6 percentage points compared with 2 percentage points on loans. The result on output is consistent with Peersman (2012), although we find that the impact on lending volume is larger possibly because we focus on loans to NFCs, while Peersman (2012) employs the overall credit to the private sector. Also the dynamic stochastic general equilibrium literature of models with financial frictions presents qualitatively similar multipliers (see for example Christiano *et al.*, 2010; Darracq *et al.*, 2011).[6]

The results also suggest that the outstanding amount of loans has a delayed response compared to GDP. The same findings are brought to light by Peersman (2012) and Giannone et al. (2012), the latter focusing on the impact of a monetary policy shock. This implies that loans to non-financial corporations lag the business cycle, possibly because debt is generally rolled over. Similar results are also obtained by Lown and Morgan (2006), who study the impact of a credit standard shock in the United States using similar variables and the recursive ordering to identify the shock. The typical credit standards shock in the United States amounts to an 8% increase in the net fraction tightening. At the trough, loan volume and GDP are about 3% and 0.5% lower than before the shock to credit standards, respectively. They also found that the path of GDP roughly parallels the path of credit standards. However, the paths of GDP and loan volume are not as close. The trough in GDP precedes the low point in loan volume. Lown and Morgan (2006) argue that GDP includes non-business output and that activity should not necessarily parallel commercial lending.

Finally, the lending rate spreads reacts relatively little compared with the contraction in GDP and loans, as in Peersman (2012). Such a mild response indicates that the identification of the credit supply shocks through the BLS answers on credit standards is likely to gear the transmission towards quantitative bank lending channels related to non-price terms and conditions.

4.1.2 Identification by sign restrictions

Identification in sign-identified models requires that each identified shock is associated with a unique sign pattern. We employ the approach of Uhlig (2005), but adopt the algorithm of Rubio-Ramirez, Waggoner, and Zha (2010), as the latter is more efficient

lending with a lagged effect of around three quarters on actual reported net lending figures.

[6] This result is also consistent with the estimated multipliers from the reduced-form analysis of Cappiello, et al. (2010) who found that a one percentage point shock to loan supply would give rise to a negative long-run impact on real GDP growth of around 0.3%.

in dealing with sign restrictions on impulse responses to a number of structural shocks.

If several structural shocks must be identified, Uhlig's algorithm searches for the orthogonal matrix column by column recursively. During this search, the orthogonal matrix may not be found for some draws, either from the bootstrap procedure or from the posterior distribution. Conversely, Rubio-Ramirez, Waggoner, and Zha' algorithm keep all the posterior draws in practice and the orthogonal matrix is simply a draw from the uniform (or Haar) distribution with only a single operation of the QR decomposition.[7] These differences make Rubio-Ramirez, Waggoner, and Zha' algorithm more efficient when several shocks are to be identified.

The basic steps are the following:

(1) Take a random draw from the posterior distribution of the reduced-form VAR parameters (inverse Wishart for the covariance matrix $\mathbf{\Sigma}$ and Normal for the reduced form parameters $\mathbf{B}$).

(2) For each draw compute $\mathbf{\Sigma}$ and $\mathbf{B}$.

(3) Compute the eigenvectors of $\mathbf{\Sigma}$ normalized.

(4) For each $(\mathbf{B}, \mathbf{\Sigma})$ consider N random draws of the rotation U from a uniform distribution, and for each combination $(\mathbf{B}, \mathbf{\Sigma}, \mathbf{U})$ compute the set of implied structural impulse responses.[8]

(5) If these impulse responses satisfy the sign restrictions, keep the draw; otherwise, repeat all the steps.

The Bayesian approach requires forming a prior for the reduced-form VAR. We employ $\mathbf{\Sigma}$ and $\mathbf{B}$ estimated using the Arellano-Bond GMM estimator.

Following Peersman (2012), we identify three main shocks: a credit supply shock, a monetary policy shock and an aggregate demand shock. However, while Peersman (2012) imposes a sign restriction on loan volumes, we identify the shocks using the BLS demand and supply factors. Therefore, the short run responses to a contractionary

[7] In linear algebra, a QR decomposition (also called a QR factorization) of a matrix is a decomposition of a matrix A into a product A=QR of an orthogonal matrix Q and an upper triangular matrix R.

[8] By construction $U'U = I_n$. Then, define $\overline{A}$=AU where $\overline{A}$ is the Cholesky decomposition of Σ such that $\overline{AA}$'=Σ. One can construct many candidate solutions $\overline{A}$ by repeatedly drawing at random from the set of orthogonal matrices U.

shock take the following sign:

	Credit supply	Monetary policy	Aggregate Demand
GDP Growth	-	-	-
Inflation	-	-	-
Credit demand factor			-
Credit supply factor	+		
Cost of lending	+	+	-
Interest rate	-	+	-
Loan growth			

The impulse response functions of the credit supply shock are presented in Figure 4. Beyond the scaling of the shock, the results suggest a high degree of similarities with respect to the previous shock identification. First, the dynamic responses of output and loan do comfort previous findings, regarding the delayed response of loans or peak GDP effects after 5 to 6 quarters. Second, the identification with sign restriction also confirms the stronger impact on loans than on GDP of credit supply disturbances. From peak to peak, loans react by 3.5 times more than GDP, precisely like in the recursive identification scheme. Third, the inflationary effects of the credit supply shock is very close to the one obtained previously for a given output effect, albeit somewhat more persistent.

[insert Figure 4 here]

At the same time, some striking differences should be noticed. It appears that the sign restriction scheme delivers on impact a milder response of the BLS answer on credit standards but stronger responses of BLS answers on loan demand and loan rate spreads. In comparison, the recursive identification scheme may therefore impose some strong assumptions on the instantaneous response of the BLS supply variable. The next section, which analyses the historical decomposition of the shock, will also assess whether these differences significantly affected the model-based assessment on the role of credit supply shocks in the euro area business cycle.

4.2 Credit supply factors during the financial crisis

We now turn to the economic importance of credit supply disturbances in the euro area business cycle. The results from the recursive identification scheme are analyzed first, followed by the comparison with the sign restriction outcomes.

Four main periods can be identified over the last decade: the period before the financial crisis started up to June 2007, when credit standards were eased; the period

up to March 2009, when the global crisis unfolded and credit standards were tightened; the short period up to December 2009, when credit standards saw some easing; and the subsequent period up to December 2011, when the re-emergence of credit supply tensions were strongly contributing to higher net tightening of credit standards (see Figure 5).

[insert Figure 5 here]

Clearly, the credit supply shocks are found to be important drivers of the BLS answer on credit standards. However, in some periods, the credit supply disturbances were not fully explaining the developments in this BLS variable. In 2010, notably, the overall answers of banks were pointing to more neutral stance on bank lending policies, despite the credit supply shock re-emerged very strongly. This demonstrates the need to treat the BLS variables as endogenous in the panel-VAR system in order to account for the dynamic interactions with other factors in order to better measure credit supply effects.

Starting with the pre-crisis period, credit supply factors supported the economic recovery from 2005 to 2007. The positive contribution to annual GDP growth peaked at around 1.5 percentage points in 2005, receding thereafter. The associated effects on price dynamics reached 0.3 percentage points of annual GDP deflator inflation. Turning to credit variables, up to 3 percentage points of annual loan growth was explained by credit supply disturbances in 2006 and 2007 while lending rate spreads were compressed by almost 30 basis points (see Figure 6).

[insert Figure 6 here]

Through the 2008-09 episodes, the positive contribution of credit supply factors to GDP growth was rapidly reabsorbed and turned largely negative. At the trough, in the beginning of 2009, the contribution reached -1.8 percentage points getting back to a small positive number in early 2010. While sizeable, the credit supply effects identified by the model still fall short of explaining the overall contraction of GDP over the period. In 2008-2009, the credit supply factors also implied temporary disinflationary pressures, by -0.3 percentage points at the maximum in 2009. Over the same period, up to -1.5 percentage points of annual loan growth was constrained due to credit supply shocks which also fuelled lending rate spreads by around 20 basis points. Between end-2009 and early-2010, all those effects receded.

The resurrection of financial tensions in 2010 and 2011 led to renewed adverse credit supply shocks, which have been weighting on annual GDP growth by -0.5 percentage points in 2011, while containing inflation by less than -0.2 percentage

points. The drag on loan dynamics reached 1.5 percentage points and the contribution to lending rate spreads increased back to 20 basis points.

Turning now to the in-sample structural decomposition implied by the sign restriction identification scheme, the results are presented and systematically compared with the previous ones in Figure 5 for the BLS variables and in Figure 7 for goods and credit markets variables. One striking similarity concerns the historical decomposition of GDP, loans and to a lesser extent inflation. As suggested by the comparison of impulse response functions, the two identification schemes attribute almost the same impact of credit supply tensions on activity and lending through the crisis, whereas the contribution to inflation dynamics appears broadly similar but somewhat more pronounced with sign restrictions. On the BLS variables, the results are qualitatively comparable but on credit standards in particular, the contribution of credit supply shocks identified with sign restrictions turns out to be more moderate and less volatile. Finally, the historical decompositions of lending rate spreads display more pronounced differences with the sign restrictions attributing stronger credit supply effects. These differences on BLS credit standards and lending spread variables correspond to the ones illustrated when comparing the impulse response functions.

[insert Figure 7 here]

Overall, the two identification schemes implemented in this paper deliver comparable macroeconomic propagation and similar explanatory power on euro area economic developments through the crisis. Such similarities are worth emphasizing given the strong conceptual and technical differences between the two identification strategies.

5 The macroeconomic impact of the 3-year LTROs

5.1 Why focusing on the bank lending channel?

As mentioned earlier, the empirical analysis on the impact of the 3-year LTROs assumes that this non-standard monetary policy measure works through the mitigation of liquidity and funding risks in the euro area banking system, which ultimately contributes to relax bank lending standards and supports the financing of the economy at large.

Within our panel-VAR framework, the effects of the 3-year LTROs on the euro area macroeconomy will therefore be inferred using the privileged information on bank lending practices from the BLS and the associated identification procedure for

credit supply shock presented in the previous sections. This strategy contrasts with other approaches found in the recent literature addressing the macroeconomic effects of unconventional monetary policy (Giannone, et al., 2012; Gambacorta, et al., 2012).

At the same time, one must acknowledge that other channels may potentially be ignored by our identification strategy. For example, non-standard measures may also be perceived as commitment devices from the monetary authority on its readiness to act and ability to deliver on its mandate, when the room for further accommodation through standard monetary policy instrument is narrow. Such expectational channels are absent from the analysis presented in this paper; thereby we might neglect potentially powerful transmission mechanisms of the 3-year LTROs.

Additional transmission channels, which go beyond or by-pass the provision of loans by the banking system, are connected to the effects of the 3-year LTROs on macroeconomic risk distribution and on the price of risk. At the end of this section, we conduct an additional scenario to make the point.

5.2 Interpreting the 3-year LTROs as the unexpected credit supply shock in the first half of 2012

In this section, the evaluation of the 3-year LTRO impact on the euro area macroeconomy will be conducted along two simulation exercises. First, the 3-year LTROs are assumed to have contributed through credit supply shocks to the unexpected changes of the BLS answers on loan demand and credit standards in 2012Q1 as well as in 2012Q2 based on respondents expectations formulated in the April 2012 survey round and the size of the shock is derived using econometric identification schemes. Second, we make use of an unpublished ad hoc questionnaire of the BLS collected between 9 and 14 February 2012, which provides the bank answers on the effect of the 3-year LTROs on credit standards and, therefore, the size of the shock.

The first exercise is carried out by first forecasting conditionally to BLS demand and supply factors available for 2012Q1 and 2012Q2 the remaining variables of the system using the euro area VAR compatible with the panel-VAR estimation. Then, the credit supply shocks are extracted. The associated credit supply shocks for the two consecutive quarters are presented in the two first lines of Figure 8 for the versions of model based on 8 or 11 countries respectively. It turns out that for the first quarter of 2012, a favorable credit supply shock is extracted and amounts to a decline in credit standards by around 20 percentage points. For the second quarter of 2012, the smoothed credit supply shock is almost negligible.

[insert Figure 8 here]

One may argue that this favorable credit supply shock in 2012Q1 could be related to other factors than the 3-year LTROs. In order to corroborate our interpretation, we relate the bank-level distribution of answers in the BLS to the actual bidding behavior of the respective banks in the two 3-year LTROs. We find that the net tightening of credit standards for loans to enterprises was much higher in 2011Q4 and declines more strongly in 2012Q1 for the group of banks which participated to the 3-year LTROs than for the non-bidding banks. Actually, the net tightening of credit standards for the non-bidding banks even increased from 2011Q4 to 2012Q1. This justifies the interpretation of the favorable credit supply shock in 2012Q1 as driven by the 3-year LTROs.

The macroeconomic impact of the 3-year LTROs could then be assessed by simulating the dynamic response of variables in the panel-VAR to the two credit supply shocks for 2012Q1 and 2012Q2. Observing all variables up until 2011Q4, this simulation is equivalent to the difference between the contribution of credit supply shocks identified in the first half of 2012 to the h-step ahead forecast and the unconditional h-step ahead forecast. The first line of panel A in Figure 9 presents the results of this exercise. The response of euro area real GDP in level displays a hump-shaped pattern reaching a peak by mid-2013 at 0.7-0.8 percentage points depending on the version of the model. The effects on inflation materialize with some lag with the annual inflation rate increasing by 0.15-0.25 percentage points at the peak in the beginning of 2014. Turning to credit variables, the outstanding amount of bank loans to non-financial corporations responds very gradually with maximum effects recorded in the second half of 2014, almost two years later than for GDP, at around 2-2.5 percentage points above baseline. At the same time, the lending rate spread declines by 15-20 basis points in the first quarters, reverting back to zero by mid-2014. Given that the monetary policy rate would decline by about 40 basis points, the ZLB issue does not affect the validity of the results and a relaxation of credit standards in the BLS is more related to a quantitative easing of loan supply.

[insert Figure 9 here]

We then compare the results of this counterfactual exercise with the ones obtained using the sign restriction identification scheme. Favorable credit supply shocks in 2012Q1 and 2012Q2 are identified with sign restrictions but appear milder (see panel C of Figure 8). This also translates into comparable but less pronounced macroeconomic

effects of the counterfactual experiment (see panel A of Figure 9). The maximum impact reaches 0.5 percentage points for GDP and 1.7 percentage points for loans while the lending rate spread narrows down by 10 basis points. The effect on inflation is within the range of results found previously. This alternative identification scheme is therefore comforting the broad assessment of the macroeconomic benefits associated with the 3-year LTROs, but points to somewhat lower quantitative estimates.

Given the similar results obtained using the two identification strategies, additional counterfactual simulations will only be carried out with the recursive identification scheme from now onwards.[9]

5.3 Making use of an ad hoc BLS on the effect of the 3-year LTROs

A special ad hoc BLS, aimed at assessing the impact on euro area banks of the 3-year LTROs, was conducted in mid-February 2012 for internal ECB purposes and is unpublished. The survey aimed at assessing the banks' reasons, the level of participation, the use of the funds collected and the impact on credit standards. Given that the survey was conducted after the first 3-year LTRO allotment, the average net loosening of credit standards for 2012Q1 and 2012Q2 is then directly interpreted as credit supply shocks in the panel-VAR.

The difference between the impact of the credit supply shocks h-step ahead and the baseline is reported in panel B of Figure 9, using the two versions of the model based on 8 and 11 countries. The results are very similar across the two specifications with some exception for inflation, suggesting that the assumption of a common transmission mechanism of the structural shock is not a key issue for the analysis. The simulation leads to higher real GDP over the next three years. The peak effect is reached in mid-2013 at 0.6 percentage points declining thereafter. Inflation edges up by 0.15-0.20 percentage points in 2014. The outstanding amount of bank loans gradually increases by 2 percentage points over the next three years, while lending rates decline by 14 basis points by end-2012.

The results with the ad-hoc survey turn out to be strikingly similar compared with the results obtained using the April BLS survey, where credit supply shocks are fully endogenously determined. The expansionary effects are somewhat smaller when using the ad-hoc BLS survey and the model with 11 countries, but almost the same when the panel excludes Greece, Ireland and Portugal. These converging outcomes reinforce the plausibility of our interpretation that the unexpected favorable credit

[9] Results with sign restrictions, which are not reported thereafter, are available from the authors upon request.

supply shock related to the release of the April 2012 BLS was due to the 3-year LTROs.

5.4 Focusing the credit supply channels on liquidity risk and access to market funding

An additional simulation exercise aims at identifying the credit supply channel using some specific supply-side determinants of bank lending policy, such as banks' liquidity management, access to market funding and capital positions, information included in the Question 2A of the BLS survey (see Appendix A).

We replace in the panel-VAR the BLS answers on credit standards by the aggregation of these three specific supply factors. In doing so, the identified credit supply shocks become more strictly related to banks' funding constraints, which the ECB policy aimed at relaxing.

Based on this new BLS variable, the panel-VAR is re-estimated using samples of 8 or 11 countries, the credit supply shock is identified as before and the simulation is reproduced as an unexpected credit supply shock in the first half of 2012 (see panel C of Figure 9). Compared with the first exercise displayed in panel A, the effects of the 3-year LTROs have broadly the same dynamic features across variables, but are stronger.

Focusing on the model version with 8 countries, the peak effect on the GDP reaches 1 percentage points by mid-2013, 0.3 percentage points higher than in the first exercise. At the end of 2014 however the effect is similar. The impact on inflation is also more elevated by 0.15 percentage points on average over 2013 and 2014. Credit expansion is more pronounced by 1 percentage points while the lending rate spread declines by 15 basis points more. The differences with the results of the first exercise are even more pronounced and more persistent regarding GDP and inflation if the model is estimated on 11 countries.

All in all, focusing the credit supply indicators on the most acute sources of bank vulnerabilities during the financial crisis and accounting for the historical experience of the weakest countries increase significantly our measurement of the effectiveness of ECB's non-standard measures.

5.5 Accounting for the 3-year LTROs impact on financial market uncertainty and risk aversion

The evaluation of ECB's non-standard measures in this paper focuses exclusively on bank lending for the main reason that those measures were precisely predicated against the emergence of exceptional tensions within the euro area banking systems. At the same time, the econometric analysis along this assumption may potentially neglect powerful mechanisms through which the 3-year LTROs can affect the euro area economy. One of them is certainly related to the distribution of economic risks and financial market sentiment towards risk taking.

As a robustness analysis, we incorporate in the panel-VAR a financial variable likely to capture those factors. A popular indicator used in the macro-financial empirical literature is the VIX. Bekaert et al (2010) show that the VIX reflects economic uncertainty as well as investors' risk aversion and that the changes in risk aversion tend to be sensitive to monetary policy actions and to have relatively strong impact on the business cycle. Here, we will not investigate the respective role of risk aversion and uncertainty in the context of the 3-year LTROs which would go beyond the scope of this paper. Instead, we only investigate (as kindly provided by the authors) how both components of the VIX evolved in 2011Q4-2012Q1 and found that risk aversion, uncertainty and the overall index declined broadly to the same extent during this period. Consequently, whether the effects of 3-year LTROs work through risk aversion or uncertainty may somehow be not so relevant when relying on the overall VIX indicator.

Using the VIX-augmented panel-VAR with 8 countries, we revisited the two previous exercises. First, the simulation of the credit supply shock based on the ad hoc BLS questionnaire (see section 4.3) enables to compare the transmission of the shock in the two models and to assess whether adding the financial risk variable would strongly mute the credit supply channels. As displayed in the Panel A of Figure 10, it turns out that the propagation of the credit supply shock and therefore the quantification of the macroeconomic impact of the 3-year LTROs remains broadly similar to the previous ones. With comparable dynamic properties, the magnitude of the effects is nonetheless smaller: for example, the pick effect on GDP reaches 0.5 percentage points with the VIX-augmented model which is 0.1 percentage points lower than with the benchmark model. Therefore, controlling for the financial factor mitigates slightly the quantification but leaves the broad assessment on the non-standard measures unchanged.

The second simulation reproduces the exercise of section 4.2, which attributes the

impact of the 3-year LTROs to the unexpected credit supply shocks in 2012Q1 and 2012Q2. With the VIX-augmented model however, we include the VIX in the set of observed variables and therefore also control for the forecast errors on the VIX when extracting the structural shocks. In order to allow for a potential effect of the 3-year LTROs on the economy beyond the bank lending channel, we consider both the unexpected financial and credit supply shocks in the simulation. The financial shock is obtained recursively using Cholesky and ordering the VIX last. The outcome is presented in the panel B of Figure 10 together with the benchmark results of Panel A of Figure 9. The effects are strikingly similar for both GDP and bank loans. On inflation however, the impact with the new model is stronger with inflation reaching 0.25 percentage points at the peak, compared with 0.15 percentage points in the benchmark case. The response of lending rate spreads is more volatile but delivers broadly the same average quantitative effect.

Insert Figure 10 here]

Overall, the robustness analysis of this section shows that the quantitative assessment would not significantly change by controlling for financial variables in the panel-VAR system or broadening the transmission channel of the 3-year LTROs to risk aversion and uncertainty.

6 On the exogeneity of the credit supply shock

Is the identified credit supply shock truly exogenous? Could we explain the phenomenon here addressed using other variables?

There is no doubt that credit supply shocks correlate with financial variables as they react much faster to economic news. However, we can show that credit standards remain a key variable to identify credit supply shocks. To support this statement we carry out several exercises.

First, it could be argued that similar conclusions on the role of credit tightening could be drawn using credit spreads. Therefore, we look at the possibility to identify a credit spread shock using either lending rate spreads or corporate credit spreads or the financial bond premium *à la* Gilchrist and Zakrajsek (2011, 2012), with the rational that financial shocks drive a wedge between the required return on capital and the risk free rate.

The corporate credit spread is computed using micro data at bond issuance level of each corporate bond as provided by Merril Lynch. The country-specific corporate

spread is computed with the following weighted average:

$$S_{c,t}^{j,m} = \sum_{k} S_{k,c,t}^{j,m} w_{k,c,t}^{j,m} / K,$$

where $S_{k,c,t}^{j,m}$ is the difference between the yield-to-maturity of the individual bond $k = 1, 2, ..., K$ with remaining maturity m issued by firm j (financial and non-financial) belonging to country c and the yield-to-maturity of a risk-free bond with identical maturity, and $w_{k,c,t}^{j,m}$ is the relative weight based on the outstanding amount of bonds issued.

The construction of the financial bond premium (the reader is referred to Gilchrist and Zakrajsek (2011) for more thorough exposition and technical details) employs only data of financial firms (banks and insurances) f and is based on the regression model of the following type:

$$\ln S_{k,c,t}^{f,m} = \beta C_{k,c,t}^{f} + \gamma X_{k,c,t}^{f,m} + \delta i_t^m + \lambda VIX_t + \mu_c + \xi_t + \tau_k^{f,m} + \varepsilon_{k,c,t}^{f,m}, \qquad (2)$$

where $C_{k,c,t}^{f}$ is credit risk measured by credit ratings,[10] $X_{k,c,t}^{f,m}$ is a vector of bond-specific characteristics that controls for potential term and liquidity premiums; i_t^m is the policy rate based on swap with maturity m; VIX is the US VIX used as a proxy of a global factor, μ_c is a country dummy, ξ_t is a time dummy, $\tau_k^{f,m}$ is a bond specific fixed effect and $\varepsilon_{k,c,t}^{f,m}$ is a "pricing error".

Using the estimated parameters of the credit spread model (2), we define the financial bond premium in month t and country c by the following linear decomposition:

$$FBP_{c,t} = \left(\sum_{k} S_{k,c,t}^{f,m} - \sum_{k} \widehat{S}_{k,c,t}^{f,m} \right) / K,$$

where the first component is the average credit spread in month t and country c and the second component is its predicted counterpart. The model is estimated over the monthly period 1999-2012 and includes the eleven euro area countries used in the panel VAR.

The results are reported in Figure 11. Panel A (B) shows the impact of the credit spread shocks using a panel VAR which excludes (includes) BLS demand and supply factors. The BLS supply factor in Panel B is ordered last to give a more prominent role to the price channel. The results, which are very similar across the panels, are consistent with the view that a credit spread shock is contractionary.

[10] Gilchrist and Zakrajsek (2011, 2012) use the distance to default constructed by Moody's to measure credit risk. However, there is no common identifier that allows merging the Moody's database with the Merrill Lynch database from which I have obtained the credit spreads.

Most importantly, the results resemble the impact of the credit supply shock shown in Figure 3. Therefore, it could be argued that credit spread shocks are sufficient to address the issue and credit standards are redundant. However, the effects of the credit supply shock with the BLS supply factor ordered last in the recursive block still produces a contractionary impact on the economy (see Figure 12) and the effects resemble the results of Figure 3. This suggests that identified shocks obtained using the BLS credit standards bring value to the analysis.

[insert Figures 11-12 here]

The correlation among the identified shocks is described in Figure 13. Panel A shows the correlation among the credit spread shocks with and without the BLS demand and supply factors in the model. All the points are along the 45 degree line and this is consistent with the fact that the impulse response functions are very similar in Panels A and B of Figure 11. Panel B shows the correlation among the credit spreads shocks obtained in the panel VAR without BLS demand and supply factors and the credit supply shocks in the model where the BLS supply factor is ordered last. The correlation is nil suggesting that credit supply shocks are exogenous to price shocks and are more related to quantity constraints. Panel C shows the correlation between the credit supply shocks obtained in the panel VAR where the BLS supply factor is ordered before and after the credit spread. Finally, Panel D shows the correlation between the credit supply shocks identified in the panel VAR where the BLS supply factor is ordered before the lending rate spreads (as in Figure 3) and the model where the BLS supply factor is ordered after one of the credit spreads (as in Figure 12). The correlations reported in Panel C and D are on the 45 degree line suggesting that the order does not matter and the type of credit spread used does not make a difference.

[insert Figure 13 here]

What about the large number of financial variables that react to news? Would they provide the timely information making the BLS supply factor redundant? Certainly, financial variances are correlated to credit supply shocks. However, they cannot explain the variance characterising the credit standards. Table 3 shows the panel regression with fixed effect of the identified credit supply shock where the BLS supply factor is ordered before the lending rate spread (as in Figure 3) on key financial variables such as credit spreads, US VIX, 3-month EURIBOR-OIS spread, stock market returns, spread between long and short lending rates, yield curve and credit

spread shocks, using the contemporaneous and the lagged values as follows:

$$Credit\ supply\ shock_{i,t} = ax_{i,t} + bx_{i,t-1} + cx_{i,t-2} + d(i) + e_{i,t},$$

where $x_{i,t}$ denotes one of the financial variables for country i at time t reported in the table and $d(i)$ is the country fixed effect. The credit spread shocks (5 variables) are those shown in the Panel A of Figure 11 using a model which includes real GDP growth, GDP deflator inflation, credit spreads (lending rate to NFCs minus 3-month OIS, corporate credit spreads or the financial bond premium), 3-month OIS and loan growth to NFCs. The credit spread shocks (7 variables) are those shown in the Panel B of Figure 11 using a model which also include BLS demand and supply factor, the latter order last in the recursive block.

[insert Table 3 here]

The results suggest that the $\overline{R}^2$ are very low, below 10%, in the model which uses the recursive approach to identify the credit supply shocks. The $\overline{R}^2$ are slightly larger when the shock is identified using sign restrictions. Specifically, the R^2 is particularly large when considering the lending rate spreads, but this is because they are a key input to identify the credit supply shock. All in all, we can argue that the credit supply shock identified using the BLS supply factor is truly exogenous to the systems of equations and contains valuable information.

7 Conclusions

The aim of the paper is to assess the macroeconomic impact of the 3-year LTROs conducted by the ECB in December 2011 and February 2012. The main transmission channel of this non-standard monetary policy measure works through the mitigation of liquidity and funding risks in the euro area banking system, which ultimately contributes to relax bank lending standards and supports the financing of the economy.

We argue that we can identify this non-standard measure by focusing on the bank lending channel, thereby using information from the Bank Lending Survey (BLS) covering the largest banks of each euro area country. Within a panel-VAR framework, the effects of the 3-year LTROs on the euro area macroeconomy are therefore inferred using the privileged information on bank lending practices from the BLS and the associated identification procedure for credit supply shocks.

The evaluation of the 3-year LTROs impact on the euro area macroeconomy is first estimated through the credit supply shocks identified recursively as well as with sign

restriction methods based on the BLS answers in the April 2012 survey round. Then, the credit supply shock is inferred directly using an unpublished ad hoc questionnaire of the BLS collected between the 9th and the 14th of February 2012, which provides the commercial bank answers on the effect of the 3-year LTROs on credit standards. All simulation exercises turn out to deliver very similar quantitative effects.

The results suggest that the 3-year LTROs are expansionary over the short to the medium term and associated with increases in GDP, loan volume to non-financial corporations and a compression of lending rate spreads. The economic support of the non-standard measure is only gradually reflected in loan dynamics while the benefits on output materialize earlier. Moreover, given the relatively muted response of spreads compared to loans, the LTROs seems to act more on the economy through quantitative credit easing than lower cost of financing.

The success of the 3-year LTROs in reducing funding risk in the banking sector can also be demonstrated by the developments of the interbank credit risk measured by the 3-month EURIBOS-OIS spread in the first half of 2012. Despite the renewed tensions in the euro area sovereign debt market in the second quarter of 2012 owing to several factors such as the solvency of some banks in Spain, negative macroeconomic releases unexpected by markets, market perception of higher political risk (political election in Greece, referendum in Ireland on the fiscal compact, debate about the role of ESFS/ESM as firewall,[11] discussions on banking union and mutualisation of financial risk in the euro area), this measure of interbank credit risk declined from 100 basis points on 8 December 2011 to 40 basis points at the end of March 2012 and fluctuated around it since then until the speech on the convertibility risk by the ECB President Draghi on 26 July 20012 (see Figure 14). After the speech, the interbank credit risk continued its declining trend reaching 12 basis points on 26 November 2012; such low level was obtained on 8 August 2007, the day before the ECB had to cope with the first signal of dislocation of the money market.

This money market resilience is consistent with the fact that bank funding risks were effectively reduced by the ECB measures announced on 8 December 2011, because the 3-year LTROs provided a window of opportunity for banks to deleverage in

[11] The European Financial Stability Facility (EFSF) is a special purpose vehicle financed by members of the euro area to address the European sovereign-debt crisis. The European Stability Mechanism (ESM) launched on 8 October 2012 is designed to provide financing to distressed euro area members so long as they are committed to strict fiscal and structural reforms that aim to put economies that have lost investor trust back on track.

a more orderly fashion and to increase their liquidity and capital buffers.

[insert Figure 14 here]

Overall, our paper brings an empirical contribution to the literature on the effectiveness of unconventional monetary policy at times of financial distress. The quantitative findings show that in the presence of acute tensions, exceptional central bank liquidity measures could help supporting the provision of bank lending to the economy and avoid an abrupt dry-up of credit supply. This assessment is consistent with the view that non-standard monetary policy measures like the one analyzed in this paper are complementary to interest rate decisions and are essentially predicated on the basis of emerging financial frictions in the credit intermediation sector.

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Appendix A

Bank lending survey (BLS) for the euro area: The questionnaire for loans or credit lines to enterprises

Please rate the contribution of the factors to the tightening or easing of credit standards using the following scale:

– – = contributed considerably to tightening of credit standards
– = contributed somewhat to tightening of credit standards
○ = contributed to basically unchanged credit standards
+ = contributed somewhat to easing of credit standards
+ + = contributed considerably to easing of credit standards
NA = not applicable

1. 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?

2. 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 (as described in question 1)?

A) Cost of funds and balance sheet constraints
a1 - Costs related to your bank's capital position
a2 - Your bank's ability to access market financing (e.g. money or bond market financing, incl. true-sale securitisation)
a3 - Your bank's liquidity position

B) Pressure from competition
b1 - Competition from other banks
b2 - Competition from non-banks
b3 - Competition from market financing

C) Perception of risk
c1 - Expectations regarding general economic activity
c2 - Industry or firm-specific outlook
c3 - Risk on the collateral demanded

D) Other factors, please specify

3. Over the past three months, how have your bank's conditions and terms for approving loans or credit lines to enterprises changed?

A) Price
a1 - Your bank's margin on average loans
a2 - Your bank's margin on riskier loans

B) Other conditions and terms

b1 - Non-interest rate charges
b2 - Size of the loan or credit line
b3 - Collateral requirements
b4 - Loan covenants
b5 - Maturity

C) Other factors, please specify

4. Over the past three months, how has the demand for loans or credit lines to enterprises changed at your bank, apart from normal seasonal fluctuations?

5. Over the past three months, how have the following factors affected the demand for loans or credit lines to enterprises?

A) Financing needs
a1 - Fixed investment
a2 - Inventories and working capital
a3 - Mergers/acquisitions and corporate restructuring
a4 - Debt restructuring

B) Use of alternative finance
b1 - Internal financing
b2 - Loans from other banks
b3 - Loans from non-banks
b4 - Issuance of debt securities
b5 - Issuance of equity

C) Other factors, please specify

6. Please indicate how you expect your bank's credit standards as applied to the approval of loans or credit lines to enterprises to change over the next three months.

7. Please indicate how you expect demand for loans or credit lines to enterprises to change at your bank over the next three months (apart from normal seasonal fluctuations)

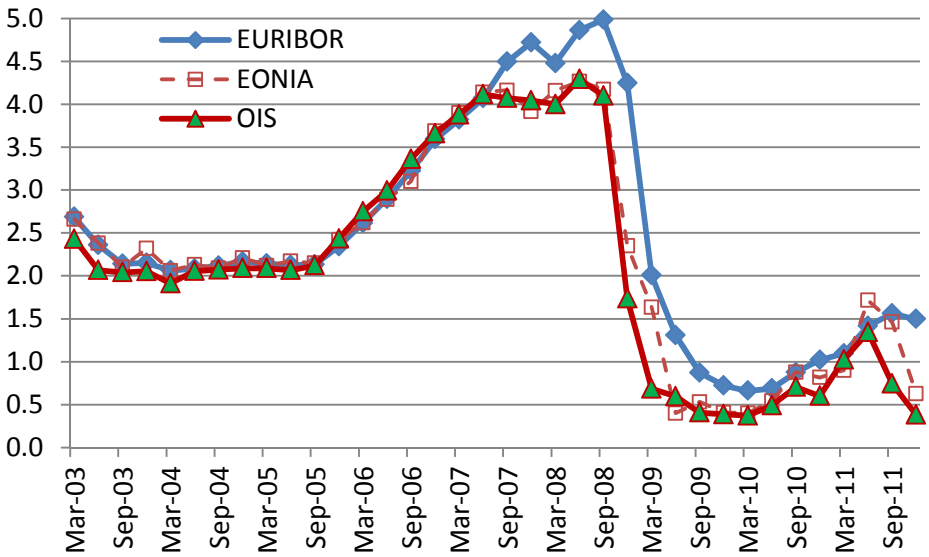
Fig. 1. Changes in credit standards applied to the approval of loans to enterprises and changes in demand for loans to enterprises in the euro area and selected euro area countries *(net percentages of banks reporting a tightening standards – BLS supply factor – and an increase in loan demand – BLS demand factor. Sample period: 2003Q1-2012Q2)*

Source: ECB.

Notes: The net percentage for the questions on supply of loans refers to the difference between the sum of the percentages for "tightened considerably" and "tightened somewhat" and the sum of the percentages for "eased somewhat" and "eased considerably". The net percentages for the questions on demand for loans are defined as the difference between the sum of the percentages for "increased considerably" and "increased somewhat" and the sum of the percentages for "decreased somewhat" and "decreased considerably"

Fig. 2. The ECB monetary policy stance

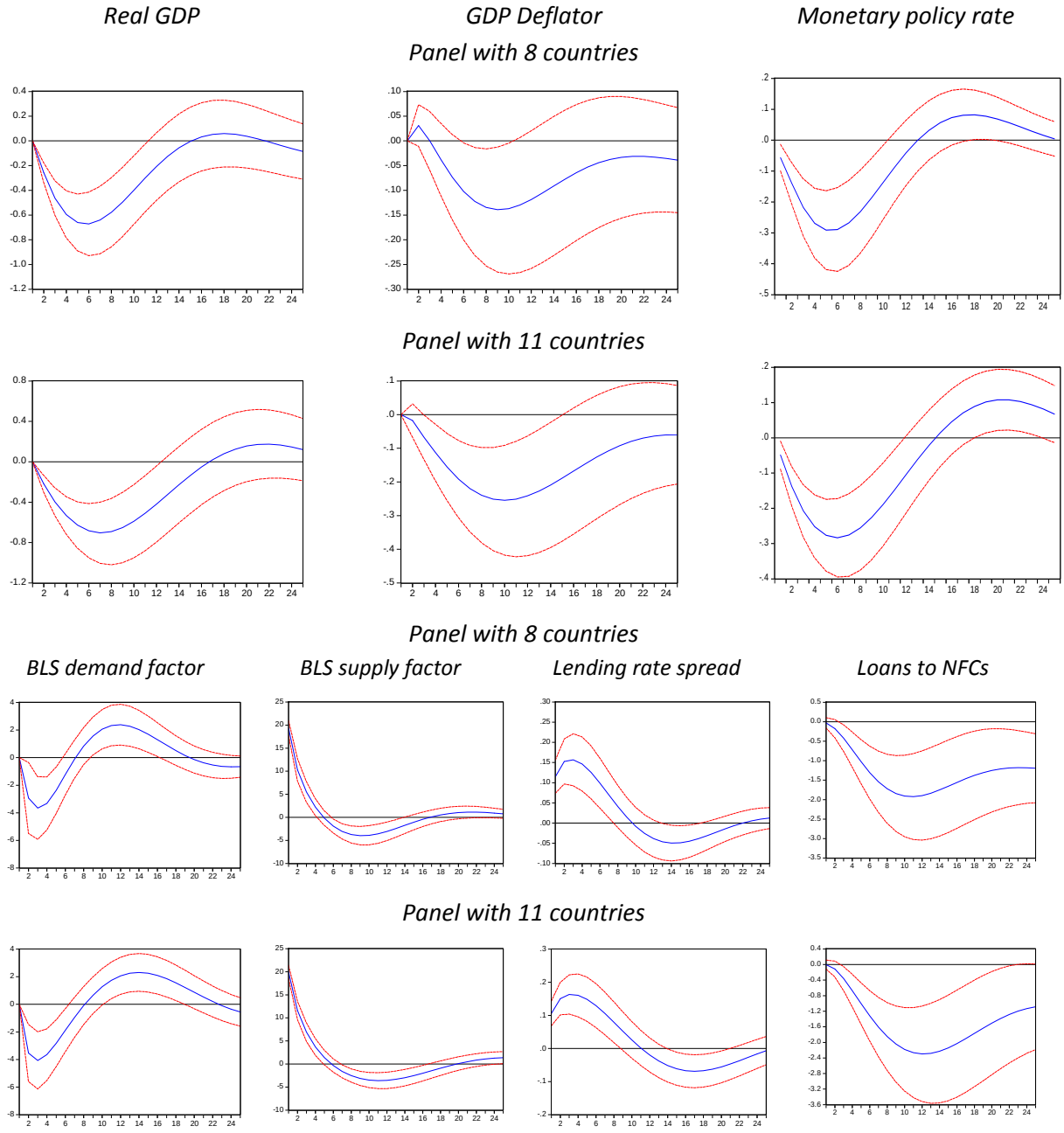
(Sample period: 2003Q1-2011Q4. %, basis points.)



Source: Thomson Reuters.

Fig. 3. Impact of credit supply shocks using the recursive method

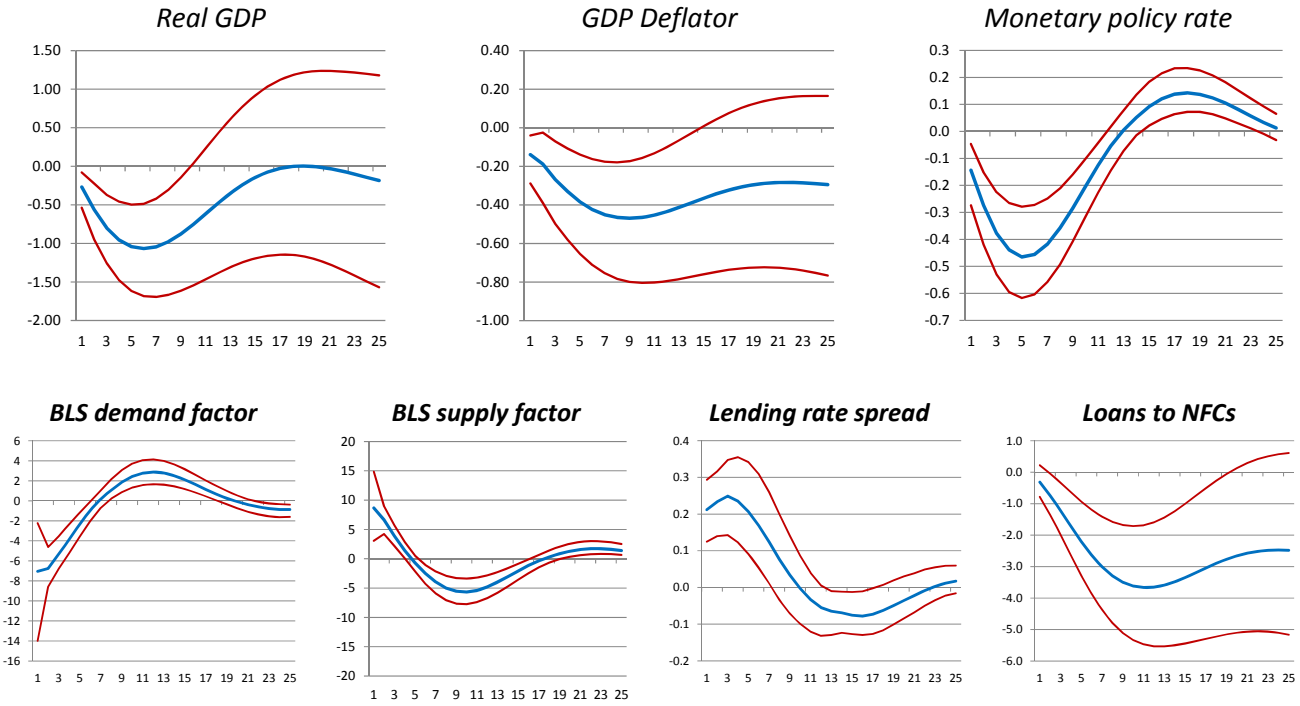
(Response to Cholesky one s.d. innovations ± 2 S.E.)



Notes: The model includes Real GDP growth, GDP deflator inflation, BLS demand factor, BLS supply factor, Lending rate to NFCs minus 3-month OIS, 3-month OIS, Loans to NFCs. The model is estimated over the 2003Q1-2011Q4 period. The credit supply shock is obtained using a standard Choleski-decomposition with the variables ordered as reported in this footnote. The underlying assumptions are that the BLS supply factor identifies credit supply and the shock has no contemporaneous impact on output, prices and BLS demand factors. The panel with 8 countries include: Austria, Belgium, Finland, France, Germany, Italy, Netherlands and Spain. The panel with 11 countries adds the adjustment programme countries: Greece, Ireland and Portugal.

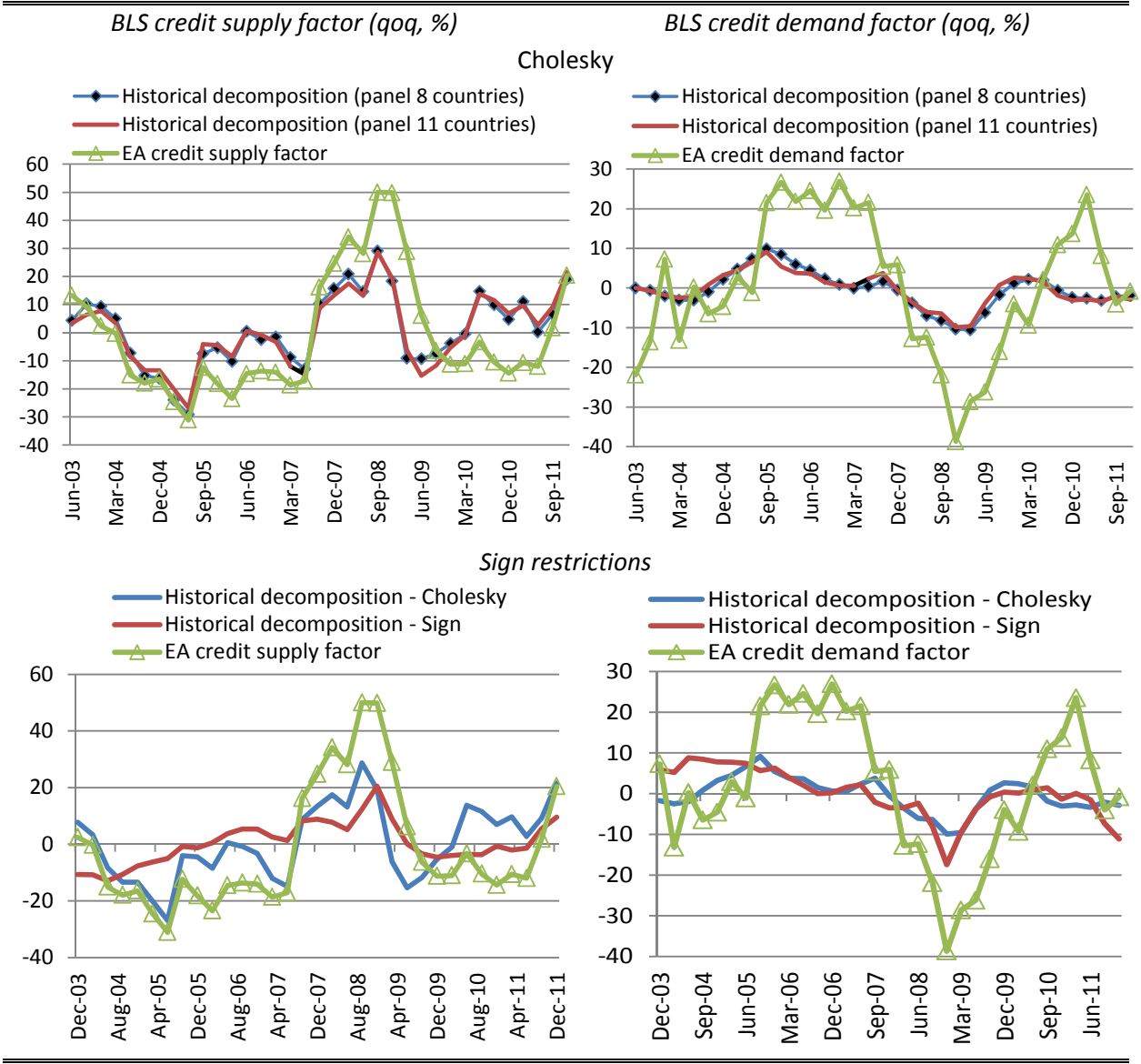
Fig. 4. Impact of credit supply shocks using sign restrictions

(response to one s.d. innovations, median of the responses along with the 16% and 84% percentiles)



Notes: The VAR specification includes Real GDP growth, GDP deflator inflation, BLS demand factor, BLS supply factor, Lending rate to NFCs, 3-month OIS, and Loan growth to NFCs. The model is estimated over the 2003Q1-2011Q4 period. The credit supply shock is obtained using sign restrictions. The panel with 11 countries include: Austria, Belgium, Finland, France, Germany, Italy, Netherlands, Spain, Greece, Ireland and Portugal.

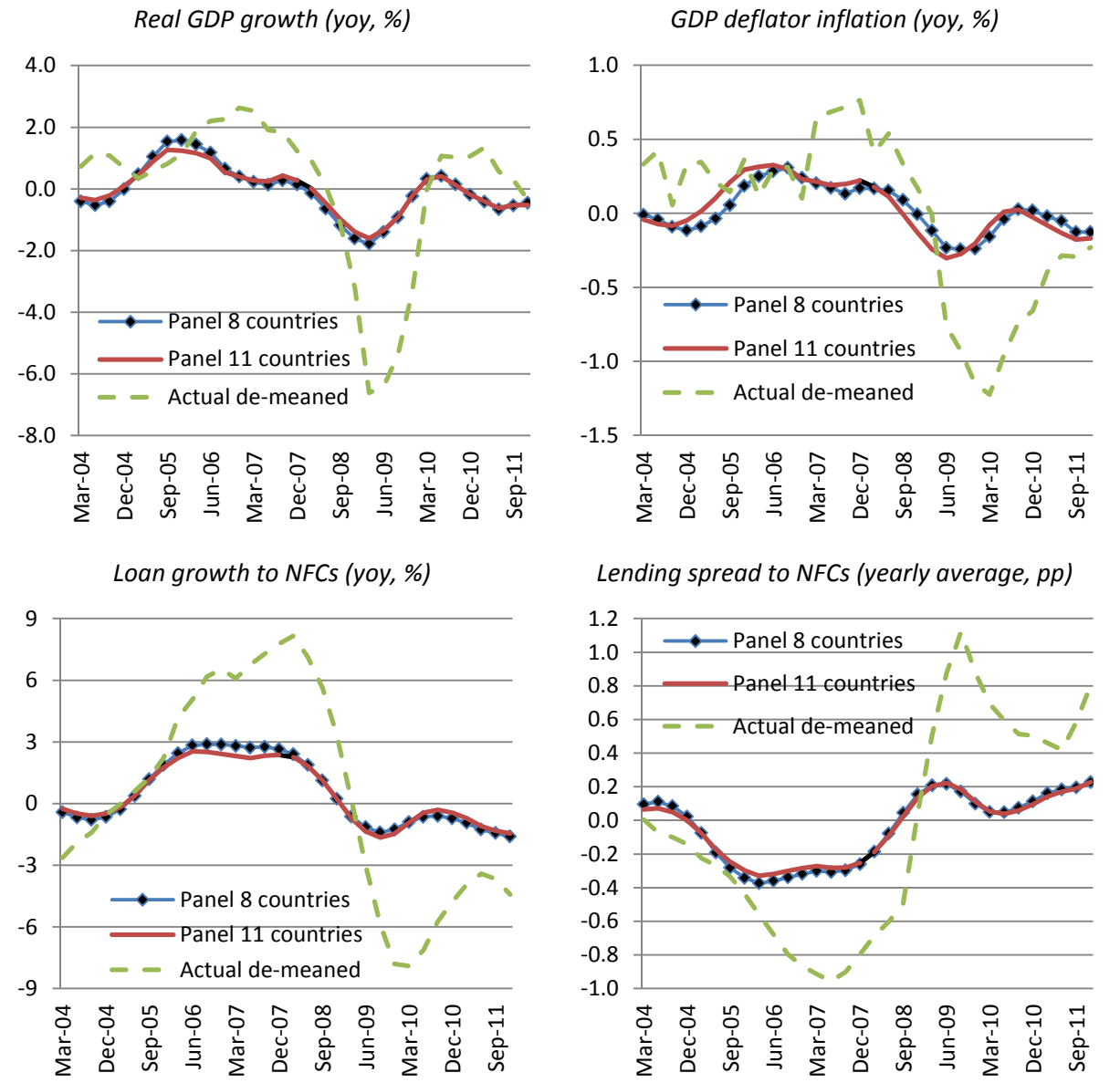
Fig. 5. Historical decomposition of the credit supply shock on BLS credit supply and demand factors in the euro area *(net percentages of banks reporting a tightening standards – BLS supply factor – and an increase in loan demand – BLS demand factor. Sample period: 2003Q1-2011Q4)*



Notes: see Figures 4 and 5.

Fig. 6. Historical decomposition of the credit supply shock on the euro area macroeconomy

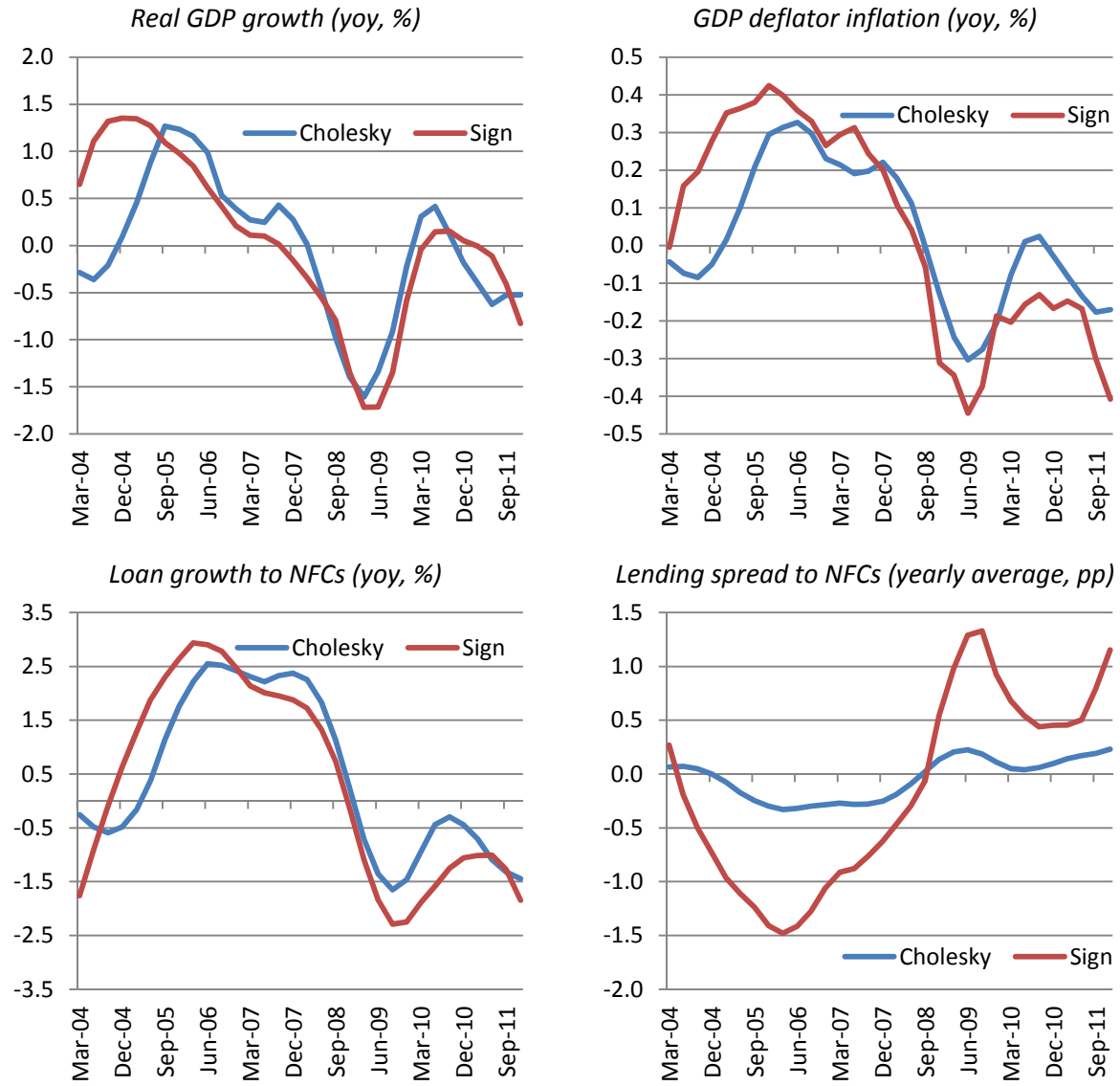
(Sample period: 2004Q1-2011Q4. Percent (%) or percentage points (pp); year-on-year (yoy) or yearly average).



Notes: see Figure 4.

Fig. 7. Historical decomposition of the credit supply shock on the euro area macroeconomy using sign restrictions

(Sample period: 2004Q1-2011Q4. Percent (%) or percentage points (pp); year-on-year (yoy) or yearly average).

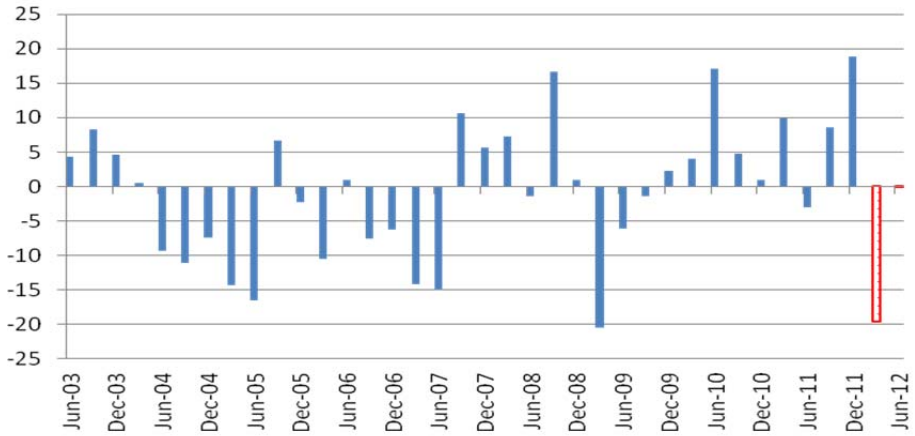


Notes: see Figure 5.

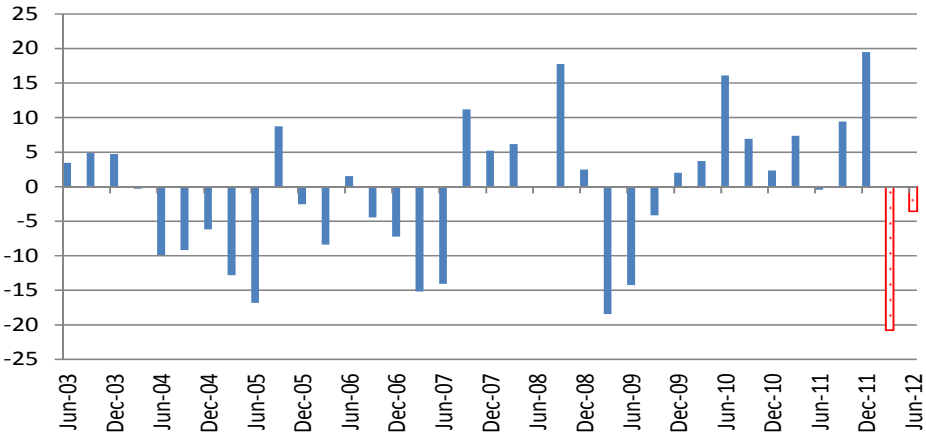
Fig. 8. Credit supply shock and the April 2012 Bank Lending Survey

(Sample period: 2003Q1-2012Q2).

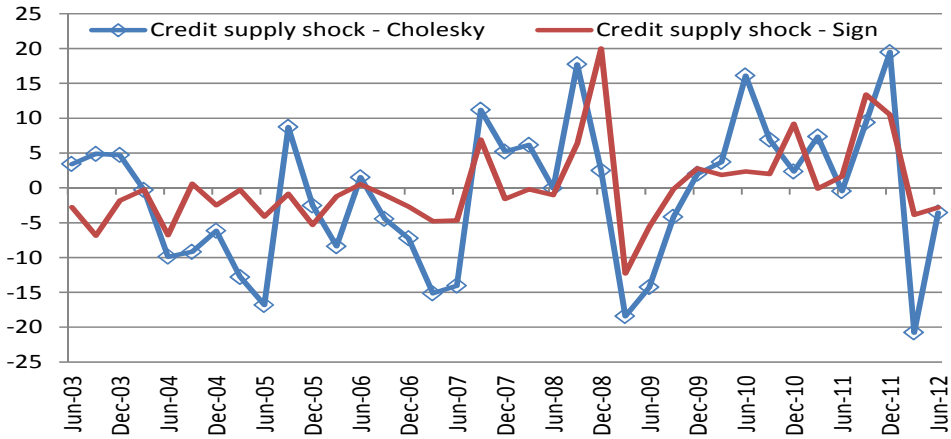
Panel A: Recursive with 8 countries



Panel B: Recursive with 11 countries



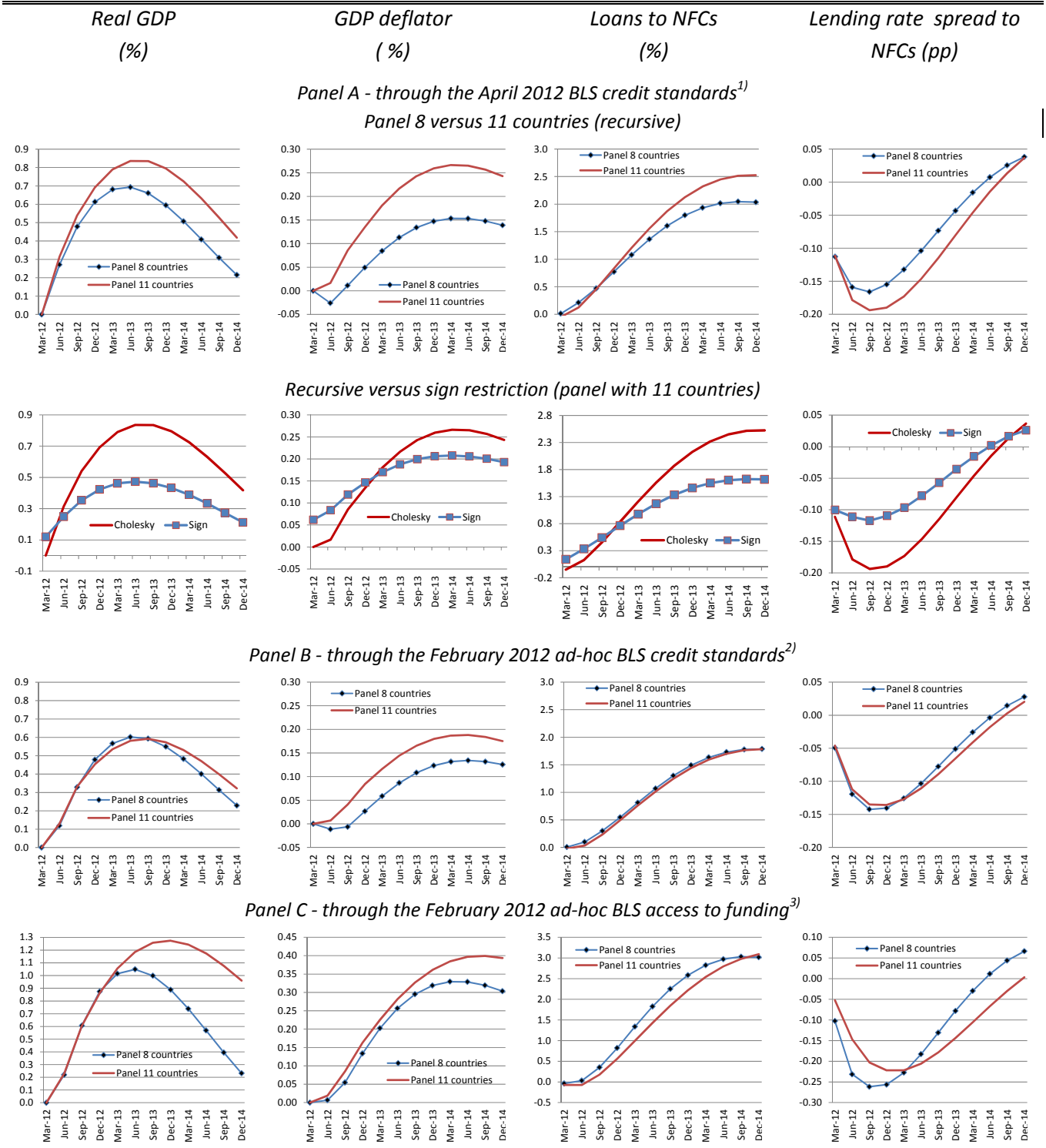
Panel C: Sign restrictions with 11 countries



Notes: See Figures 4 and 5. To identify the credit supply shock in 2012Q1 and 2012Q2 we estimate the system applying a Kalman-filter conditional to BLS credit demand and supply factors as reported by the survey respondents in 2012Q1 and as expected by the survey respondents in 2012Q2. A positive bar denotes an unexpected tightening in credit standards.

Fig. 9. Impact of the 3-year LTROs on the macroeconomy

(Sample period: 2012Q1-2014Q4. Percent (%) or percentage points (pp)).



Notes: The VAR specification includes Real GDP growth, GDP deflator inflation, BLS demand factor, BLS supply factor, Lending rate to NFCs minus 3-month OIS, 3-month OIS, and Loan growth to NFCs. The model is estimated over the 2003Q1-2011Q4 period.

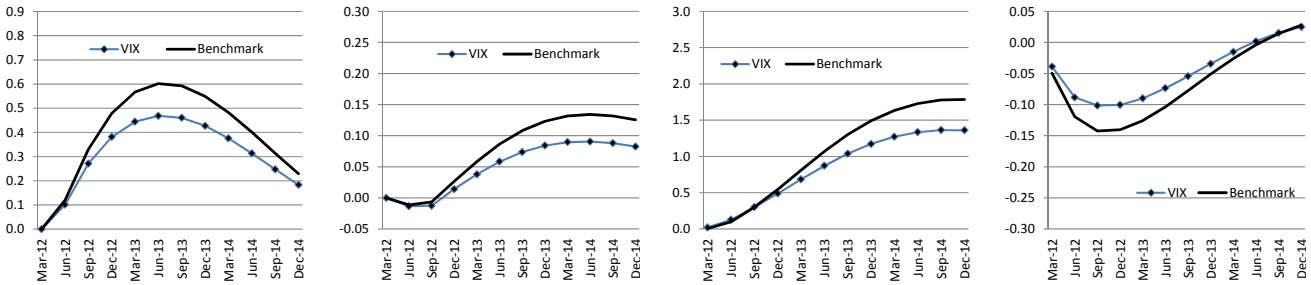
Panel A: The credit supply shocks in 2012Q1-2012Q2 are extracted using the one-sided Kalman filter observing the BLS variables only. The impact of the 3-year LTRO results from the simulation of the extracted credit supply shocks. Panel B: The credit supply shock in 2012Q1-2012Q2 is calibrated from the ad-hoc February 2012 BLS. Panel C: The BLS answers on credit standards are replaced in the panel-VAR by the contribution to changes in credit standards attributed to access to funding (both the ability to access market financing, liquidity and capital positions). The entire model is re-estimated, and we assume that the BLS access to funding identifies credit supply following the same identification scheme used to generate Figure 8.

Fig. 10. The results of the model controlling for the VIX

Real GDP (%)	*GDP deflator (%)*	*Loans to NFCs (%)*	*Lending rate spread to NFCs (pp)*

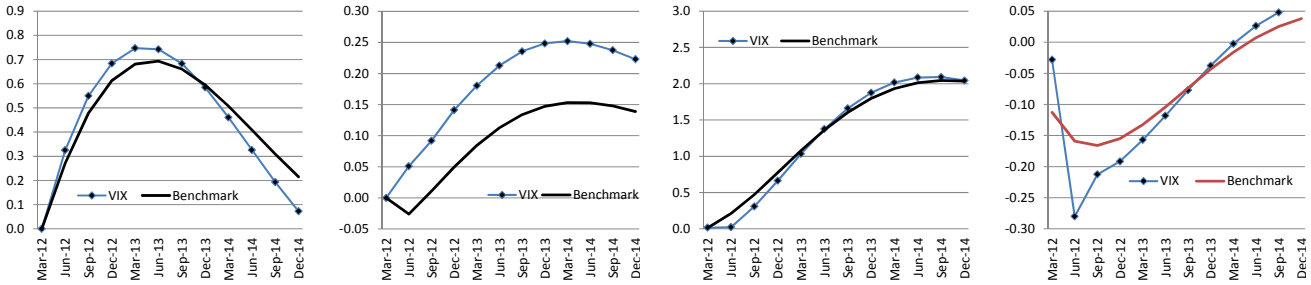
Panel A - Impact of the 3-year LTROs through the February 2012 ad-hoc BLS credit standards

(Sample period: 2012Q1-2014Q4)[1)]



Panel B – Impact of the 3-year LTROs through the April 2012 BLS credit standards

(Sample period: 2012Q1-2014Q4)[2)]



Notes: The benchmark VAR specification includes Real GDP growth, GDP deflator inflation, BLS demand factor, BLS supply factor, Lending rate to NFCs minus 3-month OIS, 3-month OIS, and Loan growth to NFCs. In order to control for the VIX, we include it in the benchmark VAR and order it last. The model is estimated over the 2003Q1-2011Q4 period based on 8 countries.

Panel A : The credit supply shock in 2012Q1-2012Q2 is calibrated from the ad-hoc February 2012 BLS. The impact of the 3-year LTRO results from the simulation of the extracted credit supply shocks.

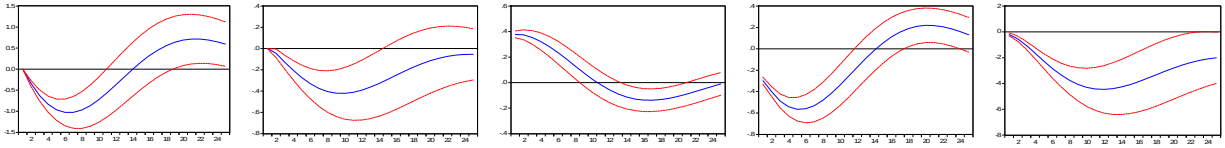
Panel B: The credit supply in 2012Q1-2012Q2 and the financial shock in 2012Q1 are extracted using the one-sided Kalman filter observing the BLS variables and the VIX only. The credit supply and financial shocks are identified through a standard Choleski-decomposition. The impact of the 3-year LTRO results from the simulation of the extracted credit supply and financial shocks.

Fig. 11. Impact of credit spread shocks using the recursive method

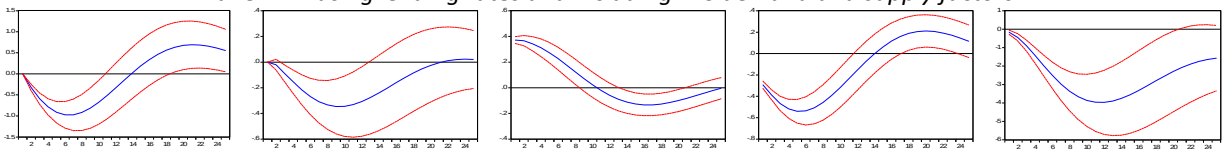
(Response to Cholesky one s.d. innovations ± 2 S.E.)

Real GDP *GDP Deflator* *Credit spreads* *Monetary pol. rate* *Loans to NFCs*

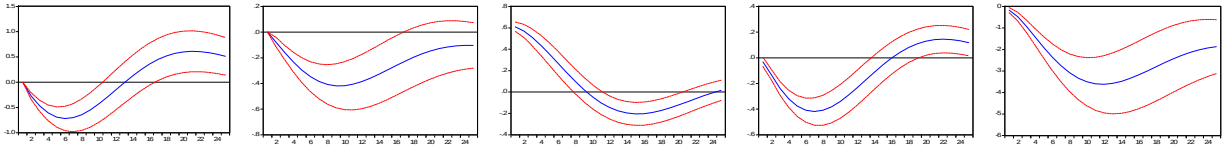
Panel A.1: using lending rate spreads and excluding BLS demand and supply factors



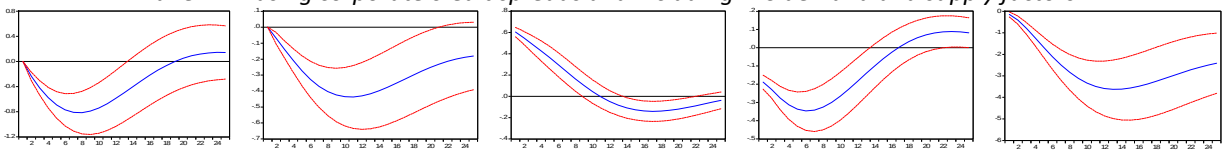
Panel B.1: using lending rates and including BLS demand and supply factors



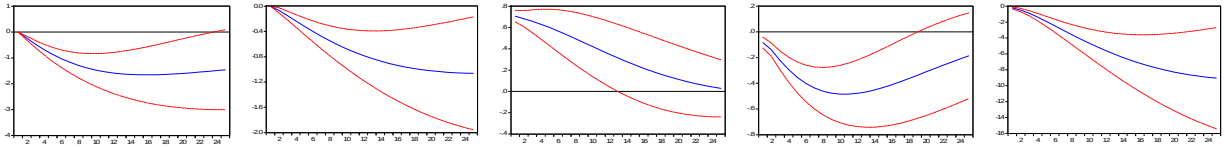
Panel A.2: using corporate credit spreads and excluding BLS demand and supply factors



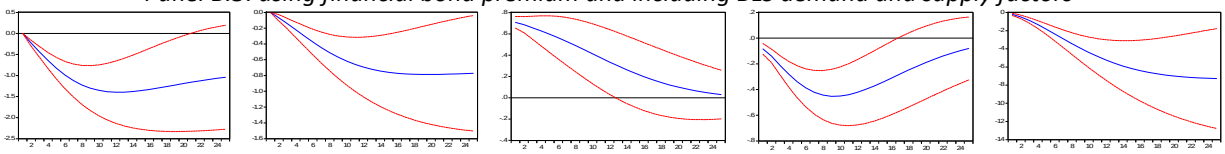
Panel B.2: using corporate credit spreads and including BLS demand and supply factors



Panel A.3: using financial bond premium and excluding BLS demand and supply factors



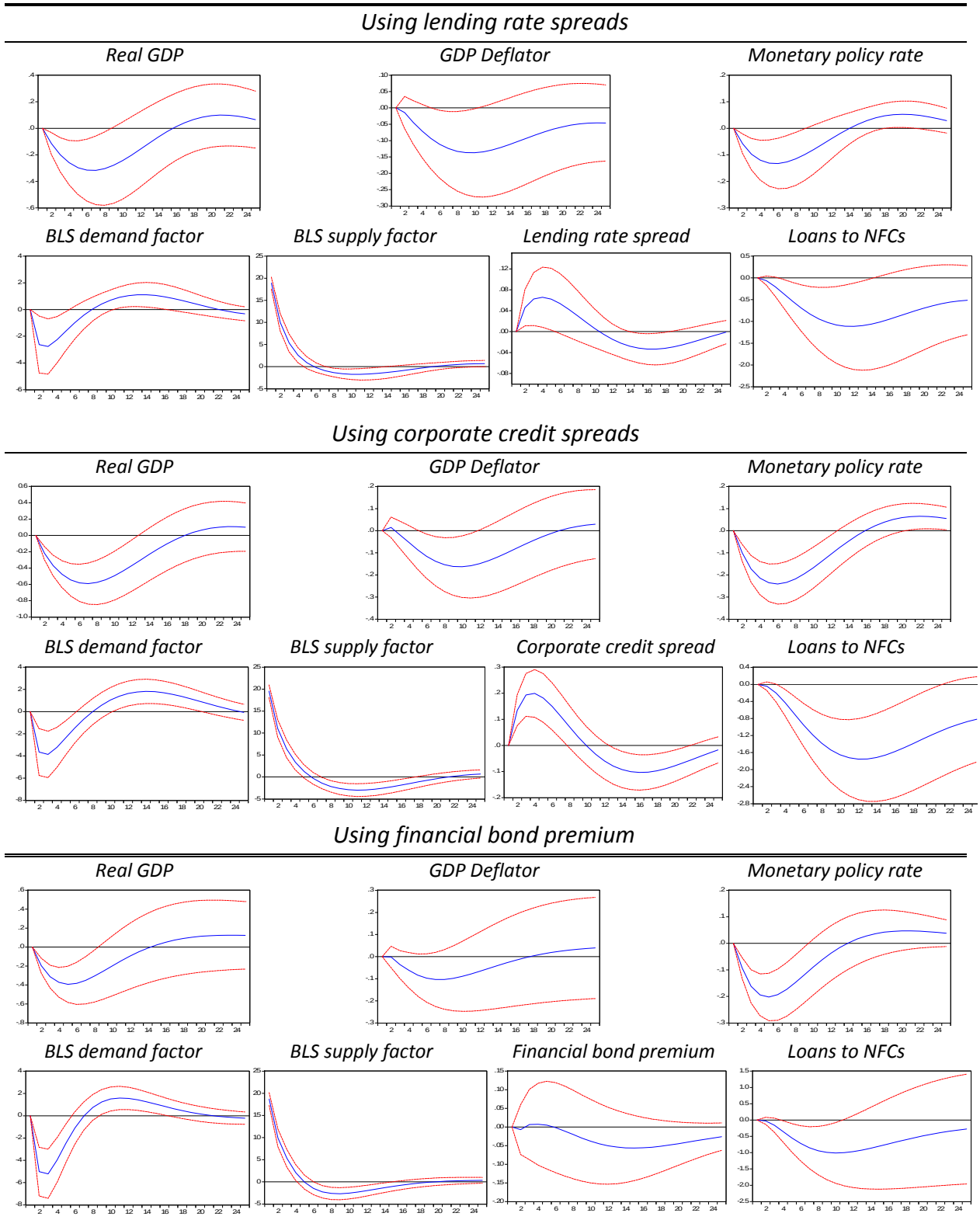
Panel B.3: using financial bond premium and including BLS demand and supply factors



Notes: Panel A – The model includes Real GDP growth, GDP deflator inflation, credit spreads (lending rate to NFCs minus 3-month OIS or corporate credit spreads or financial bond premium), 3-month OIS, Loans to NFCs. Panel B -The model includes Real GDP growth, GDP deflator inflation, BLS demand factor, credit spreads (lending rate to NFCs minus 3-month OIS or corporate credit spreads or financial bond premium), 3-month OIS, Loans to NFCs, BLS supply factor. The model is estimated over the 2003Q1-2011Q4 period. The credit supply shock is obtained using a standard Choleski-decomposition with the variables ordered as reported in this footnote. The underlying assumptions are that the lending rate spreads or the corporate credit spreads or the financial bond premium identify the credit spread shocks and the shock has no contemporaneous impact on output and inflation. The panel with 11 countries include: Austria, Belgium, Finland, France, Germany, Italy, Netherlands, Spain, Greece, Ireland and Portugal.

Fig. 12. Impact of credit supply shocks using the recursive method: Conservative approach

(Response to Cholesky one s.d. innovations ± 2 S.E.)

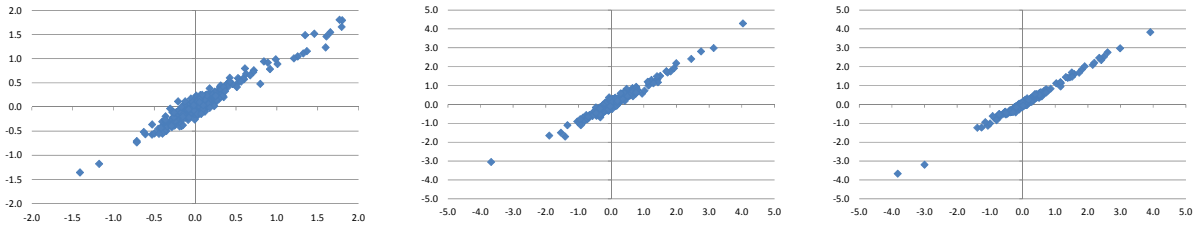


Notes: The model includes Real GDP growth, GDP deflator inflation, BLS demand factor, credit spreads (lending rate to NFCs minus 3-month OIS or corporate credit spreads or financial bond premium), 3-month OIS, Loans to NFCs, BLS supply factor. The model is estimated over the 2003Q1-2011Q4 period. The credit supply shock is obtained using a standard Choleski-decomposition with the variables ordered as reported in this footnote. The underlying assumptions are that the BLS supply factor identifies credit supply and the shock has no contemporaneous impact on all variables. The panel with 11 countries include: Austria, Belgium, Finland, France, Germany, Italy, Netherlands, Spain, Greece, Ireland and Portugal.

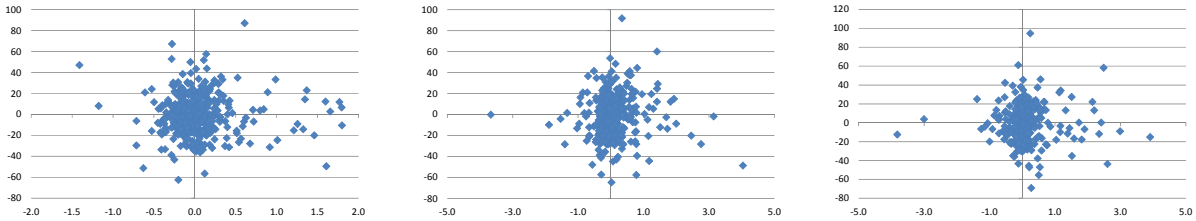
Fig. 13. Credit spread shocks versus credit supply shocks using the recursive approach
(Sample period: 2003Q1-2011Q4).

Using lending rate minus 3m OIS *Using corporate credit spreads* *Using fincancial innovations*

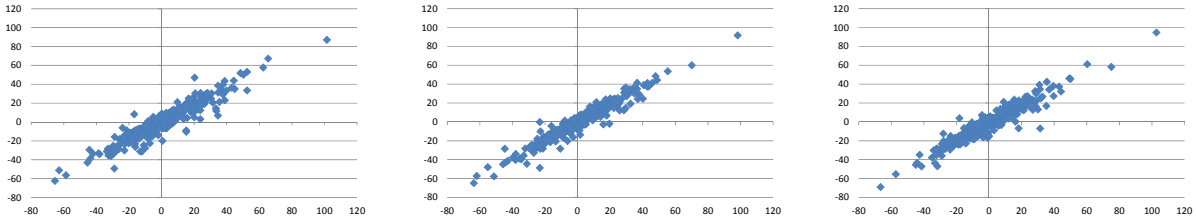
Panel A: Credit spread shocks ordered third in the panel VAR excluding BLS demand and supply factors (x-axis) versus credit spread shocks ordered forth in the panel VAR including BLS demand and supply factors (y-axis)



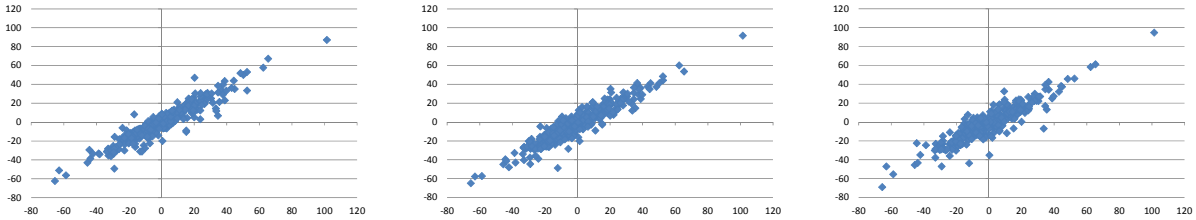
Panel B: Credit spread shocks ordered third in the panel VAR excluding BLS demand and supply factors (x-axis) versus credit supply shocks ordered seventh in the panel VAR including BLS demand and supply factors (y-axis)



Panel C: Credit supply shocks ordered fourth in the panel VAR including BLS demand and supply factors (x-axis) versus credit supply shocks ordered seventh in the panel VAR including BLS demand and supply factors (y-axis)



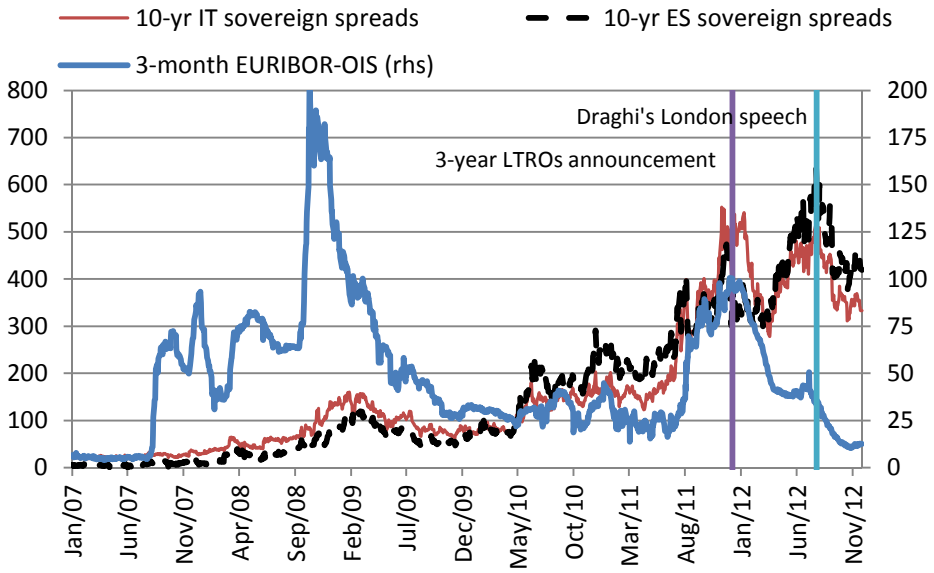
Panel D: Credit supply shocks ordered fourth in the panel VAR with lending rates (x-axis) versus credit supply shocks ordered seventh in the panel VAR with alternative corporate credit spreads' measures (y-axis)



Notes: The shocks are obtained using a standard Choleski-decomposition with the variables ordered as reported in this footnote. The model is estimated over the 2003Q1-2011Q4 period. The panel with 11 countries include: Austria, Belgium, Finland, France, Germany, Italy, Netherlands, Spain, Greece, Ireland and Portugal.
Panels A (x-axis) and B (x-axis): Real GDP growth, GDP deflator inflation, credit spreads (lending rate to NFCs minus 3-month OIS or corporate credit spreads or financial bond premium), 3-month OIS, Loans to NFCs.
Panels A (y-axis), B (y-axis), C (y-axis) and D (y-axis): Real GDP growth, GDP deflator inflation, BLS demand factor, credit spreads (lending rate to NFCs minus 3-month OIS or corporate credit spreads or financial bond premium), 3-month OIS, Loans to NFCs, BLS supply factor.
Panels C (x-axis): Real GDP growth, GDP deflator inflation, BLS demand factor, BLS supply factor, credit spreads (lending rate to NFCs minus 3-month OIS or corporate credit spreads or financial bond premium), 3-month OIS, Loans to NFCs.
Panel D (x-axis): Real GDP growth, GDP deflator inflation, BLS demand factor, BLS supply factor, Lending rate to NFCs minus 3-month OIS, 3-month OIS, Loans to NFCs.

Fig. 14. Interbank credit risk after the 3-year LTROs

(Sample period: 1 Jan. 2007 - 26 Nov. 2012. Basis points.)



Source: Thomson Reuters.

Notes: 10-yr IT (ES) sovereign spreads is the spread between the 10-year Italian (Spanish) sovereign yield and the 10-year Bund.

Table 1. Covariance analysis: Correlations among regressors

(%, t-Statistic. Sample period: 2003Q1-2011Q4)

	Real GDP growth	Deflator inflation	BLS demand factor	BLS supply factor	OIS	Lending rate to NFCs-OIS	Loan growth to NFCs	Lending rate to NFCs
Real GDP growth	1.000							
(t-Statistic)	-----							
Deflator inflation	-0.037	1.000						
(t-Statistic)	-0.630	-----						
BLS demand factor	0.297	0.193	1.000					
(t-Statistic)	5.258	3.318	-----					
BLS supply factor	-0.486	-0.051	-0.382	1.000				
(t-Statistic)	-9.408	-0.872	-6.997	-----				
OIS	0.175	0.266	0.185	0.185	1.000			
(t-Statistic)	3.005	4.668	3.183	3.175	-----			
Lending rate to NFCs-OIS	-0.518	-0.273	-0.410	0.292	-0.764	1.000		
(t-Statistic)	-10.229	-4.798	-7.607	5.172	-20.021	-----		
Loan growth to NFCs	0.215	0.349	0.361	0.023	0.632	-0.572	1.000	
(t-Statistic)	3.718	6.304	6.547	0.396	13.795	-11.805	-----	
Lending rate to NFCs	-0.137	0.180	-0.041	0.488	0.874	-0.353	0.485	1.000
(t-Statistic)	-2.331	3.094	-0.696	9.454	30.370	-6.391	9.373	-----

Table 2. Panel unit root test

(Sample period: 2003Q1-2011Q4).

	Real GDP growth		GDP Deflator Inflation		BLS demand factor		BLS supply factor		Loans to NFC growth		3-month OIS		Lending rate to NFCs minus 3-month OIS	
	Statistic	Prob.**	Statistic	Prob.**	Statistic	Prob.**	Statistic	Prob.**	Statistic	Prob.**	Statistic	Prob.**	Statistic	Prob.**
Null Hypothesis: Unit root					Tests with Individual Unit Root Processes for 8 countries									
Im, Pesaran and Shin W-stat[1]	-4.13	0.00	-8.83	0.00	-5.40	0.00	-3.99	0.00	-2.02	0.02	0.21	0.58	0.68	0.75
ADF - Fisher Chi-square[2]	49.18	0.00	114.05	0.00	61.11	0.00	43.42	0.00	26.34	0.05	9.72	0.88	9.38	0.90
PP - Fisher Chi-square[3]	48.83	0.00	130.14	0.00	71.76	0.00	41.75	0.00	41.48	0.00	5.58	0.99	9.94	0.87
Null Hypothesis: Unit root					Tests with Common Unit Root Process for 8 countries									
Levin, Lin & Chu t*[4]	-2.62	0.00	-6.39	0.00	-3.42	0.00	-1.79	0.04	-0.94	0.17	0.07	0.53	1.24	0.89
Breitung t-stat[5]	-5.42	0.00	-6.53	0.00	-3.91	0.00	0.41	0.66	-1.85	0.03	-3.18	0.00	-0.37	0.36
Null Hypothesis: Stationarity														
Hadri Z-stat[6]	0.45	0.33	1.24	0.11	0.92	0.18	-0.75	0.78	0.80	0.21	1.68	0.05	3.84	0.00
Null Hypothesis: Unit root					Tests with Individual Unit Root Processes for 11 countries									
Im, Pesaran and Shin W-stat[1]	-3.78	0.00	-10.42	0.00	-5.95	0.00	-4.29	0.00	-1.50	0.07	0.24	0.60	1.93	0.97
ADF - Fisher Chi-square[2]	63.08	0.00	161.51	0.00	78.83	0.00	55.94	0.00	30.64	0.10	13.36	0.92	10.25	0.98
PP - Fisher Chi-square[3]	92.92	0.00	214.61	0.00	90.24	0.00	52.63	0.00	46.08	0.00	7.68	1.00	10.75	0.98
Null Hypothesis: Unit root					Tests with Common Unit Root Process for 11 countries									
Levin, Lin & Chu t*[4]	-2.37	0.01	-7.49	0.00	-4.13	0.00	-2.15	0.02	-0.53	0.30	0.09	0.53	2.84	1.00
Breitung t-stat[5]	-4.62	0.00	-4.61	0.00	-3.21	0.00	-0.65	0.26	-1.23	0.11	-3.73	0.00	0.67	0.75
Null Hypothesis: Stationarity														
Hadri Z-stat[6]	2.41	0.01	3.15	0.00	2.33	0.01	0.09	0.47	2.18	0.01	1.97	0.02	5.27	0.00

*** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.*

(1) Im, et al (2003). (2) Maddala and Wu (1999). (3) Choi. (2001). (4) Levin, et al. (2002). (5) Breitung (2000). (6) Hadri (2000).

Table 3. On the exogeneity of the credit supply shock identified using the recursive and the sign restriction methods *(Sample period: 2003Q1-2011Q4).*

	Recursive						
	Coef (t)	s.e. (t)	Coef (t-1)	s.e. (t-1)	Coef (t-2)	s.e. (t-2)	R^2
Lending rate spreads (i,t)	13.292***	(2.543)	-14.754***	(3.696)	2.472	(2.759)	0.074
Corporate spreads (i,t)	5.47***	(1.577)	-5.975**	(2.404)	2.254	(1.674)	0.040
Financial innovation (i,t)	5.402***	(1.473)	-1.509	(2.069)	-2.084	(1.734)	0.080
VIX (t)	0.594***	(0.178)	0.266	(0.202)	-0.504***	(0.192)	0.060
3-month EURIBOR-OIS (t)	13.38***	(2.71)	-8.346**	(3.465)	-0.786	(2.804)	0.068
Stock market returns (i,t)	-0.566***	(0.11)	0.201	(0.127)	-0.033	(0.114)	0.076
Long-short lending rates (i,t)	-2.907	(3.007)	-0.292	(3.546)	2.923	(3.095)	0.007
Yield curve (i,t)	4.072***	(1.57)	-8.525**	(3.333)	3.958	(2.462)	0.023
Lending rate spread shocks (5 variables) (i,t)	15.58***	(2.792)	0.983	(2.766)	1.495	(3.059)	0.088
Lending rate spread shocks (7 variables) (i,t)	16.478***	(2.818)	1.451	(2.811)	2.366	(3.068)	0.094
Corporate credit shocks (5 variables) (i,t)	6.853***	(1.784)	0.804	(1.895)	1.369	(1.961)	0.048
Corporate credit shocks (7 variables) (i,t)	6.599***	(1.83)	-0.049	(1.94)	1.41	(1.989)	0.042
Financial shocks (5 variables) (i,t)	5.742***	(1.523)	3.677**	(1.613)	-0.588	(1.74)	0.087
Financial shocks (7 variables) (i,t)	5.922***	(1.533)	3.662**	(1.616)	-0.899	(1.751)	0.091
	Sign restrictions						
	Coef (t)	s.e. (t)	Coef (t-1)	s.e. (t-1)	Coef (t-2)	s.e. (t-2)	R^2
Lending rate spreads (i,t)	1.222***	(0.06)	-1.407***	(0.087)	0.37***	(0.065)	0.548
Corporate spreads (i,t)	0.444***	(0.046)	-0.58***	(0.07)	0.277***	(0.048)	0.238
Financial bond premium (i,t)	0.326***	(0.048)	-0.237***	(0.067)	0.008	(0.056)	0.160
VIX (t)	0.029***	(0.006)	0.012*	(0.007)	-0.027***	(0.006)	0.122
3-month EURIBOR-OIS (t)	1.136***	(0.072)	-0.993***	(0.092)	0.115	(0.074)	0.420
Stock market returns (i,t)	-0.034***	(0.003)	0.009**	(0.004)	0.001	(0.003)	0.261
Long-short lending rates (i,t)	-0.142	(0.1)	0.084	(0.118)	0.176*	(0.103)	0.025
Yield curve (i,t)	0.405***	(0.047)	-0.75***	(0.1)	0.402***	(0.074)	0.219

*Note: The table presents the panel regression with fixed effect of the identified credit supply shock on key financial variables using the contemporaneous and the lagged values as follows: Credit supply shock(i,t) = a * x(i,t) + b*x(i,t-1) + c*x(i,t-2) + d(i) + e(i,t), where x(i,t) denotes one of the financial variables for country i at time t reported in the table. The credit spread shocks (5 variables) are identified using a model which includes Real GDP growth, GDP deflator inflation, Lending rate to NFCs minus 3-month OIS (or Corporate credit spread), 3-month OIS, Loans to NFCs. The credit spread shocks (7 variables) are identified using a model which includes Real GDP growth, GDP deflator inflation, BLS demand factor, Lending rate to NFCs minus 3-month OIS (or Corporate credit spread), 3-month OIS, Loans to NFCs, BLS supply factor. The latter two shocks are obtained using a standard Choleski-decomposition with the variables ordered as reported in this footnote. The panel with 11 countries include: Austria, Belgium, Finland, France, Germany, Italy, Netherlands, Spain, Greece, Ireland and Portugal.*