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Effectiveness and Transmission of the ECB's Balance Sheet Policies

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Effectiveness and Transmission of the ECB's Balance Sheet Policies

Abstract

We estimate the effects of exogenous innovations to the balance sheet of the ECB since the start of the financial crisis within a structural VAR framework. An expansionary balance sheet shock stimulates bank lending, stabilizes financial markets, and has a positive impact on economic activity and prices. The effects on bank lending and output are smaller in the member countries that have been more affected by the financial crisis, in particular those countries where the banking system is less well-capitalized.

JEL-Code: C320, E300, E440, E510, E520.

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1 Introduction

There is a large literature that has used Structural Vector Autoregressive (SVAR) models to examine the macroeconomic effects of changes in policy-controlled interest rates (e.g. Bernanke and Blinder 1992; Bernanke and Mihov 1995; Christiano *et al.* 1999; Peersman and Smets 2003). VAR models are reduced form multivariate representations of macroeconomic variables. By imposing a minimum set of restrictions, it is possible to identify the structural shocks that drive the variables, such as exogenous innovations to the policy-controlled interest rate. Once the shocks are identified, the SVAR model allows to study the dynamic responses of the variables to the shocks. There is considerable agreement in this literature that a decline in the policy rate leads to a hump-shaped temporary rise in economic activity, while prices increase persistently. These effects are typically used as a benchmark for the construction of monetary general equilibrium models of the business cycle (e.g. Christiano *et al.* 2005; Smets and Wouters 2007).

In contrast, little is known about the effectiveness and pass-through of monetary policy measures that expand central bank balance sheets for a given policy rate.¹ Indeed, this is exactly what the European Central Bank (ECB) and other major central banks have done in the aftermath of the financial crisis to counter the risks to macroeconomic and financial stability. The ECB, for instance, shifted from a variable rate tender to a fixed rate tender with full allotment, the pool of collateral accepted for refinancing operations has been enlarged and liquidity to banks has been provided at longer maturities than in the pre-crisis period. The ECB also intervened in the secondary markets of some euro area government bonds and conducted two covered bond purchase programs. A better understanding of the transmission mechanism and impact of such policies on the macroeconomy is not only essential for policymakers, it is also important to construct theoretical monetary models for the analysis of unconventional monetary policy and the financial crisis.

In this study, we apply the SVAR methodology to analyze the macroeconomic effects

¹The literature on the effects of so-called unconventional monetary policy, however, has been growing recently. Theoretical examples are Curdia and Woodford (2011) and Gertler and Karadi (2011). Empirical applications are Peersman (2011), Ciccarelli *et al.* (2013), Fahr *et al.* (2013), Lenza *et al.* (2010) and Gambacorta *et al.* (2014).

and transmission mechanism of shocks to the ECB's balance sheet that are orthogonal to real economy fluctuations, disturbances in financial markets, changes in the demand for central bank liquidity, and conventional innovations to the policy rate. We focus exclusively on the period since the onset of the financial crisis. More precisely, we first estimate a benchmark monthly SVAR model for the euro area containing output, consumer prices, the policy rate, central bank total assets, the CISS indicator of financial stress, and the spread between the EONIA and the policy rate over the sample period 2008M1-2013M12. We find that an exogenous expansion in total assets leads to a significant but temporary rise in output and prices. The dynamic effects are very similar to the ones typically found in the literature on conventional interest rate innovations. This confirms that a central bank can also use its balance sheet to stabilize the real economy without altering the policy rate. Notice, however, that the estimations represent the average impact of a generic series of exogenous balance sheet innovations during the crisis period. The shocks are a mixture of different policy actions affecting the ECB's balance sheet of which the effects are not necessarily the same. Some caution when interpreting the results is thus required.

In a second step, we extend the VAR model and also estimate the impact of balance sheet shocks on a set of financial market and banking sector variables in order to shed more light on the transmission channels. On the one hand, we find that an exogenous rise in the ECB's balance sheet improves bank lending conditions for households and firms in the euro area, increasing the volume of bank lending. On the other hand, equity prices rise, the exchange rate depreciates, and there is a fall in government bond yields and the intra-euro area government bond spreads vis-à-vis Germany. These results suggest that non-standard monetary policy measures that affect the balance sheet of the ECB are also effective to counter risks to financial stability.

Finally, we estimate the impact of the balance sheet shocks on output and prices in individual euro area countries. The effects on prices are very similar across countries. The output effects, however, are very diverse. In particular, we find a more subdued or insignificant impact in those countries that have been more affected by the financial crisis (e.g. Greece, Portugal, Cyprus, the Netherlands and Spain). The responses of output

across countries turn out to correlate positively with the degree of capitalization of national banking sectors, which suggests that the solvency of the banking sector might be important for the effectiveness of the ECB's balance sheet policies, while a recapitalization of less well-capitalized banks could potentially restore the monetary transmission mechanism.

The remainder of the paper is organized as follows. In the next section, we provide an overview of the most important unconventional monetary policy measures of the ECB in the wake of the global financial crisis, and their influence on the central bank balance sheet. Section 3 presents the benchmark VAR model and the identification strategy to isolate exogenous balance sheet innovations. Section 4 reports the results of the benchmark estimations, whereas the impact on financial market and banking sector variables is shown in section 5. In section 6, we discuss the cross-country differences within the euro area. Section 7 concludes.

2 The balance sheet of the ECB and the financial crisis

The financial crisis has affected the balance sheet of the ECB in several waves. Starting in the summer of 2007, euro area banks suffered significant losses from the fall-out of the subprime mortgage crisis in the United States. As a consequence, banks started to have doubts about their counterparts in the interbank market, which resulted in a shortage of liquidity and a collapse of activity in many financial market segments. In addition, several banks started to build up large liquidity buffers. To accommodate banks' increased (and unpredictable) demand for liquidity, the ECB started to conduct a *fixed interest rate with full allotment* (FRFA) policy after the collapse of Lehman Brothers. From October 2008 onwards, banks had unlimited access to liquidity from the ECB at a pre-specified interest rate set by the ECB, as long as they could provide the required collateral. As can be seen in Figure 1, this resulted in a first expansion of the ECB's balance sheet. At the same time, the ECB also lowered its key interest rates to close to zero.

Crucial for the analysis in this paper, is that the FRFA policy has remained in place throughout the crisis for all standard liquidity-providing operations of the ECB, although it has been suspended temporarily for three-month operations in the spring of 2010. Specif-

ically, the main challenge of this study lies in identifying changes in the balance sheet that could be interpreted as exogenous monetary policy decisions, i.e. not the result of movements in other variables. The FRFA policy, however, implies that fluctuations in the volume of liquidity distributed by the ECB to the banking sector after October 2008 are essentially demand-driven. Nevertheless, shifts in the volume of lending to the banking sector that are the consequence of deliberate monetary policy decisions are possible and did happen during the sample period. In particular, the ECB has conducted a number of non-standard monetary policy measures that raised the demand for liquidity by banks and hence the size of its balance sheet, such as alterations to the *collateral requirements* for its liquidity-providing operations. The list of eligible collateral accepted in the refinancing operations has been extended several times, e.g. in October 2008 and December 2011, allowing banks to refinance less liquid assets, expanding the balance sheet of the ECB. On the other hand, the collateral framework has also been made more restrictive at some points in time, e.g. by limiting the range of eligible assets or by changing haircuts.²

The ECB has also stimulated liquidity demand from the banking sector by *extending the maximum maturity* of its longer-term refinancing operations (LTRO's). Whereas in the pre-crisis period, the ECB only offered operations with a maturity up to three months, the maximum maturity was extended to 6 months in February 2009, then to 12 months in June 2009. There were even two refinancing operations with a maturity of 36 months in December 2011 and March 2012 (and an option to repay the funds after one year). As shown in Figure 1, all these operations got considerable interest by banks, boosting the balance sheet of the ECB. Furthermore, in order to alleviate banks' funding problems in *foreign currency*, the ECB has offered funding in foreign currency in cooperation with other central banks, such as USD and CHF. These operations have at times been suspended and reintroduced, resulting in balance sheet fluctuations that are at least partly the consequence of policy decisions.

The ECB has also made outright asset purchases, which influenced the size of its balance sheet (see Figure 1). The ECB conducted two *Covered Bond Purchase Programs* (CBPP) between June 2009 and October 2012, which implied outright purchases of €76.4

²In early 2009, for instance, the ECB raised its rating threshold for ABSs from *one A-rating* towards *two AAA-ratings at issuance*.

billion in covered bonds issued by banks in the euro area. In addition, between May 2010 and the summer of 2012, the ECB intervened in the secondary markets of some euro area government bonds in the context of its *Securities Markets Program* (SMP). Overall, the ECB bought €219.5 billion of government bonds.

In sum, there have been several deliberate monetary policy decisions after the introduction of the FRFA policy (which was also a policy decision) that had an influence on the balance sheet of the ECB. Hence, it should be possible to isolate exogenous monetary policy shocks. The identification strategy to do so, will be discussed in the next section.

3 Euro area SVAR-model for the financial crisis

3.1 Benchmark specification

Structural VAR models are typically used to estimate the macroeconomic effects of conventional monetary policy innovations, e.g. Christiano *et al.* (1999) for the United States and Peersman and Smets (2003) for the euro area. SVARs impose very little theoretical structure on the data and can be used to establish some relevant stylized facts. In this paper, we also use the SVAR methodology to explore the dynamic effects of unconventional monetary policies. The benchmark VAR model that we consider has the following representation:

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

where Y_t is a vector of endogenous variables, α a vector of constants, $A(L)$ a matrix polynomial in the lag operator L , and B the contemporaneous impact matrix of the mutually uncorrelated disturbances ε . The VARs in this study are estimated in (log) levels, which allows for implicit cointegration relationships in the data (Sims, Stock and Watson 1990).³

In the benchmark specification, the vector of endogenous variables Y_t contains six euro area variables: the log of seasonally adjusted real GDP, the log of seasonally adjusted consumer prices, the log of central bank total assets, the level of financial stress as measured

³In this paper, given the short sample available, we do not perform an explicit analysis of the long-run behavior of the economy.

by the Composite Indicator of Systemic Stress (CISS), the spread between EONIA and the MRO-rate, and the main refinancing operations (MRO) policy rate. We use monthly data for the period 2008M1-2013M12.⁴ Several empirical studies on unconventional monetary policy use data starting before the financial crisis, which may not be adequate to assess the effects of the policy measures that were taken in the aftermath of the financial crisis (e.g. Lenza *et al.* 2010; Giannone *et al.* 2012; Peersman 2011). Both banks and sovereign bond markets in the euro area behaved very differently in the financial crisis compared to the pre-crisis period. Moreover, before 2008, the ECB never used its balance sheet as a policy tool to influence macroeconomic conditions.⁵

The benchmark specification should capture the main macroeconomic, financial and monetary interactions during the financial crisis. Output and prices represent the macroeconomic developments in our sample, while the MRO-rate captures conventional monetary policy. The central bank balance sheet variable that we use in the estimations is ECB total assets. Alternatively, one could use the liquidity surplus or the monetary base. However, decisions related to, for instance, the SMP would then not be included. The purchases under this program have been sterilized during our sample, and should therefore not affect the liquidity surplus or base money. Some studies on the effects of unconventional monetary policy (e.g. Lenza *et al.* 2010; Peersman 2011; Darracq-Paries and De Santis 2013), measure unconventional monetary policy indirectly through its impact on money market rates or on credit supply, but these variables are also driven by non-policy and conventional monetary policy innovations.⁶

In order to capture financial stress and economic risk during the sample period, we include the CISS-indicator of Holló *et al.* (2012) in the benchmark VAR-model. The CISS-indicator summarizes information on financial stress in euro area money markets, bond markets, equity markets, foreign exchange markets and financial intermediaries.

⁴We construct a monthly measure of real GDP using the Chow-Lin interpolation procedure and monthly industrial production as a reference series.

⁵One notable example of a change in the size of the balance sheet that was not related to the monetary policy stance of the ECB, is the drop in the balance sheet prior to the changeover of national banknotes into euro banknotes in January 2002.

⁶In December 2011 the ECB decided to offer banks liquidity with a maturity of three years. But at the same meeting it also decided to lower the MRO-rate with 25 basis points. Without additional information or assumptions, it is not possible to assign a change in money market rates or credit supply of banks observed after the December 2011 meeting to either conventional or unconventional monetary policy.

Conditioning on such an indicator is also crucial to disentangle exogenous changes in the central bank balance sheet from endogenous responses to financial stress and uncertainty. Specifically, as discussed in Section 2, innovations to the balance sheet could be demand-induced due to the FRFA policy, whereas several unconventional monetary policy measures of the ECB were taken in direct reaction to financial and macroeconomic jitters. Failing to take into account the endogenous response of the balance sheet to financial turbulence and economic uncertainty could seriously bias the estimation results (Gambacorta *et al.* 2014). Indeed, Figure 2 shows that the year-on-year percentage change in total ECB assets is closely related to the CISS indicator. The positive co-movement between both variables mainly reflects the endogenous response of the balance sheet to financial stress.⁷ Finally, the benchmark VAR includes the spread between the EONIA and the MRO-rate, which will also be useful for the identification of exogenous balance sheet shocks.

3.2 Identification of balance sheet shocks

Isolating exogenous balance sheet shocks involves making identifying assumptions. As explained in Section 2, fluctuations in the ECB’s balance sheet are a combination of changes in monetary policy that could be interpreted as exogenous, and an endogenous response to developments in the economy. The latter reflects, in turn, the systematic reaction of monetary policy to financial stress and macroeconomic fluctuations, as well as the demand-driven nature of the FRFA policy.⁸ To identify exogenous innovations to the balance sheet, we use a mixture of zero and sign restrictions on the contemporaneous

⁷The positive correlation between the size of the balance sheet and our indicator of financial stress is analogous to the positive correlation between interest rates and inflation in conventional monetary policy VARs. Also in that case, the positive (unconditional) correlation is mainly the result of an endogenous response of monetary policy to changes in prices, rather than exogenous monetary policy shocks which drive interest rates and prices in opposite directions.

⁸The benchmark estimations reveal that only 25 percent of the forecast error variance decomposition of total ECB assets at horizon 0 is driven by unconventional balance sheet shocks, which even declines to 6 percent at longer horizons. Fluctuations in the ECB’s balance sheet are thus mainly endogenously driven by other shocks in the economy.

matrix B in equation (1), which can be found in Table 1.

Table 1 - Identification of an (unconventional) central bank balance sheet shock

Output	Prices	CB Total Assets	CISS	EONIA-MRO spread	policy rate
0	0	≥ 0	≤ 0	≤ 0	0

First, we assume that there is only a lagged impact of a balance sheet shock on output and consumer prices, i.e. the contemporaneous impact on both variables is restricted to be zero. Conversely, innovations to output and prices are allowed to have an immediate effect on the balance sheet of the central bank. This assumption, which is also made in most VAR-studies on the effects of conventional monetary policy shocks (e.g. Bernanke and Blinder 1992; Christiano *et al.* 1999; Peersman and Smets 2003), is plausible for monthly estimations, and allows to disentangle monetary policy shocks from real economy disturbances such as aggregate supply and demand shocks.

Second, following Gambacorta *et al.* (2014), we assume that an unconventional monetary policy shock that increases the balance sheet of the ECB *does not increase* financial stress.⁹ This restriction, which embodies the notion that exogenous innovations to the balance sheet have a mitigating effect on financial stress, is required to disentangle such innovations from the endogenous response of the balance sheet to financial stress.¹⁰ In particular, it follows as a complementary restriction from the assumption that central bank assets typically increase in response to a rise in the CISS-indicator. The latter reflects the idea that (i) the ECB reacts to increased financial stress by expanding its balance sheet, and (ii) due to the FRFA policy, the balance sheet of the ECB rises endogenously when financial market uncertainty increases.

Third, we assume that an expansionary balance sheet shock *does not increase* the EONIA-MRO spread. Also this restriction is motivated by the FRFA policy and the accompanying unlimited access of banks to central bank liquidity. Specifically, there could

⁹Gambacorta *et al.* (2014) estimate the impact of central bank balance sheet innovations with a four-variables panel-VAR for eight industrialized countries over the crisis period. Their VAR does not contain the policy rate nor the EONIA-MRO spread, while they use the VIX rather than the CISS indicator as a proxy for financial stress.

¹⁰Expansions in the balance sheet which did lead to increased financial markets volatility are not identified and hence captured by the other innovations in the VAR.

have been (exogenous) shocks to the demand for bank reserves without a policy action from the ECB, which have lowered the CISS-indicator and augmented the size of the central bank balance sheet during the sample period. A rise in the demand for bank reserves, however, typically raises the EONIA, and hence also the EONIA-MRO spread for a given policy rate. In contrast, an expansionary balance sheet shock that is the consequence of an unconventional monetary policy action typically increases the liquidity surplus, exerting downward pressure on the EONIA and the spread with the policy rate.¹¹

Finally, given that we want to estimate the dynamic effects of innovations to the ECB's balance sheet that are orthogonal to shifts in the policy rate, the identified shocks have a zero contemporaneous impact on the MRO-rate.

All sign restrictions are imposed on impact and the first month after the shock, and implemented in a weak form, i.e. as *smaller/larger than or equal to zero*. This allows for the possibility that an unconventional monetary policy measure, for example, immediately influences the CISS-indicator, and central bank assets only with a lag. Hence, it accommodates for the fact that some monetary policy decisions are announced before they are implemented.

4 Benchmark estimation results

The VAR is estimated over the sample period 2008M1-2013M12. Data were taken from the ECB Statistical Data Warehouse and Datastream. Based on the usual lag-length selection criteria, the estimations include four lags of the endogenous variables. Most criteria even suggest a shorter lag length, but the results proved robust to different specifications of the lag length. We use a Bayesian approach with Gibbs sampling for estimation and inference. The prior and posterior distributions of the reduced form VAR belong to the Normal-Wishart family. To draw the 'candidate truths' from the posterior, we take a joint draw from the posteriors of the reduced form VAR parameters, as well as a random possible decomposition B of the variance-covariance matrix. If the draw satisfies the

¹¹Notice that not all unconventional monetary policy measures imply downward pressure on the EONIA. The impact of the SMP on liquidity, for instance, has been sterilized. Moreover, the EONIA can never fall below the interest rate on the deposit facility of the ECB. To account for this, the sign restriction is implemented in a weak form.

restrictions, the draw is kept. Otherwise, the draw is rejected by giving it a zero prior weight. For details, we refer to Peersman (2005) or Uhlig (2005). After a burn-in period of 5,000 draws, a total of 10,000 successful draws from the posterior are used to produce the figures.

4.1 Time series of exogenous balance sheet innovations

Before we discuss the dynamic effects and transmission mechanism of the balance sheet shocks, we first examine the time series of the identified shocks. An inspection of the time series of the shocks should help to interpret their exact source more carefully, and assess whether the major measures taken by the ECB in the aftermath of the crisis are captured by the estimated innovations. Figure 3 shows the cumulative time series of the balance sheet shocks for all possible decompositions B that fulfill the restrictions (light blue area), as well as the median value (red line) for each quarter in the sample. The scale is standard deviations innovations. By construction, the sum of the shocks is zero over the whole sample period. A rise in the cumulative shock series implies an expansionary balance sheet shock, while a decline reflects a tightening of the balance sheet relative to the average endogenous response to the other shocks hitting the economy.

The figure reveals that the identified shocks capture the dates of important unconventional monetary policy measures. As most decisions have to some extent an unexpected component, this indicates that our identification strategy is plausible. Examples of (series of) expansionary balance sheet shocks identified by the VAR model are the decision of the Governing Council to offer US dollar funding to Eurosystem counterparties in March 2008, the FRFA policy and the easing of collateral requirements in October 2008, both CBPPs, the one-year LTRO's of May 2009 and December 2009, the three-year LTRO's of December 2011 and March 2012, the easing of collateral requirements and the announcement that the FRFA will be continued "for as long as necessary and at least another six months" in June 2012, and several modifications to the risk control framework in July 2013. Somewhat surprising, the start of the SMP in May 2010 is not identified as an expansionary balance sheet shock, which implies that the corresponding rise in the ECB's balance sheet can be fully considered as an endogenous reaction to the ongoing macroeconomic and financial

jitters.

The periods that are identified as restrictive balance sheet shocks are typically associated with a lack of policy measures, despite a worsening of economic conditions and financial stability. Examples are the banking crisis in 2009 and the sovereign debt crisis in 2011. Also the end of the one-year LTRO's and completion of the first CBPP in June 2010 are identified as a tightening of the (unconventional) monetary policy stance. Interestingly, the early repayments of three-year LTRO's in January 2013 resulted in a negative shock to the balance sheet of more than one standard deviation. In sum, we can conclude that the identified balance sheet shocks make sense, and capture the most important non-standard monetary policy measures of the ECB during the sample period.

4.2 Impulse response analysis

Figure 4 shows the impulse responses to a one-standard deviation balance sheet innovation. The dotted (red) lines are the median impulse responses of the posterior distributions, while the shaded (light blue) areas represent the 68 percent posterior probability regions of the estimated responses. The shock is characterized by an increase in total ECB assets between 1 and 3 percent, which fades out after about six months. While being (weakly) imposed by the sign restriction on impact and the first month after the shock, an expansionary balance sheet shock leads to a significant decline of the CISS indicator that lasts for more than one year. Also the spread between the EONIA and the MRO-rate is assumed to fall on impact, but remains negative for about 5 months.

The dynamics of real GDP and consumer prices reveal that the unconventional balance sheet policies conducted by the ECB in the aftermath of the financial crisis were effective in supporting the macro-economy. Both variables display a significant increase after an expansion in the central bank balance sheet. Real GDP is found to rise with a peak effect after about one year and to return gradually, over approximately 18 months, to the value it would have been without the rise in the balance sheet. Compared to the existing evidence on the transmission of conventional monetary policy shocks that are associated with a change in the short-term interest rate, the response pattern of output turns out to be qualitatively very similar. The impact on consumer prices is, however, somewhat

different. Specifically, as can be seen in Figure 4, the pattern of consumer prices coincides with that of the output response following a balance sheet shock, while the impact of interest rate shocks on the price level is typically found to be very sluggish with a peak only after about two years or more. Finally, we observe a tightening of the policy rate after about six months, which is consistent with an endogenous monetary policy reaction that tries to stabilize output and inflation fluctuations.

5 Transmission channels

In this section, we analyze the transmission channels of the central bank balance sheet shocks to the real economy in more detail. Given that borrowing and lending in the euro area predominantly take place through the intermediation of the banking system, and most ECB unconventional monetary policy actions were primarily aimed at influencing the banking sector, we first examine the impact of the shocks on a set of bank lending variables. In a next step, we assess whether the balance sheet policies also had an impact on a number of financial market variables that are not included in the benchmark model. We do this by extending the basic SVAR model as follows:

$$\begin{bmatrix} Y_t \\ Z_t \end{bmatrix} = \begin{bmatrix} \alpha \\ \gamma \end{bmatrix} + \begin{bmatrix} A(L) & 0 \\ C(L) & D(L) \end{bmatrix} \begin{bmatrix} Y_{t-1} \\ Z_{t-1} \end{bmatrix} + \begin{bmatrix} B & 0 \\ E & F \end{bmatrix} \begin{bmatrix} \varepsilon_t \\ v_t \end{bmatrix} \quad (2)$$

We use a block diagonal structure to estimate the effects of a balance sheet shock on the banking and financial market variables, i.e. we estimate a so-called near-VAR. As before, Y_t is a vector of the benchmark endogenous variables, and B the contemporaneous impact matrix of the shocks ε_t . Z_t is a vector containing the banking or financial variables of interest. Each time, we include two (related) variables in Z_t , for instance the volume of bank lending to households and the corresponding lending rate. In order to keep the balance sheet shock and the dynamics of the benchmark variables invariant to the inclusion of the additional variables, we assume that the banking and financial market variables do not affect the block of the benchmark endogenous variables. This approach is very similar to Peersman and Smets (2003), who estimate the impact of a conventional monetary policy

shock on various euro area macroeconomic variables. The CISS indicator - reflecting stress in the banking system and a wide range of asset markets - should be a sufficient proxy to capture the state of financial and banking markets.¹²

Bank lending The dynamic effects of a balance sheet shock on a set of euro area bank lending variables are shown in Figure 5. The results suggest that the unconventional monetary policy measures of the ECB did support bank lending to households and firms during the financial crisis. In particular, both the volume of lending to non-financial corporations and households rise significantly following an expansion in the central bank balance sheet for a given policy rate. The peak of the response of loans to non-financial corporations is later than the peak of loans to households. This is in line with existing evidence, which typically finds that loans to households coincide more with output, whereas loans to non-financial corporations are lagging with respect to output (ECB 2013). These findings are also consistent with those of Affinito (2013), who finds that lending reacts positively to changes in unconventional monetary policy using micro firm data.

The impulse responses of the interest rates charged on loans to households and firms, which are shown in the second row of Figure 5, denote that the rise in the volume of lending is essentially supply-driven. In particular, while the volume of lending increases, there is a decline of both lending rates in the short run after an expansionary balance sheet shock. The increase in bank lending rates after six months is in line with the endogenous reaction of the policy rate documented before. The impact on bank lending is consistent with the existence of a bank lending channel of balance sheet policies. This is further supported by the regular Bank Lending Survey (BLS) conducted by the ECB on supply and demand conditions of bank loans.¹³ The question on supply conditions asks how the bank has changed its credit standards for loans or credit lines to respectively households and firms. The question on demand conditions asks how the demand for loans and credit lines by households and firms has changed, apart from normal seasonal fluctuations. The

¹²As a robustness check, we have also estimated VARs where the additional variables are included in the block of benchmark endogenous variables. The results are very similar.

¹³As the BLS is a quarterly survey, the series is linearly interpolated to obtain a monthly series. For more details about the construction of the series, see <http://www.ecb.europa.eu/stats/money/surveys/lend/html/index.en.html>.

bottom part of Figure 5 shows the impulse responses of both indexes to the identified shocks. A decline in the supply index implies a loosening of credit standards, whereas a fall in the demand index corresponds to a decline in loan demand. The impulse responses reveal that supply conditions are significantly loosened after a shock to the balance sheet, in contrast to demand conditions. The response of demand conditions for households is even negative in the short run. In sum, the responses of the BLS data confirm that it is the supply of bank loans and not the demand that increases after an expansion in the ECB's balance sheet, which corroborates with a bank lending channel of monetary policy in the spirit of Bernanke and Blinder (1988) and Kashyap and Stein (1995).

Financial markets The impact of a balance sheet shock on a number of financial market variables is shown in Figure 6. Consistent with the rise in the volume of bank loans, there is a significant rise of M3 after an expansionary innovation to the ECB's balance sheet. Furthermore, there is a fall in the three-month Euribor rate, which can be explained by the drop in the EONIA, as well as by a decline in the credit risk premium embedded in Euribor. There is indeed a fall in the Euribor-OIS spread, which reflects the favorable impact of the balance sheet measures on the risk premium for banks in the interbank market. In line with this, credit default swaps for banks drop between 4 and 10 basis points. The liquidity support of the ECB hence also lowers the probability investors attach to a credit event in the banking sector.

Figure 6 also shows that equity prices increase after a balance sheet shock, whereas there is a depreciation of the nominal effective exchange rate of approximately 1 percent. The latter is consistent with an exchange rate channel of the balance sheet policies. Finally, we find that a balance sheet shock has a negative impact on euro area sovereign bond yields, which can be explained by several factors. On the one hand, the term premium could fall, as the rise in liquidity might lead investors to rebalance their portfolios towards longer-term assets. On the other hand, the fall in the sovereign yield could also reflect a drop in the credit risk premium. Since we use an aggregate euro area bond yield also comprising risky sovereign bonds, the yield also contains credit risk. There is for instance evidence (e.g. Acharya and Steffen 2013) that in response to the ample ECB liquidity, many banks have bought government bonds of euro area countries under financial stress,

and that this has lowered the spread between the yields of these countries and the German Bund. As can be seen in Figure 6, this hypothesis is confirmed by the impulse response of the sovereign yield spread vis-à-vis Germany.

6 The effects across euro area countries

It may be useful to also analyze how individual euro area countries are affected by the balance sheet shocks. For that purpose, we include output and consumer prices of each individual country in the Z -block of the near-VAR presented in Section 5.¹⁴ The effects on economic activity turn out to be quite diverse. Figure 7 shows that the effects of a central bank balance sheet shock on output are relatively large in Germany, Finland, Estonia, Ireland, Slovenia, Slovak Republic and Luxemburg. The effects are much more subdued in France, Italy, Austria and Belgium. The estimations further reveal that the impact of the unconventional monetary policy measures of the ECB were negligible in Spain, the Netherlands, Portugal and Cyprus. For Greece, we even find a puzzling negative response of output to a balance sheet expansion. On the other hand, as shown in Figure 8, the effects on consumer prices are much more similar across countries. Hence, there is little evidence that in countries where output reacts more (less), also inflation reacts more (less).

Since the peripheral countries of the euro area participated relatively more in the non-standard monetary policy actions of the ECB, the finding that the effects of expansionary (and restrictive) central bank balance sheet shocks turn out to be stronger in countries that are generally less affected by the financial crisis is striking. A potential explanation is that a lot of banks in peripheral countries have not been able to convert the extra liquidity into more lending to the private sector because of their financial fragility and low capitalization. In particular, it is difficult for banks to increase lending supply if they are capital-constrained. Accordingly, the macroeconomic effects of the balance sheet policies could be more subdued in countries where banks are on average less capitalized. This conjecture is supported by the data shown in Figure 9. The figure plots the correlation

¹⁴Since individual countries are part of the euro area aggregate, it is not necessary to allow for feedback of the individual countries on the euro area variables. We can thus again use a block diagonal VAR system, which ensures that the dynamics of the euro area variables are invariant to the inclusion of the individual country variables, allowing for a comparison across countries (see also Peersman and Smets 2003).

between bank capital and the estimated effects of the balance sheet shocks on output and bank lending across individual countries. Given that correlation does not mean causation, we have to be careful when interpreting the results, but they are nevertheless informative about a potential relationship. More specifically, there is a strong positive correlation (0.78) between the (maximum) impact of an innovation to the ECB's balance sheet on economic activity in an individual country and the average Tier 1 capital ratio of the respective consolidated national banking system over the sample period. Similarly, there is a positive correlation between bank capital and the rise in bank lending to households and firms after an expansion in the ECB's balance sheet, in particular lending to non-financial corporations.¹⁵ In other words, the solvency of the banking system seems to be important for the transmission of central bank liquidity support to the real economy. If the central bank injects liquidity but banks are not able or willing to lend to households and firms because of their own financial fragility, the effects on economic activity are more subdued. As a consequence, countries with a weakly capitalized banking system also react less to the unconventional monetary policies of the ECB.

7 Conclusion

In this paper, we have analyzed the effectiveness and transmission of the ECB's unconventional monetary policies since the onset of the financial crisis. Within an SVAR framework, we have identified exogenous innovations to the central bank balance sheet for a given policy rate, and estimated the dynamic effects on the macro-economy. We find that euro area output and prices rise after an increase in the balance sheet of the ECB. The effects are qualitatively very similar to the impact of conventional monetary policy, in particular the output effects. This confirms that unconventional monetary policy actions that influence the size of the central bank balance sheet can be effective at stabilizing the economy.

Financial market and bank lending variables also react significantly to central bank balance sheet disturbances. We find that equity prices, lending volumes, and broad money

¹⁵Impulse responses of lending to non-financial corporations and households in individual countries are shown in respectively Figures A1 and A2. The responses are estimated by including both variables in Z_t of the near-VAR model.

rise after an expansionary balance sheet shock, whereas sovereign yields, the intra-euro area sovereign bond spread vis-à-vis Germany, bank lending rates, bank CDS's, and money market rates fall. Financial markets and banks are thus important in passing on ECB unconventional monetary policy to the real economy. Based on survey responses of banks about their lending standards, we can conclude that the increase in bank lending coincides with a loosening of lending standards, and not so much with an increase in loan demand.

The identified unconventional monetary policy shock seems to affect euro area countries differently. Specifically, output reacts more in countries that have been less affected by the financial crisis. The differential reaction of output across countries turns out to be strongly correlated with the degree of capitalization of the national banking sector. Output increases more in countries with a relatively better capitalized banking sector. This seems to underscore the importance of capitalization of the banking sector in transmitting unconventional monetary policy to the real economy. Whether this is indeed the case, is an interesting avenue for future research.

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Figure 1 - Balance sheet of the ECB (assets) in the aftermath of the financial crisis

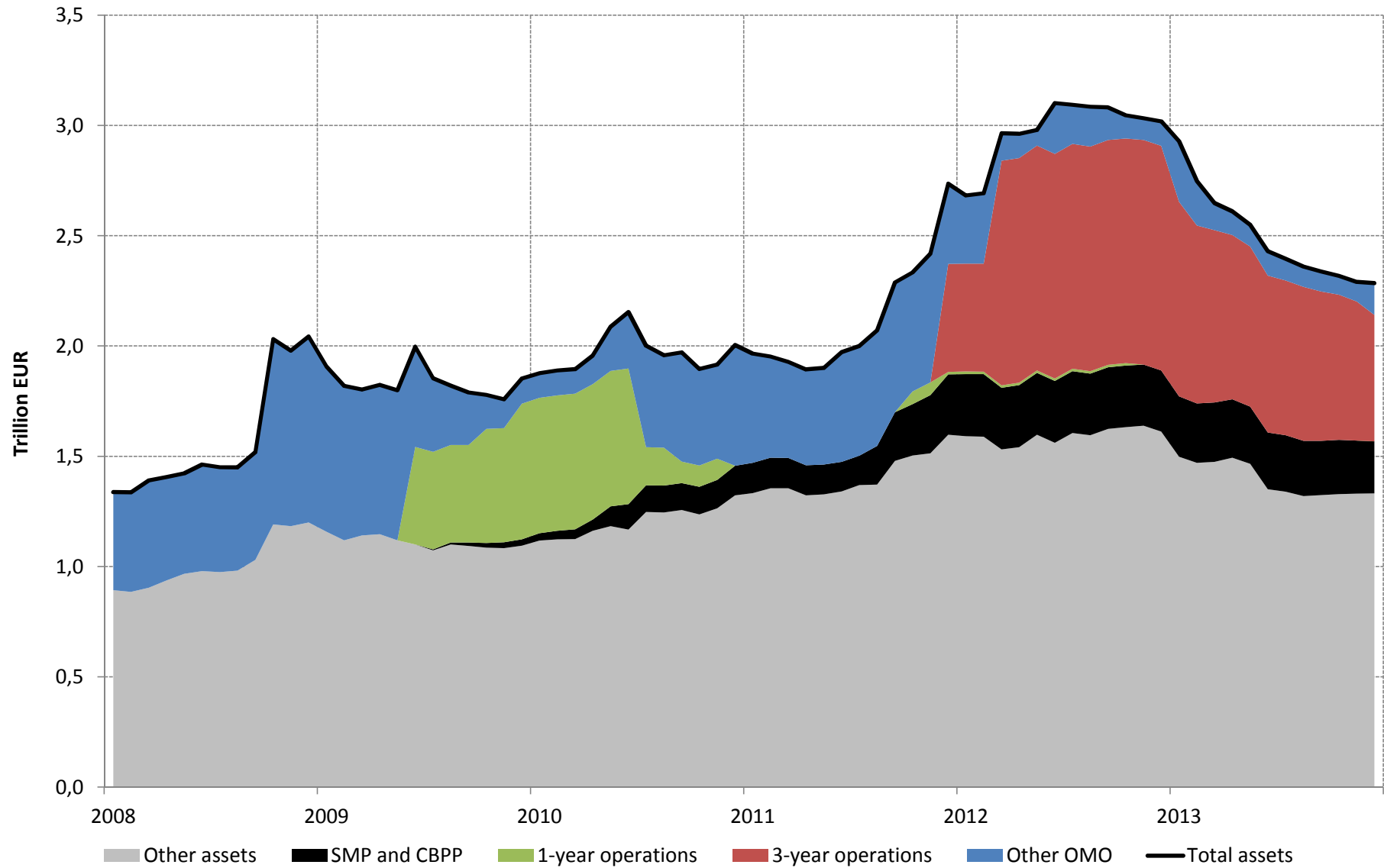


Figure 2 - ECB balance sheet and financial stress in the euro area

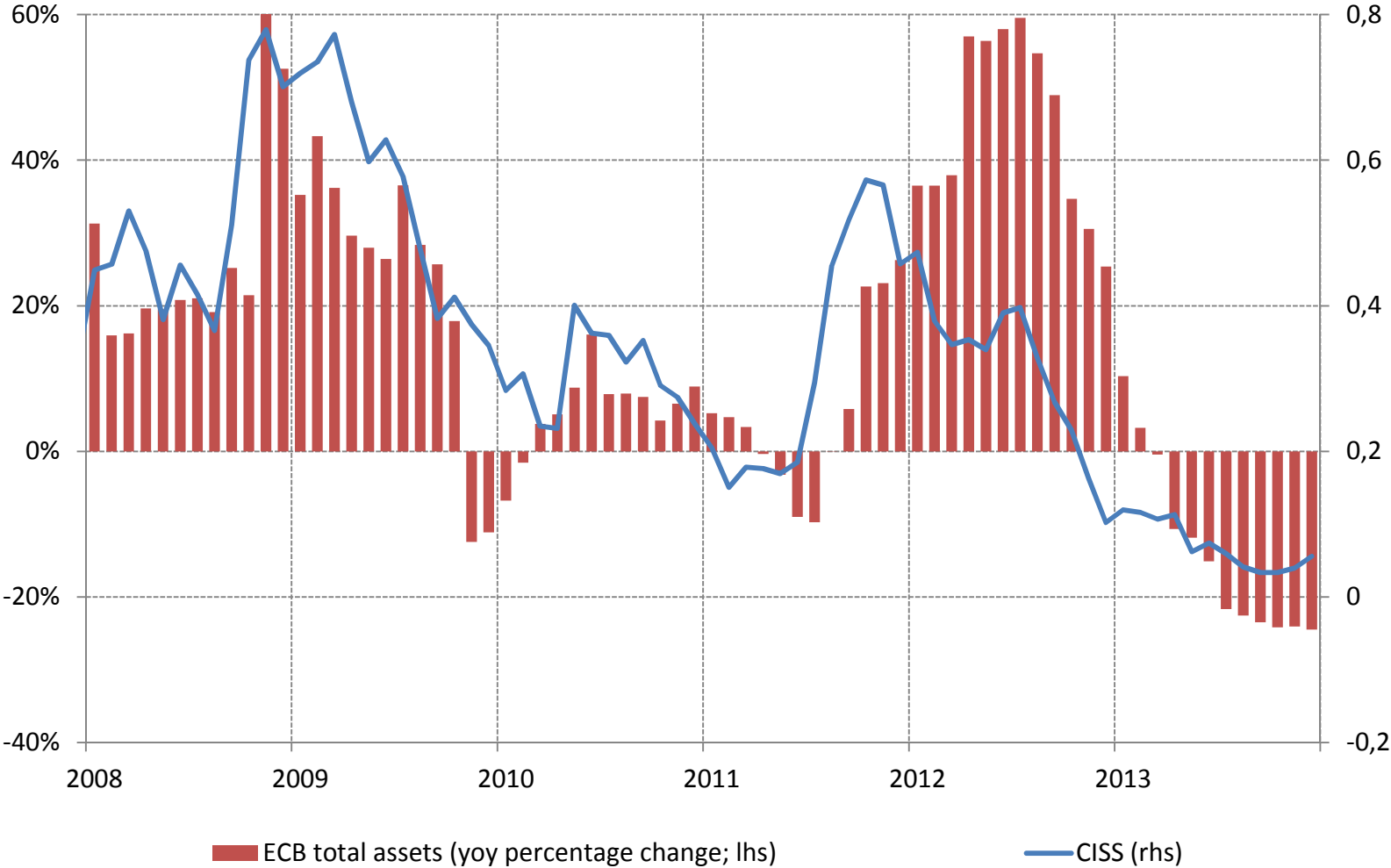


Figure 3 - Time series of cumulative identified balance sheet shocks

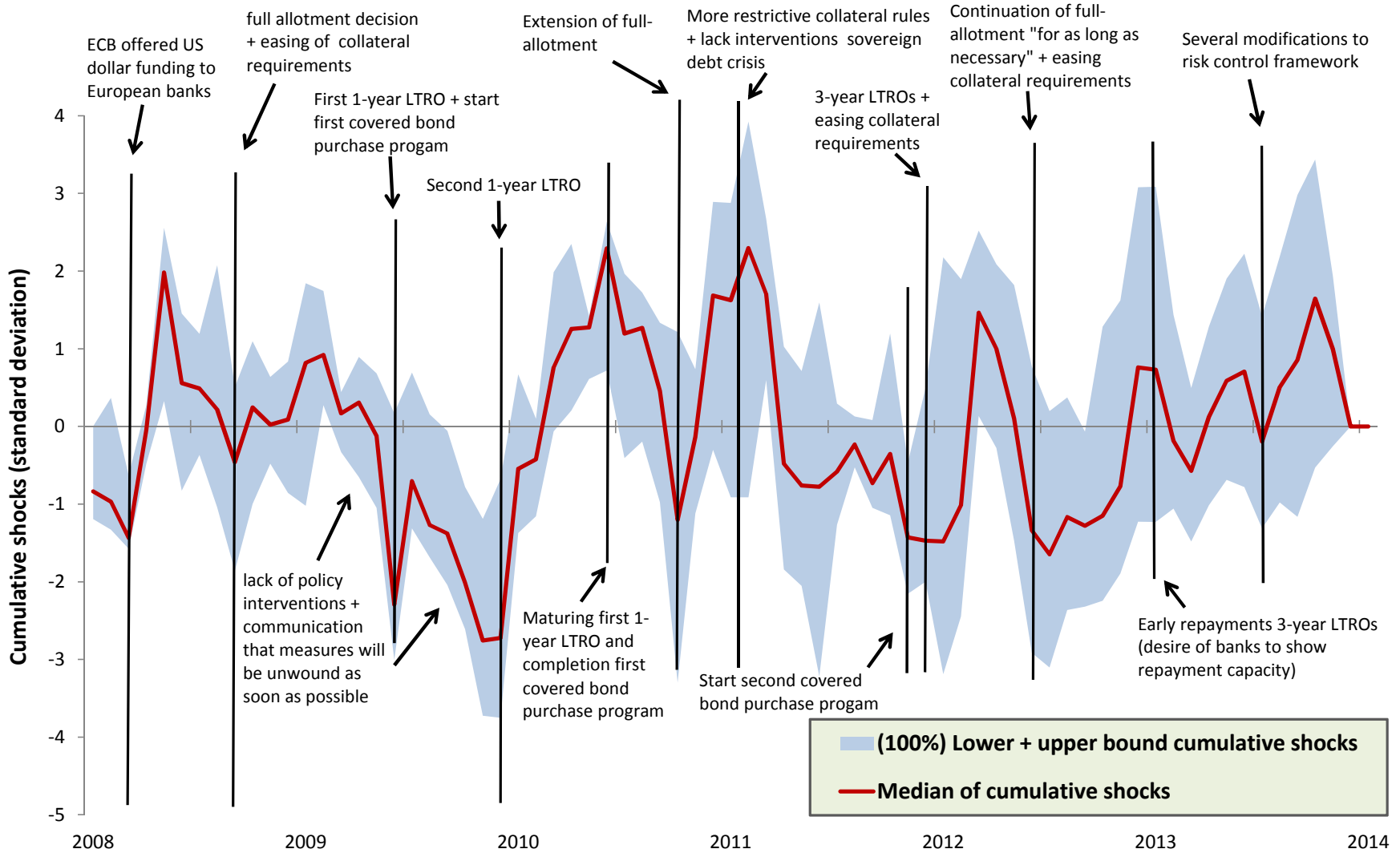
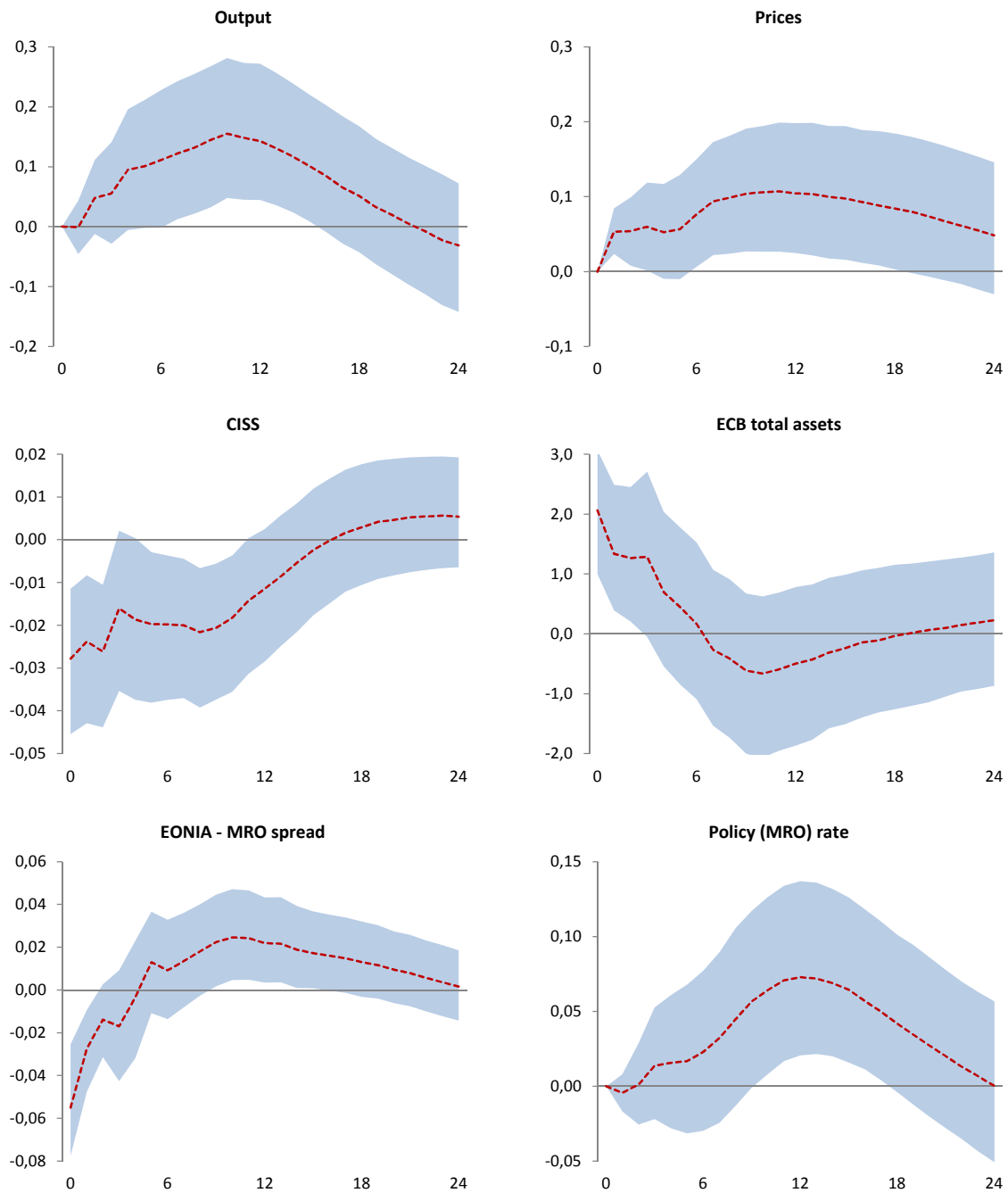
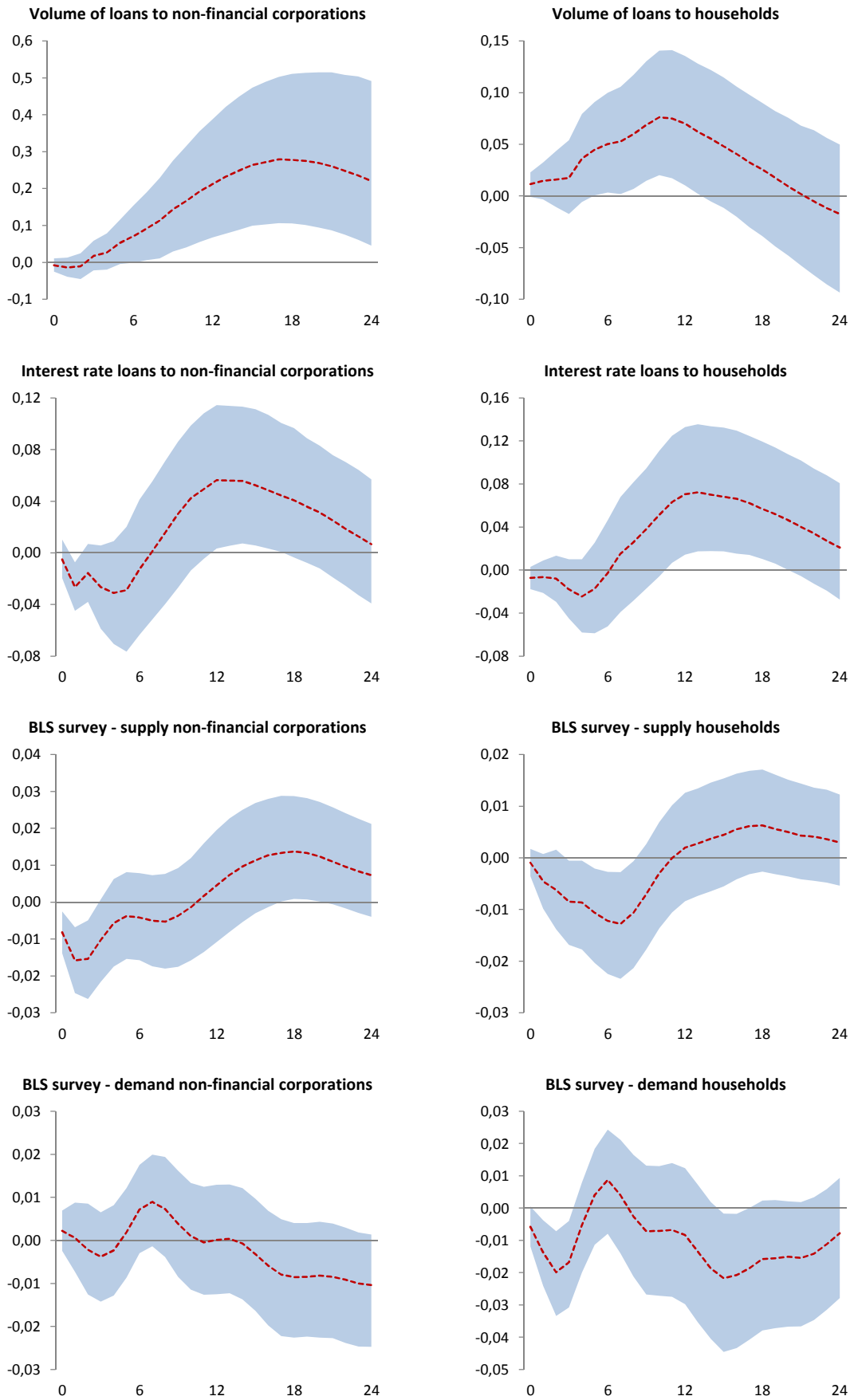


Figure 4 - Impulse responses to balance sheet shocks in the euro area



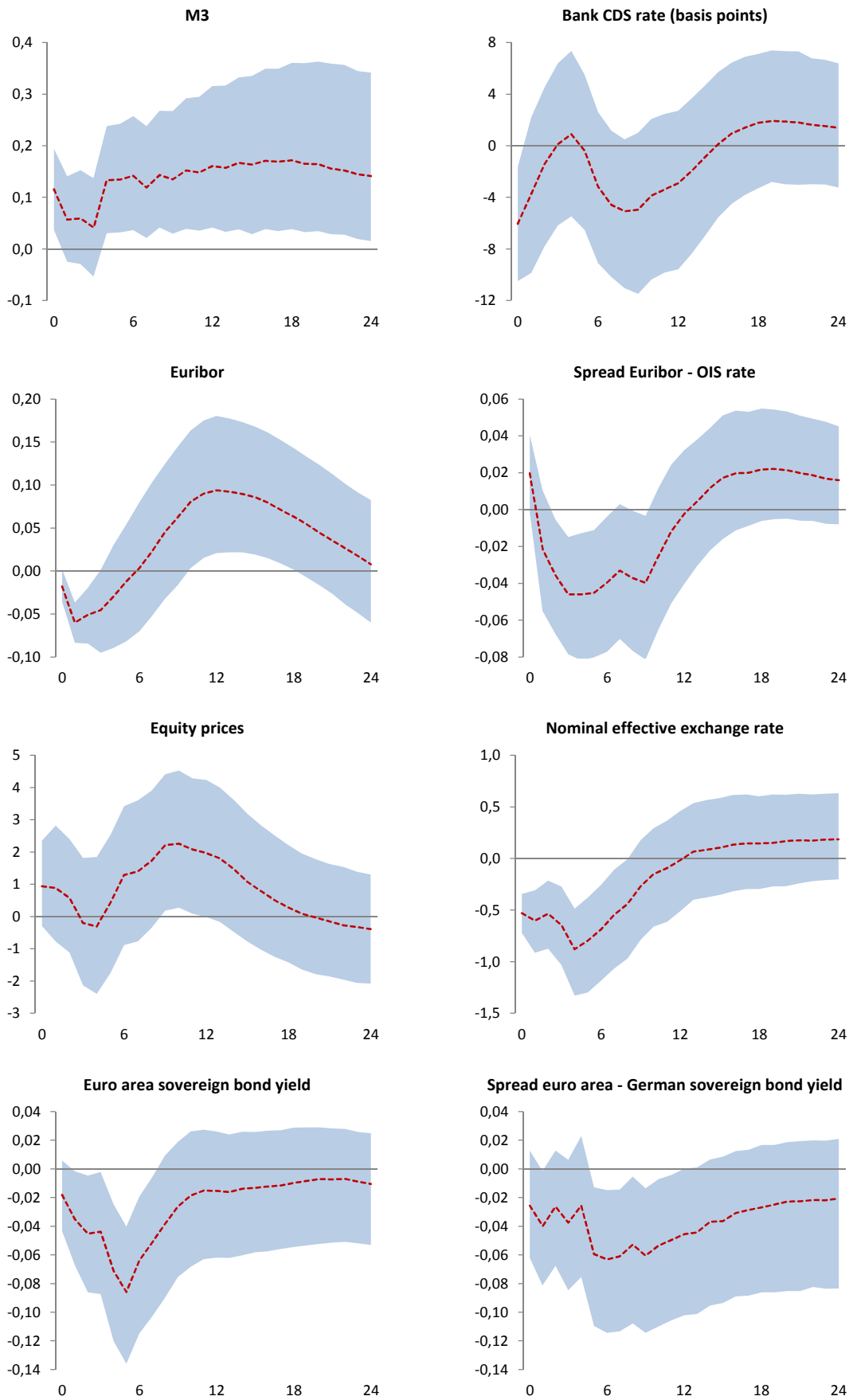
Note: figures show median responses, together with 16th and 84th percentiles of the posterior distribution; horizon is monthly

Figure 5 - Impact of balance sheet shocks on bank lending in the euro area



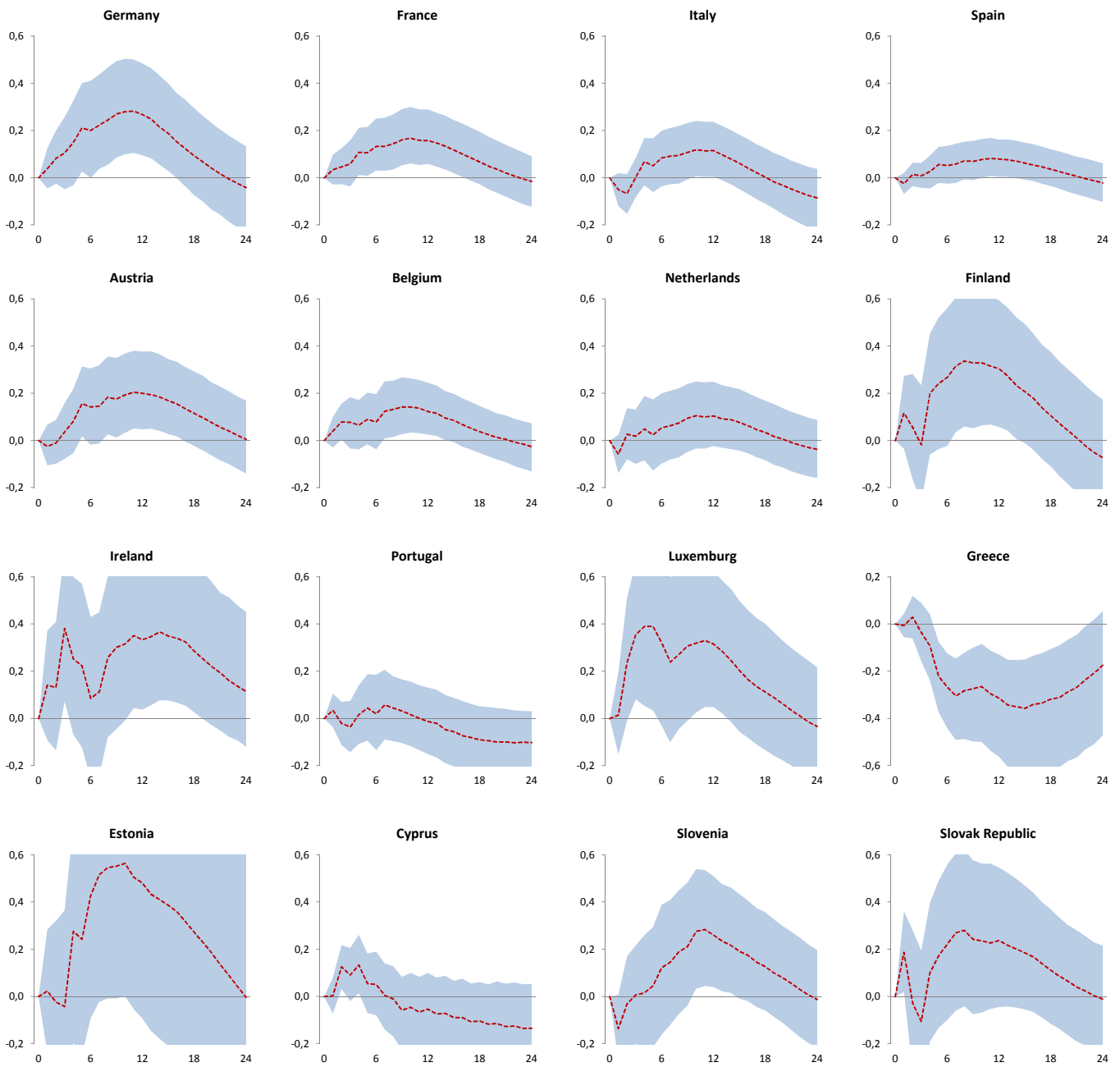
Note: figures show median responses, together with 16th and 84th percentiles of the posterior distribution; horizon is monthly

Figure 6 - Impact of balance sheet shocks on financial market variables in the euro area



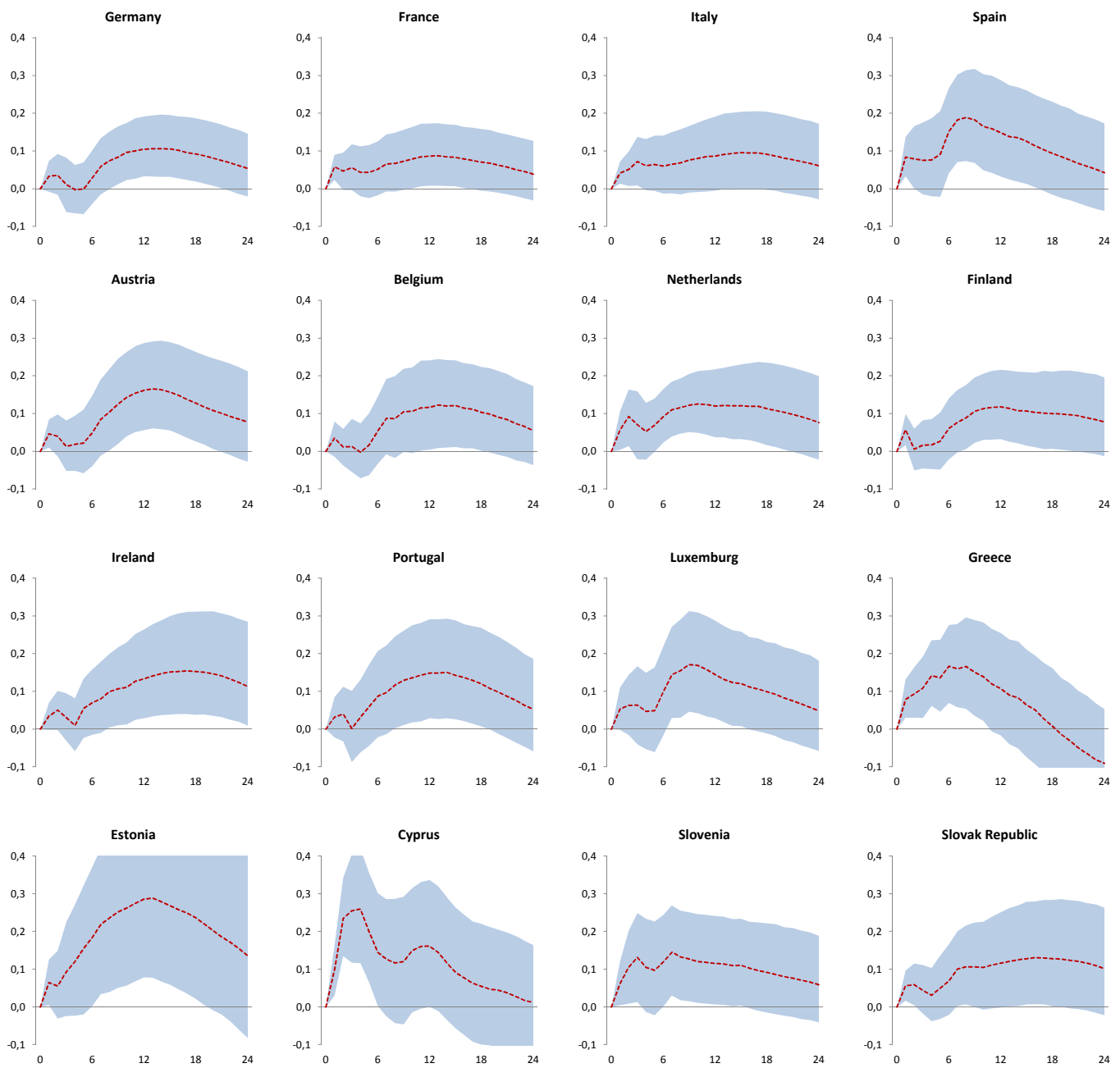
Note: figures show median responses, together with 16th and 84th percentiles of the posterior distribution; horizon is monthly

Figure 7 - Impact of balance sheet shocks on output in individual member countries



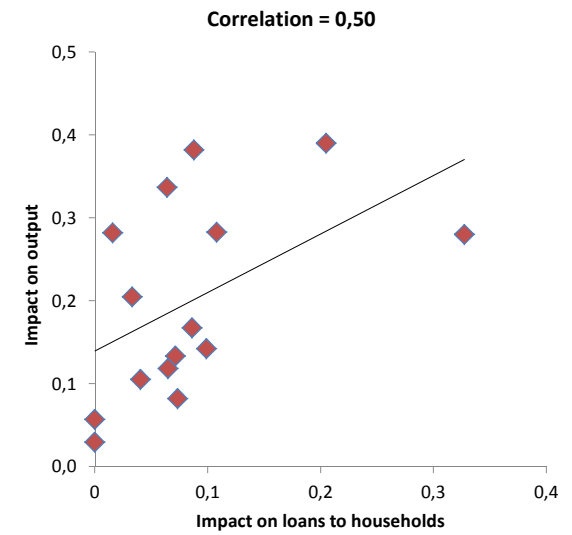
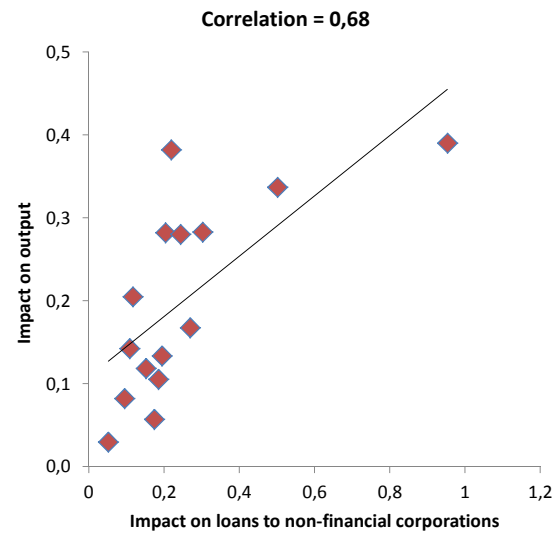
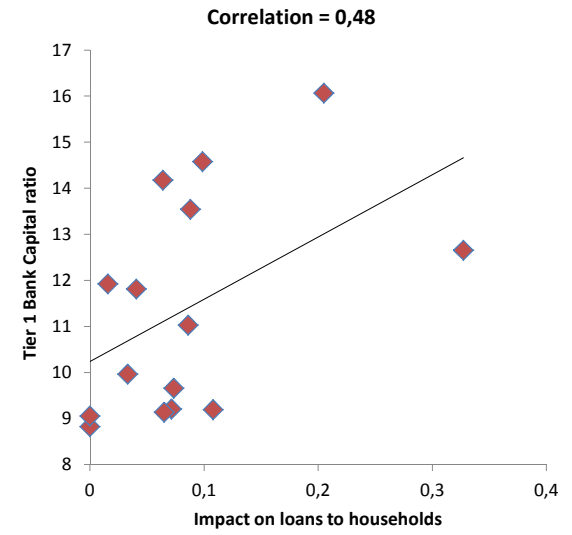
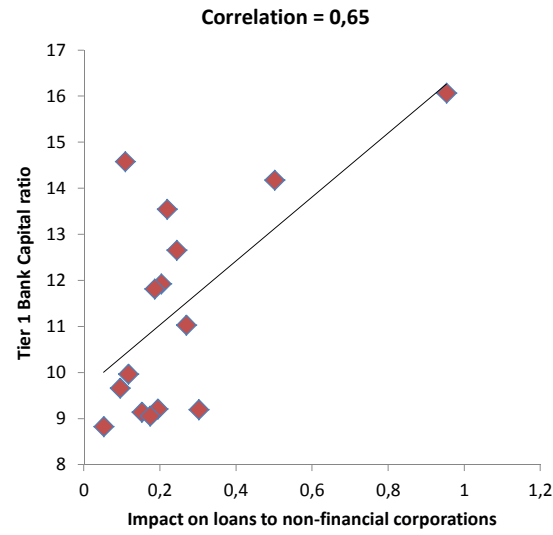
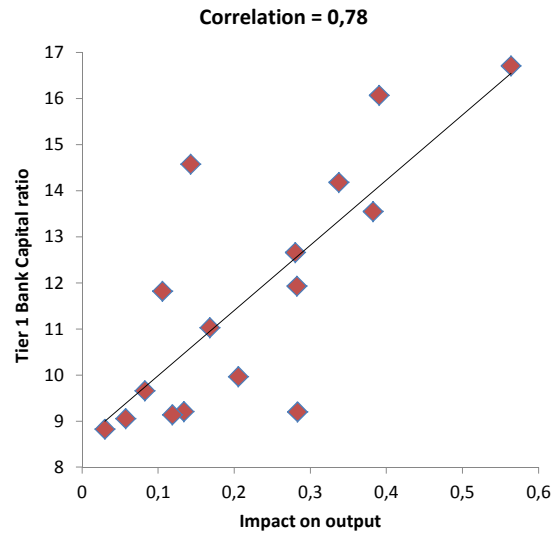
Note: figures show median responses, together with 16th and 84th percentiles of the posterior distribution; horizon is monthly

Figure 8 - Impact of balance sheet shocks on consumer prices in individual member countries



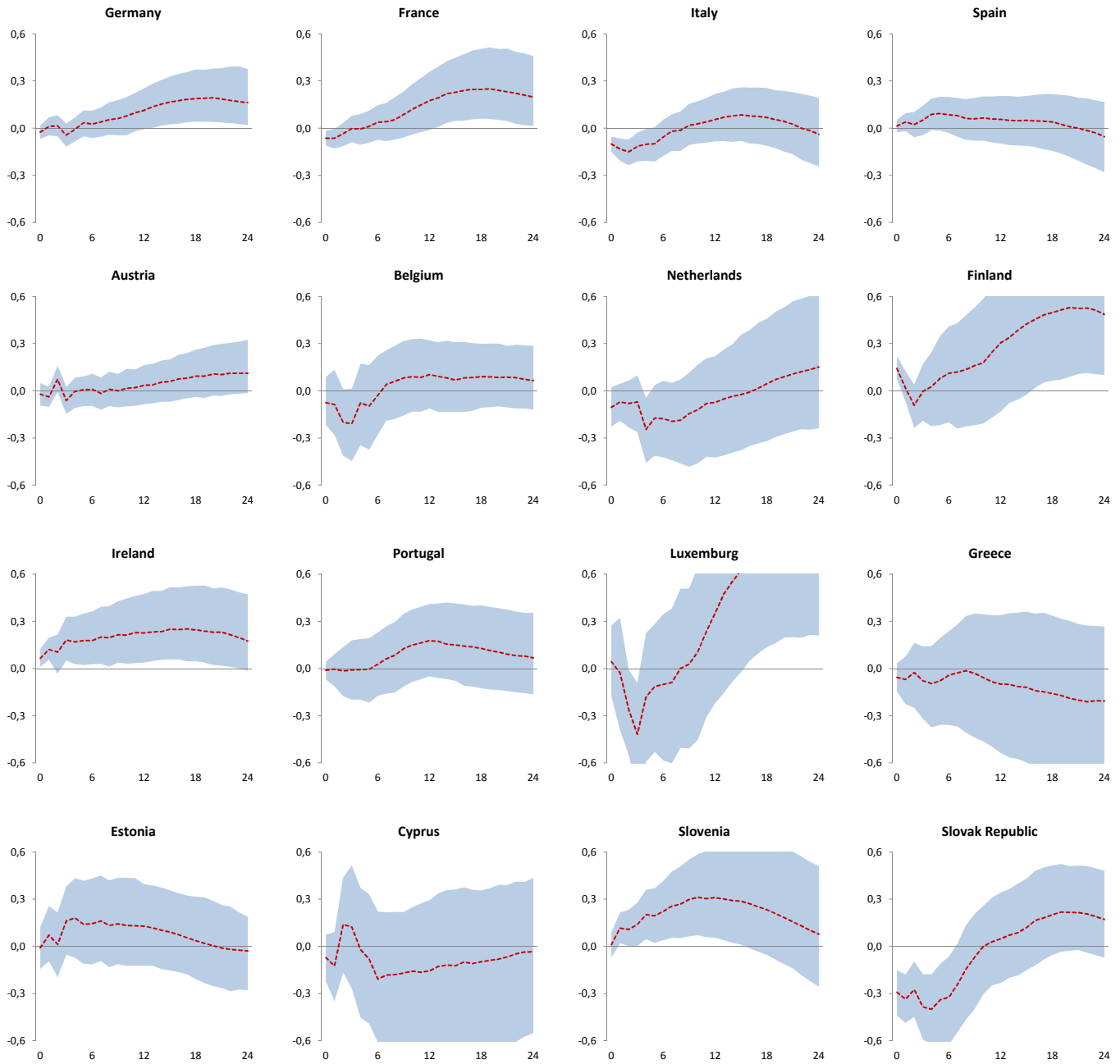
Note: figures show median responses, together with 16th and 84th percentiles of the posterior distribution; horizon is monthly

Figure 9 - Bank capital and the effects of balance sheet shocks on output and bank lending in euro area countries



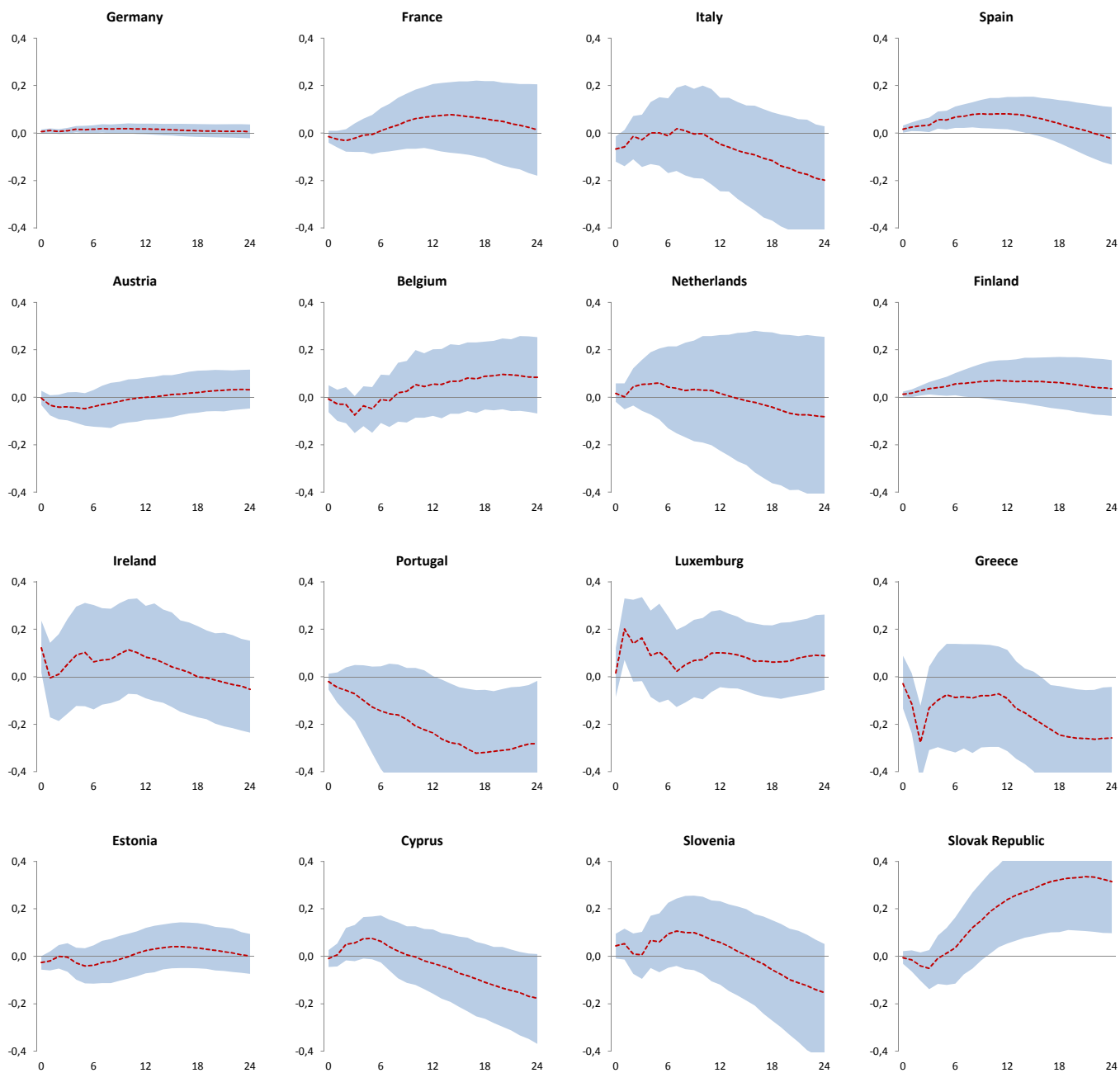
Note: figures show correlations between Tier 1 Capital ratio of National banking sector and maximum estimated effects of balance sheet shocks (median impulse responses) on output and bank lending variables in member country

Figure A1 - Impact of balance sheet shocks on the volume of loans to non-financial firms in individual member countries



Note: figures show median responses, together with 16th and 84th percentiles of the posterior distribution; horizon is monthly

Figure A2 - Impact of balance sheet shocks on the volume of loans to households in individual member countries



Note: figures show median responses, together with 16th and 84th percentiles of the posterior distribution; horizon is monthly