Bank Lending Shocks and the Euro Area Business Cycle*

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February 2012

Abstract

I estimate the impact of different types of bank lending shocks on the euro area economy. I first show that the dynamic effects depend on the type of shock. Whereas surges in lending caused by shocks at the supply side of the banking market have a significant positive impact on economic activity and inflation, exactly the opposite is the case for exogenous lending demand shocks. Second, the macroeconomic relevance of bank lending shocks is considerable. Overall, they account for more than half of output variation since the launch of the euro and up to 75 percent of long-run consumer prices variability. The majority of the fluctuations are caused by innovations to lending supply which are independent of a monetary policy action. A more detailed inspection suggests that these innovations are mainly the result of shocks in the risk-taking appetite of banks triggered by shifts in long-term interest rates or the term spread. Specifically, when long-term government bond yields decline, banks reduce the volume of government loans and securities on their balance sheets whilst increasing the supply of loans to the private sector, which in turn boosts economic activity, inflation and short-run interest rates. Hence, in contrast to conventional wisdom, a falling term spread could predict rising economic activity, which has been the case for some periods within the sample.

JEL classification: C32, E30, E44, E51, E52
Keywords: Bank lending shocks, risk-taking, SVARs

*E-mail: gert.peersman@ugent.be. This paper is an extended version of the first part of an earlier paper entitled "Macroeconomic Consequences of Different Types of Credit Market Disturbances and Non-Conventional Monetary Policy in the Euro Area", which has been split in two separate and independent papers. I thank Julio Carrillo, Hans Degryse, Selien De Schryder, Boris Hofmann, Michele Lenza, Benoit Mojon, Frank Smets, Harald Uhlig, Ine Van Robays, Timo Wollmershaeuser and participants at the CEPR/EABCN conference on "Advances in business cycle research - Directions since the crisis", CESifo conference on "Macro, money and international finance", Norges Bank workshop on "The interaction between monetary policy and financial stability", CEPR/JMCB/ECARES/UGENT workshop on "Macroeconomics and Financial Intermediation: Directions since the Crisis", the EEA 2011 and SED 2011 Annual Meetings for useful suggestions and comments. All remaining errors are mine.

1 Introduction

Since the global financial crisis, it has been widely believed that disruptions in credit markets can have serious macroeconomic consequences.[1] There are, however, still a lot of uncertainties about the exact relevance and transmission mechanism to the real economy. A better understanding of the dynamic effects of disturbances that are specific to these markets is not only essential for policymakers, it should also improve the construction of theoretical models that try to incorporate financial intermediaries. In this paper, I use a structural vector autoregressive (SVAR) framework to examine the macroeconomic relevance and transmission of different types of bank lending shocks in the euro area. SVARs impose very little theoretical structure on the data and can be used to establish some relevant stylized facts. The euro area is particularly interesting given the prominent role of the banking sector. In contrast to economies where securities markets play a crucial role in the funding of the private sector, borrowing and lending in the euro area predominantly take place through the intermediation of the banking sector.[2]

More precisely, I estimate an SVAR model with monthly data since the introduction of the euro. Within this model, I identify three types of bank lending shocks: (i) exogenous lending demand shocks, (ii) lending supply shocks caused by monetary policy shifts and (iii) lending supply disturbances which are independent of a policy action. I label the latter as "lending multiplier shocks". The lending multiplier represents the volume of bank lending to non-monetary and financial institutions (non-MFI) excluding the general government that is generated by the financial sector with a specific amount of central bank money. Innovations to the multiplier have probably played a key role for macroeconomic fluctuations over the past decade. Examples are shocks to risk-taking by banks, securitization activities or advancements in the bank intermediation process. The growth of securitization markets between the introduction of the euro and the financial turmoil was for instance remarkable. This increase was part of a wider trend of financial innovations in credit markets, which also included changes in the syndicated loan market and a growing importance of credit derivatives (ECB 2008). These developments have likely influenced the capacity of banks to issue loans and might thus have significantly contributed to macroeconomic dynamics prior to the recession. On the other hand, the illiquidity of asset-backed securities markets and the deterioration of risk profiles and capital positions

[1] Gilchrist et al. (2009) find for instance that shocks emanating from the corporate bond market account form more than 30 percent of the forecast error variance in US economic activity at the two- to four-year horizon.

[2] Bank loans have in recent years accounted for around 85 percent of the total external financing of the private sector in the euro area (ECB 2008).

of banks in the summer of 2007 are expected to have negatively affected bank loan supply, contributing to the subsequent slowdown of economic activity. The present study should help to clarify the exact role of these evolutions for macroeconomic fluctuations.

In a first step, I show that all three types of bank lending shocks have a significant impact on economic activity and inflation. The exact effects, however, depend on the source of the disturbance. Whereas positive innovations to the supply of lending caused by lending multiplier and monetary policy shocks have a significant positive impact on output and consumer prices, exactly the opposite is the case for innovations to bank lending that are the result of exogenous lending demand shocks. The latter can be rationalized by an upward impact of such demand shocks on bank lending rates, in contrast to declining rates for shocks on the supply side of the loan market.

Overall, the macroeconomic relevance of bank lending shocks is considerable, accounting for more than half of the forecast error variance in economic activity at the one- to three-year horizon. The majority of these effects, i.e. approximately one-third of output variation, are the result of shocks to the lending multiplier. Positive disturbances to the multiplier boosted activity between 2001-2003 and again in the period 2005-2007, whereas negative innovations contributed significantly to the recession afterwards. Even more striking is the relevance for inflation fluctuations. The contribution of bank lending shocks to inflation variability in the short run (e.g. six months horizon) is negligible, i.e. the forecast error variance of consumer prices is mainly driven by "other" (real) shocks. In contrast, disturbances to the banking sector matter from the one-year horizon onwards and explain up to 75 percent of the long-run forecast error variance. The bulk of inflation variability is again driven by shocks to the lending multiplier.

In a second step, I examine the underlying source and transmission mechanism of the identified multiplier shocks in more detail by adding some additional variables one-by-one to the benchmark VAR model, which is then each time re-estimated. This analysis suggests that these innovations mainly capture shocks to the risk-taking appetite of banks, which have been triggered by shifts in long-term interest rates that are orthogonal to real economy disturbances and monetary policy. In a nutshell, the dynamics of a typical expansionary lending multiplier shock in the sample period can be described as follows. When government bond yields decline, banks tend to reduce the volume of on-balance government loans and securities in order to increase the supply of more risky lending to the private sector, which in turn spurs economic activity and inflation. In a second stage, banks' liabilities also start to increase, which further boosts the supply of bank loans, output and inflation. The latter triggers an immediate tightening of the monetary policy

rate, which lasts more than two years.

These findings complement recent studies that exhibit a link between interest rates and risk-taking by banks. Ioannidou et al. (2009) and Jiménez et al. (2009) document that banks tend to issue more risky loans when policy rates are low. Whereas these studies find changes in the composition of loans to the private sector, I find substitution between the overall volume of loans to the private sector and less risky lending to the government sector. In contrast to Jiménez et al. (2009), I find a negative relationship between bank risk-taking and shifts in long-term interest rates that are orthogonal to the policy rate, while they report less or no such behavior for changes in long rates. More generally, whilst both studies document a link between risk-taking and interest rates with micro datasets, the present paper demonstrates that it matters for macroeconomic fluctuations.

From a theoretical point of view, the results are in line with Rajan (2005), who argues that low returns on risk-free securities such as government bonds could create incentives for banks to search for higher yields in more risky projects, and with the literature on the so-called risk-taking channel of monetary transmission which argues that lower interest rates increase the value of outstanding bank loans leading to more risk appetite of the banking system (e.g. Borio and Zhu 2008; Adrian and Shin 2009).

Finally, the results are at odds with the literature which finds that a fall in the term spread predicts a future decline in real economic activity and inflation (e.g. Estrella and Hardouvelis 1991; Mishkin 1990). The implicit presumption of this literature is that a fall in the term spread captures lower expected inflation and expectations of easy monetary policy, which are in turn associated with lower output growth. However, the opposite should be the case after lending multiplier shocks that are triggered by a shift in long-term interest rates. Specifically, such shocks are characterized by increasing short-run interest rates, falling long-term rates, and are followed by rising economic activity and inflation. When I estimate the predictability of the yield curve for future euro area economic activity over a rolling window, I indeed find that the correlation declines and even becomes significantly negative for periods when lending multiplier shocks were also the dominant driving force of the euro area business cycle in the SVAR estimations.

The rest of the paper is structured as follows. In the next section, I discuss the model and data that will be used for the estimations. The identification strategy to disentangle the shocks is presented in section 3, and the estimation results in section 4. A detailed analysis of the source and transmission mechanism of lending multiplier shocks is conducted in section 5. Finally, section 6 concludes and discusses some policy implications.

2 Baseline VAR model and data

I start by presenting the baseline model and data that will be used for decomposing innovations to bank lending into mutually orthogonal components in the rest of the paper. Consider a VAR with the following representation:

$$Z_t = \alpha + A(L)Z_{t-1} + B\varepsilon_t \tag{1}$$

where Z_t is a vector of endogenous variables containing the seasonally adjusted natural logarithms (multiplied by 100) of respectively output (y_t), prices (p_t), the volume of bank loans (l_t), the monetary base (b_t), the level of the interest rate on bank loans (i_t), and the level of the monetary policy rate (s_t). α is a vector of constants, $A(L)$ is a matrix polynomial in the lag operator L, and B the contemporaneous impact matrix of the mutually uncorrelated disturbances ε_t. The VARs in this study are estimated in (log) levels, which allows for implicit cointegrating relationships in the data (Sims et al. 1990). A more explicit analysis of the long-run behavior of the various variables is limited by the relatively short sample available. In particular, the VARs have been estimated with monthly data over the sample period 1999M6-2010M8. Based on standard likelihood ratio tests and the usual lag-length selection criteria, the estimations include four lags of the endogenous variables.[3]

All data are obtained from the ECB Statistical Data Warehouse. The series for the benchmark VAR can be found in Figure 1. Since I am using monthly data, I proxy economic activity by the index of industrial production and prices by the HICP. The monetary base is defined as the sum of banknotes in circulation and bank reserves (credit institutions current accounts and deposit facility). Conclusions are, however, similar when employment or unemployment are used as output measures, when core HICP is used as a price measure or when the monetary base is replaced by bank reserves or the volume of liquidity providing operations of the Eurosystem.[4]

The ECB mainly conducts its policy by steering the EONIA. The desired level is signalled to the markets through either the minimum bid rate of variable rate tenders or the rate applied to fixed rate tenders in its main refinancing operations (MRO). Notice that, as a consequences of several non-standard policy actions, the EONIA has been systematically

[3] Most criteria even suggest a shorter lag length. The results are however robust for different choices of lag length.

[4] Extending the VAR with oil prices does also not affect the results. All these and other robustness checks reported in the paper are available upon request.

lower than the MRO rate after September 2008. To capture these effects, I use the EONIA as the policy rate in the estimations (see Ciccarelli et al. 2010 for a similar application).

Over the past decade, there has been an expansion in securitization activity in the euro area. In the context of the present study, it is important that these developments are accommodated when the volume of bank lending is measured. More specifically, true-sale securitization could drive a wedge between actual fluctuations in bank lending and that derived from monetary financial institutions (MFI) balance sheet statistics due to the accompanying transfer of loans off the MFI balance sheet.[5] Similarly, as markets for various asset-backed securities became illiquid during the financial crisis, there was a lot of re-intermediation of loans onto MFI balance sheets, without a corresponding increase in actual lending. To take these evolutions into account, the ECB publishes a monthly index of MFI loans to the private sector adjusted for sales and securitization, which I use as a measure for the volume of bank loans in the estimations.

Finally, for the interest rate on bank lending, I construct a composite lending rate which is a weighted average of interest rates charged by MFI's on (new business) loans to households and non-financial corporations.[6] As can be seen in Figure 1, which also contains the EONIA and the 10 year government bond yield as a proxy for respectively bank funding conditions and the opportunity cost of bank lending, bank lending rates seem to have fluctuated in a similar way as the monetary policy rate. Nevertheless, as also shown in the figure, the spread between both rates has not been constant over the sample period. The same is true for the spread between lending rates and government bond yields, suggesting they might have been influenced by bank market disturbances. The panel also contains a measure of the term spread, i.e. the difference between the 10 year government bond yield and the EONIA, which will be relevant for the discussion in section 5.

[5] In the case of true-sale securitization, the loan is transferred from the bank's balance sheet to that of a financial vehicle corporation, which reduces the recorded volume of MFI loans in statistical terms, while the loan is still outstanding from the perspective of the borrower. In contrast, synthetic securitization only transfers the associated credit risk, whereas the loan itself remains on the balance sheet of the bank. See also Adrian and Shin (2010) for the increasing role of market based financial intermediaries and the relevance of these aggregates in the U.S.

[6] Since January 2003, the ECB publishes monthly interest rate series for different types of loans, as well as the corresponding volumes to calculate the weights. For the period 1999-2002, however, no volume data are available. For this period, I use the average weights over the 2003-2010 period. The results are not sensitive for using constant or time-varying weights for the 2003-2010 period. I thank the ECB for providing the lending rates before 2003.

3 Disentangling different types of lending disturbances

The ultimate consequences of innovations to bank lending may depend on the underlying source of the innovation. In particular, the impact of a surge in bank lending could be different if the underlying shock is supply or demand driven, or if the surge is due to a shift in monetary policy versus a shock in the banking sector. In this section, I propose a strategy to identify three different types of innovations to lending with a structural economic interpretation. I use a mixture of zero and sign restrictions on the contemporaneous impact matrix B of equation (1) to decompose shocks on the demand and supply side of the lending market. The restrictions are intuitively very appealing and consistent with a large class of theoretical models, including the textbook IS-LM model extended with bank lending (e.g. Bernanke and Blinder 1988). The set of restrictions to uniquely disentangle lending demand, monetary policy and lending multiplier shocks can be summarized as follows:[7]

Identification of different types of bank lending shocks

	y_t	p_t	l_t	i_t	b_t	s_t	$l_t - b_t$
Shock 1							
Shock 2	0						
Shock 3	0	0					
Loan demand shock	0	0	$\uparrow^{lagged}$	$\uparrow$			
Monetary policy shock	0	0	$\uparrow^{lagged}$	$\downarrow$		$\downarrow$	
Lending multiplier shock	0	0	$\uparrow^{lagged}$	$\downarrow$		$\uparrow$	$\uparrow$

y_t = output, p_t = prices, l_t = volume of loans, i_t = lending rate, b_t = monetary base, s_t = EONIA

First, shocks that are specific to the lending market need to be distinguished from other macroeconomic disturbances that could influence bank lending, in particular the demand for bank loans.[8] These real economy disturbances (captured by shock 1 and 2), as well as non-identified bank lending shocks (shock 3), will be aggregated and labeled as "other" shocks when results are reported. I simply follow the conventional approach in the literature by assuming that there is only a lagged impact of lending market disturbances on output and prices, i.e. the contemporaneous impact on both variables is restricted to be zero. In contrast, innovations to output and prices are allowed to have an immediate

[7] Note that the sign restrictions are implemented as $\geqslant$ or $\leqslant$, which implies that a zero impact is also possible.

[8] Examples are technology, labor market, government spending or aggregate demand shocks.

impact on the volume of bank loans, the monetary base, the interest rate on bank lending and the policy rate. Despite being a conservative assumption, restraining the contemporaneous impact of nominal disturbances on real variables is considered as being plausible for monthly estimations and allows for comparability with previous results.[9] Notice that there are four remaining variables in the VAR while only three disturbances are explicitly identified. Hence, all innovations which are specific to the banking market that do not fulfill the restrictions of one of the identified lending shocks are captured by shock 3 in the estimations.

Loan demand shocks Innovations to lending demand that are not driven by fluctuations in the real economy are referred to as *exogenous lending demand shocks*. These shocks could for instance be the consequence of changes in the access to alternative forms of finance or shifts in borrowers' preferred volume of lending. A lending demand shock is simply identified by a positive (or non-negative) co-movement between the volume of bank loans and lending rate innovations. Conversely, the shocks that lead to a negative (or non-positive) co-movement between the interest rate and the volume of bank loans are considered as shocks on the supply side of the lending market.[10]

In the empirical analysis, the sign restrictions are imposed on the immediate impact and the following four months after the shocks. An exception is the response of the volume of bank loans, for which the restrictions are only imposed on the third and fourth lag after the disturbances. This should allow a possible short-run rise of bank lending after a rise in the interest rate. Giannone et al. (2009) find that an unexpected interest rate hike only affects consumer loans and loans for housing purposes negatively on impact, while

[9] E.g. Bernanke and Blinder (1992) amongst others make the same assumption for the identification of monetary policy and other nominal shocks in the US. Several studies even make this assumption using quarterly data, e.g. Christiano et al. (1999) or Peersman and Smets (2003). As an alternative, I have also considered identification strategies which do allow for feedback of disturbances that are specific to the lending market to economic activity and consumer prices within the period, but it turned out that the results are not very sensitive to this assumption. For instance, when I impose the restriction that output moves in the same direction as prices and in the opposite direction as the interest rate for all bank market disturbances on impact, the estimated magnitudes of the immediate effects are negligible and the impact becomes more or less the same after a few months. On the other hand, the contemporaneous output and inflationary effects are insignificant when both variables are left unrestricted for the two supply shocks that move the volume of bank loans and lending rates in the opposite direction. An implicit assumption is then that shocks originating in the real economy all move the volume of loans and lending rates in the same direction or, in other words, a disturbance that boosts economic activity shifts the demand curve for bank loans to the right. Again, the conclusions of the paper are not affected.

[10] Notice that I assume that shocks to net worth, which could also lower interest rates whilst increasing the volume of lending, are captured by shock 1 and 2 in the estimations. Put differently, they are assumed to have an immediate effect on output or prices. It is also worth mentioning that, when I add equity prices to the VAR, the contemporaneous impact of a lending multiplier shock on equity prices turns out to be insignificant. This indicates that the identified multiplier shocks are indeed not innovations to net worth.

the component loans to non-financial corporations respond negatively with a lag, but positively on impact (see also Den Haan et al. 2007). Firms could, for instance, still draw on their credit lines at a prespecified rate when the interest rate on new loans increases.[11] Notice also that, due to the aggregation level of the dataset, this identification strategy does not take into account possible changes in the composition of bank loans. Banks could, for instance, increase the supply of loans to riskier firms at a higher interest rate. In the estimations, such shocks will be identified as loan demand shocks.[12]

Monetary policy shocks Lending conditions could obviously be influenced by monetary policy. An expansionary *monetary policy shock* is expected to increase the supply of bank loans. According to the conventional monetary transmission mechanism, a decline in the policy rate reduces other interest rates and stimulates bank lending. These are also the restrictions that I impose to identify an innovation to lending supply which is caused by a monetary policy shock. It is important to mention that monetary policy shocks are only identified if they ultimately affect the supply of bank loans, i.e. policies that influence the economy beyond financial intermediaries are not identified. However, given the central role of banks for channelling funds from savers to investors in the euro area, most effects should be captured by this shock and results could be compared with other studies that identify monetary policy shocks in a more traditional way.

Lending multiplier shocks Bank lending could also increase due to additional credit supplied by banks independently of a shift in monetary policy. Consider, for instance, an innovation that makes it easier or more profitable for financial institutions to securitize their loans, such as increased risk-appetite of investors who want to buy more asset backed securities. This allows banks to increasingly fund themselves by selling loans in the secondary market and boosts their ability to supply new loans for a given policy stance. In contrast to the US, securitization activities in the euro area have been developing more recently. Enhanced financial market integration as a consequence of the new currency and a rising importance of non-bank financial intermediaries such as investment funds have created a larger investor base and hence, have facilitated the placement of financial assets

[11] In the end, also this assumption did not seem to matter since the immediate response is always in line with the subsequent months for all three disturbances.

[12] For an analysis of the impact of monetary policy on the composition of credit supply, I refer to Jiménez et al. (2009) or Ioannidou et al. (2009). Jiménez et al. (2009) find an expansion of credit to riskier firms and riskier new applicants after a policy easing, whereas Ioannidou et al. (2009) find that a decline in the federal funds rate spurs the granting of new loans to riskier borrowers at a lower interest rate spread. The latter is actually in line with the identifying restrictions.

originated by banks. As a consequence, the issuance of euro-denominated asset-backed securities increased from around €50 billion in 1999 to almost €400 billion in mid-2007 (ECB 2008). Other examples of disturbances that could influence the supply of bank loans independently of a policy decision are shocks to risk-taking by banks or financial innovations such as credit risk transfer instruments. The notional amount outstanding in the global credit default swap market rose for instance from virtually zero in 2001 to around $60 trillion at the end of 2007 (ECB 2008). Several of these advances in bank risk management have allowed an improved allocation and dispersion of risk which in turn may have enhanced the ability of banks to expand their balance sheets. On the other hand, unfavorable shocks to the supply of lending that are orthogonal to monetary policy have very likely played an essential role during the financial crisis. In particular, when funding conditions deteriorate, the capacity of banks to supply loans relative to the amount of liquidity provided by the central bank decreases. The deterioration of the securitization and credit derivatives markets should at least temporarily have hampered the upward effects of credit risk transfer activities on loan supply.[13]

A positive loan supply shock that is independent of a policy action is assumed to increase the lending multiplier. The latter can be calculated as the difference between the (log) responses of bank loans and the monetary base and captures the volume of bank loans that is generated by the financial sector with a specific amount of central bank money. Hence, I label such shocks as *innovations to the lending multiplier*. All that is required is that banks are somehow able to obtain extra funding in the market to finance the additional loans, which could be either deposits, other liabilities, or a reduction in other asset categories such as government bonds. The restriction on the lending multiplier should help to disentangle the shocks from monetary policy measures aimed at influencing financing conditions and the flow of credit beyond the ECB's main policy rate. For instance, changes in the allocated volume of liquidity in its main and longer term refinancing operations in the pre-crisis period or outright purchases of covered bonds as a response to the financial crisis could also have influenced the supply of lending at a given policy rate. Such measures, however, typically reduce the lending multiplier (denominator effect).[14] In addition, I impose the restriction that the ECB reacts to a positive lending multiplier shock by increasing the policy rate. Put differently, given the weak sign restrictions, the policy rate will at least not decline on impact. A policy tightening is consistent with a

[13] Notice that deteriorations in bank funding conditions will only be identified as lending multiplier shocks when the overall volume of lending by the banking sector is affected, which is not necessarily the same as lending within the banking sector.

[14] See Peersman (2011) for an explicit identification of such non-standard monetary policy disturbances, which indeed turn out to reduce the multiplier the first twelve months after a shock.

central bank that tries to stabilize the output and inflation consequences, like in a Taylor rule, and helps to distinguish the shocks from monetary policy shocks on the supply side of the lending market.

Notice that lending multiplier shocks could also be the consequence of depositors substituting deposits into currency since this limits the capacity for banks to offer loans. If banks cannot perfectly substitute to other sources of funding, loan supply and the multiplier decline. In traditional textbooks, such disturbances are considered as the main driver of changes in the multiplier.[15] That's also why the monetary base should be used to calculate the multiplier in the estimations. The results are however very similar when I use bank reserves, the volume of liquidity providing operations or the overall size of the central bank balance sheet as an alternative.

4 Estimation results

I use a Bayesian approach for estimation and inference. For details, I refer to Peersman (2005) or Uhlig (2005). The prior and posterior distributions of the reduced form VAR belong to the Normal-Wishart family. To draw the 'candidate truths' from the posterior, I take a joint draw from the unrestricted Normal-Wishart posterior for the VAR parameters as well as a random possible decomposition B of the variance-covariance matrix, which allows the construction of impulse response functions. If the impulse response functions from a particular draw satisfy the imposed restrictions, the draw is kept. Otherwise, the draw is rejected by giving it a zero prior weight. Each draw is required to satisfy the restrictions of all three identified shocks simultaneously. Finally, a total of 1000 successful draws from the posterior are used to produce the figures. I first discuss the estimated impulse response functions in section 4.1. The macroeconomic relevance is examined in section 4.2.

4.1 Impulse response functions

Figure 2 displays the impulse response functions. The shaded (light blue) areas represent the 68 percent posterior probability regions of the estimated impulse responses to

[15] A popular textbook version (e.g. Mishkin 2010) of the multiplier is $\frac{1+c}{r+e+c}$, where r is the required reserves ratio, e the excess reserves ratio and c the currency ratio. Hence, if some proceeds from loans are used to raise the holding of currency, the multiplier declines. Put another way, a rise in the monetary base that goes into deposits is multiplied, whereas an increase that goes into currency is not multiplied.

one standard deviation innovations. The identified bank lending shocks all have a significant impact on output and consumer prices. The hump-shaped output pattern and more sluggish but persistent price response to a loan supply shock which is caused by monetary policy are broadly in line with the pre-EMU VAR evidence on the monetary transmission mechanism (e.g. Peersman and Smets 2003), and the existing evidence for the U.S. (e.g. Bernanke and Blinder 1992 or Christiano, Eichenbaum and Evans 1999) who identify monetary policy shocks in a more direct way. There is also a so-called liquidity effect of monetary policy, i.e. the money aggregate directly controlled by the central bank (monetary base) rises significantly, while the corresponding interest rate falls after a policy easing.

We observe a qualitatively similar output and consumer prices pattern when the rise in the volume of bank credit is driven by a lending multiplier shock. In particular, an innovation to the multiplier tends to be followed by a significant rise in economic activity which reaches a peak after 12-15 months and gradually returns to baseline afterwards. On the other hand, consumer prices rise permanently. Hence, innovations to the supply of bank lending that are independent of a policy action do result in stronger aggregate spending. The latter explains the persistent rise in the policy rate which lasts for about two years. Noticeable is the estimated significant decline of the monetary base for more than one year, which suggests that the additional lending by banks is fully generated with alternative sources of liquidity.

The results further reveal that the underlying disturbance is crucial to determine the ultimate repercussions on the economy. In particular, when a surge in lending is driven by an exogenous increase in the demand for bank loans, there is a significant decline in economic activity and consumer prices after a while, which contrasts with both shocks on the supply side of the market. These opposing effects could be rationalized by the upward impact of lending demand shocks on bank lending rates, whereas the interest rate declines after supply side shocks. An increase in the volume of bank lending does hence not necessarily requires a policy tightening. Surprisingly, the ECB seems not to take the source into account in the very short run since the initial policy rate response turns out to be very similar for exogenous lending demand and multiplier shocks, i.e. restrictive when the volume of bank loans rises.

4.2 Macroeconomic relevance

Forecast error variance decompositions Figure 3 shows the forecast error variance decompositions for all variables from the benchmark VAR model. To preserve orthogonality between the shocks and guarantee that variance shares sum to one, the figures show the variance decompositions obtained with the median target method proposed by Fry and Pagan (2007).[16] The relevance of bank lending disturbances in explaining macroeconomic fluctuations is considerable. Overall, at the 1-3 years forecast horizon, the shocks account together for more than half of output variability. The majority of these effects are driven by shocks to the lending multiplier, accounting for approximately one-third of output variation. On the other hand, exogenous lending demand and monetary policy shocks explain together around 20 percent of expected output fluctuations in the medium term.[17]

The contribution of bank lending disturbances to consumer prices volatility is even more striking. In the very short run, there is little contribution to inflation variability, i.e. consumer price fluctuations are mainly driven by "other" shocks. Only after six months, lending shocks start to matter for inflation. However, at longer horizons, and in particular from the one year horizon onwards, bank lending disturbances clearly dominate, explaining more than two-thirds and up to 75 percent of consumer prices variability. This finding is actually in line with the ECB's monetary policy strategy, i.e. the monetary analysis focusing on longer-term price developments and the economic analysis rather focusing on short to medium-term inflation determinants.[18] Again, the bulk of long-run consumer prices variability is explained by lending multiplier shocks, being around 40 percent.

In the monetary analysis of the ECB, strong credit expansion is typically interpreted as an upward risk to price stability, requiring a more restrictive policy stance. The results in

[16] An alternative would be to show the median values of the posterior distributions. This would however imply that the reported values i) over the forecast horizon, ii) across variables and iii) across shocks, are not simultaneously generated by a single model but come from different models. Accordingly, there is no longer guarantee that the implied shocks are uncorrelated and sum up to one (Fry and Pagan 2007). For the impulse response functions, this is not really a problem since they are only a description of a range of possible outcomes. It is also important to note that the median values of the posterior lead to similar conclusions.

[17] The relevance of lending multiplier shocks in explaining output fluctuations turns out to be higher than Hristov *et* al. (2011) and De Nicoló and Lucchetta (2010). Hristov *et* al. (2011) consider real GDP instead of industrial production, and estimate the effects of loan supply shocks for a panel of individual Euro area countries rather than aggregate variables. De Nicoló and Lucchetta (2010) consider G-7 countries and a sample period which starts in 1980. A further analysis of the differences is out of the scope of this paper.

[18] Interestingly, fluctuations in lending aggregates seem to contain much more information about future inflation than money aggregates. In particular, when I re-estimate the SVAR replacing bank loans by M3 and the bank lending rate by the 3-months Euribor, i.e. identifying money demand, monetary policy and money multiplier shocks, the role of these disturbances for future inflation variability is substantially lower.

Figure 3 show, however, that exogenous lending demand shocks are important contributors to the variability of the volume of bank loans in the short run, for which actually no tightening is required. In contrast, from the impulse response analysis, we know that a surge in bank lending as a result of an exogenous lending demand shock has a downward impact on output and prices due to the accompanying interest rate hike. A comprehensive analysis of the composition of credit growth is therefore crucial to assess the consequences for the outlook of price stability and to determine the appropriate policy response. The variance decompositions further reveal that fluctuations in bank lending rates are in the short run mainly the result of shocks that are specific to the banking market, whereas other (real economy) shocks are the dominant driving force at longer horizons.

In-sample decomposition of the euro area business cycle The relevance of the three identified bank lending shocks for output fluctuations is confirmed by the historical contribution of the shocks to the evolution of euro area industrial production in Figure 4. Panels A to D plot the deviation of actual annual industrial production growth from baseline, together with the estimated contribution of respectively lending demand, monetary policy, lending multiplier and the sum of all three bank lending shocks. Baseline industrial production growth is measured by the (median) unconditional forecast of annual industrial production growth, that is in the absence of any shock. The contribution of the shocks is calculated as the difference between the forecast of industrial production growth conditional on the estimated series of shocks under consideration and the unconditional forecast. The figures contain the medians (dotted blue lines), as well as the 68 percent probability regions of the forecasts (shaded blue areas). Note that this is an in-sample analysis based on the estimated VAR over the whole sample period.

As can be seen in Figure 4, except for negative loan demand shocks between 2002 and 2004, monetary policy and loan demand shocks were never crucial to explain deviations of industrial production growth from baseline within the sample. This contrasts with the contribution of lending multiplier shocks. Except for the 2002-2004 period, innovations to the supply of bank loans that are independent of monetary policy actions were clearly the dominant driving force of fluctuations in the euro area business cycle. More specifically, disturbances to the multiplier explain why industrial production growth was below trend in the second half of 2000 and the beginning of 2005, and in particular the boom in activity between mid 2005 and the second half of 2007. In the latter period, innovations to the multiplier alone explain almost perfectly the evolution of industrial production growth. Finally, a series of unfavorable multiplier shocks starting in the summer of 2007 also made

a significant, albeit not exclusive, contribution to the recession of 2008-2009. This finding is consistent with Hristov *et* al. (2011).

5 Source of lending multiplier shocks

Lending multiplier shocks are obviously a combination of several disturbances influencing the supply of bank loans. As discussed in section 3, popular examples are shocks to risk-taking by banks, fluctuations in securitization activities or innovations in credit derivatives markets. In order to better understand bank loan supply within the sample period, the underlying sources of the identified lending multiplier shocks are examined in more detail in this section. Specifically, I have re-estimated the benchmark VAR model by adding each time an additional variable of interest to the block of bank market variables. The identifying restrictions are exactly the same as in the benchmark model and the response of the additional variable is not restricted on impact. The results for each variable can be found in Figure 5.[19] Notice that this approach does not allow to pin-down whether the contemporaneous response of the additional variable represents the consequence of a lending multiplier shock or the source which triggered the shock. It should rather be interpreted as the correlation between the innovation to the additional variable and the shock. A number of interesting observations can nevertheless be made.

Currency substitution, securitization versus risk-taking shocks If banks cannot perfectly substitute to other sources of funding, innovations to the lending multiplier could be the consequence of changes in the currency-to-deposits ratio. When agents convert some of their currency into deposits, the capacity for banks to grant additional loans increases. The de-hoarding of currency in the run-up to the euro cash changeover in 2002 and the gradual re-hoarding of currency afterwards could for instance have influenced the supply of loans by banks. To check this hypothesis, panel A of Figure 5 contains the impulse response of the currency ratio (calculated as the ratio currency in circulation/M3) to the identified lending multiplier shock. There is indeed a significant decline in the currency ratio, but only after 4 months. Hence, portfolio shifts between deposits and currency could have magnified innovations to lending multiplier, but given the zero contemporaneous impact, it is not likely that they have triggered the innovations.

Loan supply and multiplier shocks could also have been caused by innovations to

[19] Due to space constraints, I only show the impulse response function of the additional variable to the lending multiplier shock.

securitization. When it is easier for banks to repackage and sell part of their assets, they have access to additional funding, which could be used to supply new loans. The large growth of securitization markets between the introduction of the euro and the financial turmoil has often been considered as an important source of lending activities by banks during that period. In its Monthly Bulletin of February 2008 (p 88), for instance, the ECB states *"Furthermore, by fully removing loans from their balance sheet, banks have been able to obtain regulatory capital relief and have used it to expand the supply of loans. In this respect, the large increase in securitisation probably contributed to the strong loan growth and favourable lending standards from early 2005 to the first half of 2007"*. Data on the volume of securitization are unfortunately not available from the Eurosystem's data warehouse. They only publish an index of MFI loans to the private sector adjusted for sales and securitization, which has been used in the benchmark estimations, as well as an index of retained loans on the balance sheets of MFIs. To learn more about the role of securitization activities, panel A of Figure 5 shows the relative response of both variables to a lending multiplier shock. Interestingly, after a typical lending multiplier shock, retained loans on balance sheets of banks turn out to increase relatively more than the issuance of new loans in the short run. Only after more than two years, the volume of loans adjusted for securitization increases more than the volume of loans on MFI balance sheets. This finding suggests that the identified lending multiplier shocks are not driven by innovations in securitization markets but rather capture shocks to the incentive of banks to hold more or less loans on their balance sheets.[20]

Composition of bank balance sheets To analyze more carefully what exactly happens on banks' balances, panels B and C of Figure 5 show the impulse responses of several components on the assets and liabilities side of MFI's balance sheets to lending multiplier shocks. The estimations reveal that the rise of the volume of bank loans to the private sector is in the short run generated by an on-balance reduction of government loans and securities. The overall volume of loans and securities on banks' balance sheets does not even increase the first twelve months after the shock. This suggests that the identified lending multiplier shocks mainly represent changes in the (on-balance) risk-taking appetite of banks. Specifically, banks tend to reduce the volume of low-risk government bonds in order to increase more risky lending to the private sector, which is further confirmed by the

[20] This finding does not necessarily mean that securitization shocks do not have an impact at the macro level. They clearly do not dominate. Micro results also suggest that the impact of securitization on bank lending may be time varying or depend on the type of borrowers (e.g. Jiménez *et* al. 2011; Carbo *et* al. 2011).

simultaneous and significant increase in the volume of shares (and equity) on the balance sheets of banks.

Given the fact that the total volume of loans and securities does not increase on impact, there are also no significant alterations to the liabilities side in the very short run that could be the source of lending multiplier shocks.[21] Only after a while, all liabilities start to rise, which amplifies the capacity of banks to grant new loans. The category which ultimately responds the most at the liability side is M3-M2, i.e. repurchase agreements, debt securities and money market funds shares with a maturity up to two years. In sum, the identified lending multiplier shocks which explain more than 30 percent of euro area output variation are mainly caused by innovations to the risk-taking appetite of banks, who reduce their volume of government securities in order to supply more loans to the private sector in a first stage. In a second stage, banks' liabilities also start to increase, which further boosts the supply of bank loans.

Interest rates and spreads But what exactly triggers the changes in the risk-taking appetite of banks and the decision to substitute government bonds for loans to the private sector? As can be seen in Figure 6, the motivation is a search for yield. The figure presents the impulse response functions of some relevant interest rates and spreads to lending multiplier shocks. The bank lending and policy rate are the ones obtained from the benchmark VAR model, whereas the spreads are calculated as the difference between the respective responses for each draw from the posterior. Strikingly, a positive innovation to the supply of lending that is independent of a monetary policy decision is typically accompanied by a significant decline in government bond yields. In particular, 10-year government bond yields decline on average with approximately 8 basis points on impact. Very likely, the shift in long-term interest rates is the trigger of the change in risk appetite of banks and the underlying reason why banks substitute government loans and securities for loans to the private sector on their balance sheets. A reverse causality is not very plausible given the fact that bond yields should rise when banks start selling government securities. In sum, low risk-free rates make government securities less attractive, leading to a search for yield by banks who increase the supply of more risky loans to the private sector. Conversely, higher government bond yields increase the opportunity cost for banks to issue loans, resulting in less supply of new loans.

This finding complements recent empirical studies that find a significant link between

[21] This also explains why innovations to lending aggregates contain much more information about future output and inflation than money aggregates, as discussed in section 4.2.

low policy rates and banks' risk-taking. Ioannidou et al. (2009) find for instance that Bolivian banks take more credit risk and reduce the loan spread when the federal funds rate is low, while Jiménez et al. (2009) find that Spanish banks tend to grant more risky loans and soften lending standards when overnight interest rates are low. Whereas these studies find changes in the composition of loans to the private sector, I find substitution between the overall volume of loans to the private sector and less risky lending to the government sector. Interestingly, Jiménez et al. (2009) report smaller or no such effects for long-term interest rates. In contrast, I find such behavior after a shift in long-term interest rates that is orthogonal to the policy rate.

The evidence is also in line with several theoretical work on bank risk-taking. Rajan (2005) argues that low returns on risk-free securities such as government bonds could create incentives for banks to search for higher yields in more risky projects for instance to meet a nominal return target or because of institutional reasons. Hence, they have an incentive to search for risk when interest rates are low and to become more conservative when they are high. This is consistent with the fact that the reduction in bank lending rates for new loans in Figure 6 is more subdued than the fall in government bond yields, while the corresponding spread increases. On the other hand, Borio and Zhu (2008) and Adrian and Shin (2009) argue that lower interest rates increase the value of outstanding bank loans through an increase in collateral and the expected associated repayment flows. As a consequence, the value of banks' marked-to-market equity rises leading to an increased risk appetite of the banking system, which in turn results in greater loan supply. In particular, financial intermediaries will attempt to find ways to allocate their surplus capital. Borio and Zhu (2008) and Adrian and Shin (2009) refer in this context to the risk-taking channel of monetary policy.

However, as mentioned above, monetary policy is not the source of risk-taking behavior in the present study. In contrast, the Eurosystem reacts to the expansion of loan supply with a significant policy tightening which lasts more than two years. The trigger is instead a decline in the term spread (see Figure 6). The latter is at odds with Adrian et al. (2010), who argue that a flattening of the term spread leads to a contraction in the supply of credit because it reduces net interest margins, making lending less profitable. Since loans offered by banks tend to be of longer maturity than the liabilities to finance the loans, they consider the term spread as being indicative for the marginal profitability of an extra loan. My findings are not necessarily in conflict with Adrian et al. (2010) because they consider a compression of the term spread caused by a policy tightening. In particular, when short-term interest rates rise, the interest margin declines, causing intermediaries to

reduce lending. The causal mechanism is different when there is a fall in the term spread triggered by a decline in long-term interest rates. Banks tend to substitute government bonds for loans to the private sector in order to restore average interest margins. The result is a shift in the supply of bank loans which induces a rise in economic activity. The reduction in the interest rate margin (proxied by the spread between the lending rate and the EONIA in Figure 6) and the term spread as a consequence of the policy tightening seems not to be enough to offset this effect.[22]

Term structure as a predictor of economic activity The results are at odds with the literature that examines the role of the yield curve as a predictor of economic activity (e.g. Estrella and Hardouvelis 1991). This literature documents that a fall in the term spread is typically associated with a future decline in real economic activity. It is even considered as *"one of the most robust stylized facts in macroeconomics"* (Adrian et al. 2010). The implicit presumption is that a fall in the term spread predicts a drop in future short-term interest rates and that these lower rates are associated with lower real GDP growth. The latter can be explained by lower expected inflation and expectations of easy monetary policy. However, following a lending multiplier shock which is triggered by a shift in long-run interest rates, the opposite should be the case. Specifically, an expansionary multiplier shock is characterized by a fall in the term spread which is followed by a rise in economic activity and inflation.

To assess the predictability of the yield curve for euro area economic activity in this context, I have estimated the following regression equation:

$$Y_{t,t+12} = \alpha_0 + \alpha_1 SPREAD_t + u_t \tag{2}$$

where $Y_{t,t+12}$ is the cumulative percentage change in industrial production between month t and month $t+12$, and $SPREAD_t$ the slope of the yield curve measured as the difference between the 10-year government bond yield and the EONIA. The results are shown in Figure 7. The red dotted line represents the estimated value for α_1 over the sample period 1999M1-2010M8, together with 2 standard deviation error bands. Consistent with the existing literature, this coefficient is positive and significant, i.e. a steepening of the yield curve is associated with rising economic activity. However, the blue line with shaded light-blue area error bands shows the same coefficient, but estimated over a rolling window of

[22] Note that a contemporaneous decline of the interest rate spread after a positive innovation to the lending multiplier is implicitly imposed by the identifying restrictions, but the fall turns out to be very persistent.

60 months. As can be seen, there has been a lot of time-variation in the predictability of the yield curve for economic activity. The coefficient was even significantly negative between 1999 and mid-2000. Furthermore, from the end of 2004 onwards, the coefficient started to decline, becoming again negative in the course of 2006. Interestingly, these are also periods when lending multiplier shocks turned out to be the dominant source in explaining the euro area business cycle (see Figure 4 and section 4). Accordingly, a steepening of the yield curve does not always predict rising economic activity. When the reason for the steepening is a rise in long-term interest rates, it may be that banks start to buy more government bonds while reducing the supply of lending to the private sector. The latter depresses economic activity shortly afterwards.

6 Conclusions

In this paper, I have examined the macroeconomic effects of different types of bank lending disturbances on the euro area economy since the launch of the new currency. A number of interesting results came out of the analysis. First, the underlying source of the disturbance is crucial to determine the economic consequences. In contrast to shocks on the supply side of the banking market, surges in lending which are driven by exogenous lending demand shocks have a significant negative impact on output and consumer prices after a while due to the rising impact that the shocks have on bank lending interest rates. Hence, rising credit aggregates do not require a mechanical policy tightening, a feature which is relevant for the monetary analysis of the Eurosystem. Second, the macroeconomic relevance of shocks that are specific to the banking market is considerable, accounting for more than half of output variation and even up to 75 percent of long-run inflation variability. The dominant driving force for both variables turns out to be innovations to bank loan supply that are independent of monetary policy. These disturbances almost exclusively explain the strong output growth above its trend between 2005 and the beginning of 2007. On the other hand, unfavorable loan supply shocks since the summer of 2007 also made a significant contribution to the recession in 2008 and 2009.

A closer inspection of the identified lending supply shocks suggests that these disturbances are mainly caused by alterations to the risk-taking appetite of banks. In particular, when long-term interest rates decline, banks tend to reduce the on-balance volume of government bonds in order to increase more risky lending to the private sector. The latter increases economic activity and inflation, inducing a policy tightening of the Eurosystem. Hence, a decline in the term spread could predict rising economic activity, which turns

out to have been the case for specific periods within the sample. It is therefore crucial to carefully analyze the reason for the shift in the yield curve.

The results of this paper could also be relevant for the transmission of quantitative easing policies and the European sovereign debt crisis to the real economy. In particular, when central banks buy government bonds, long-term interest rates decline, increasing the risk appetite of financial intermediaries and hence the supply of loans. Similarly, rising bond yields reduce the incentives for banks to supply loans to the private sector, resulting in a deterioration of the macroeconomy.

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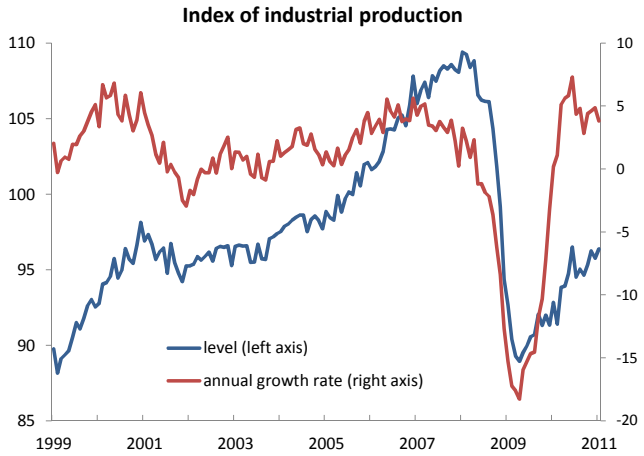
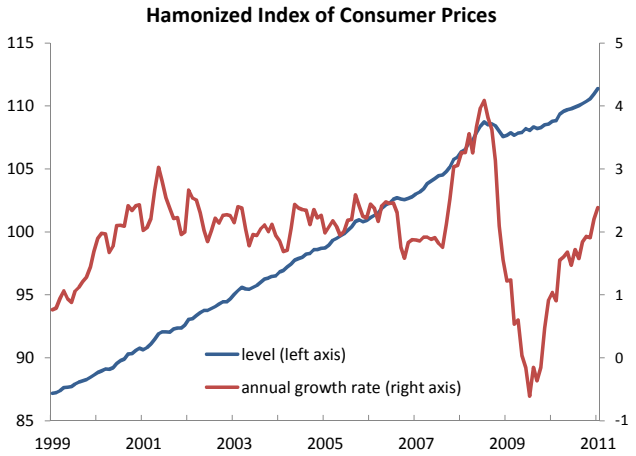
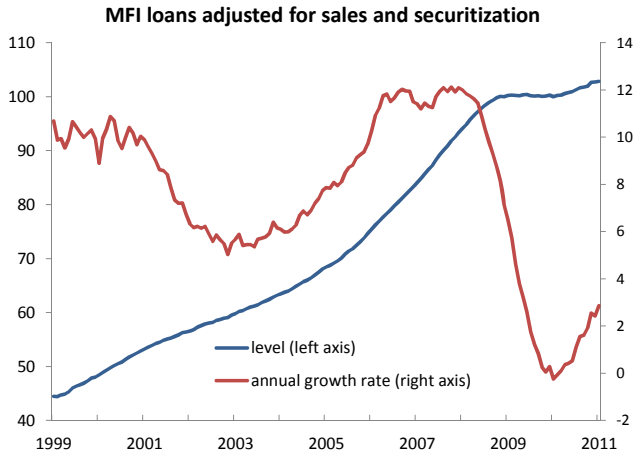
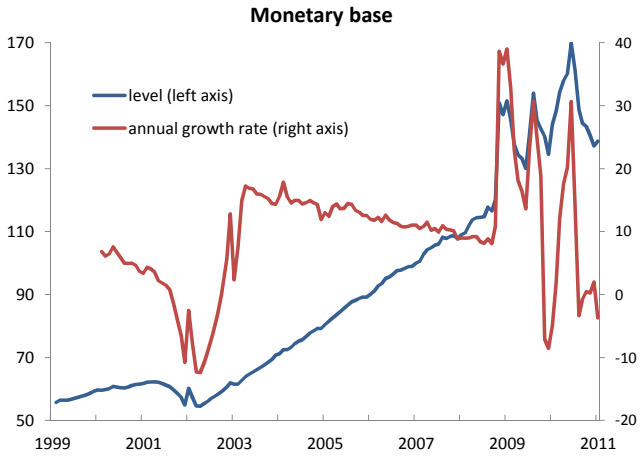
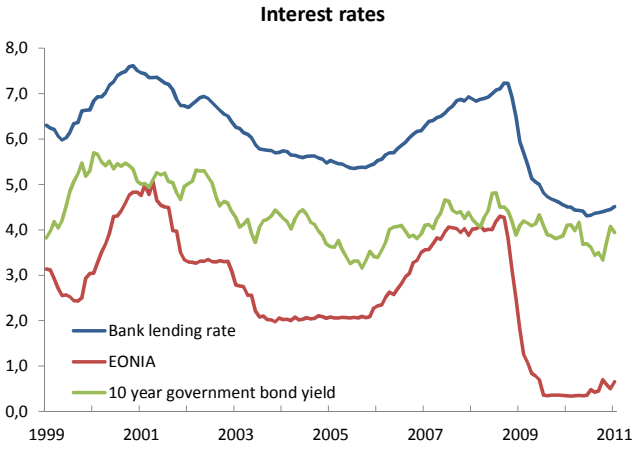
Figure 1 - Data series











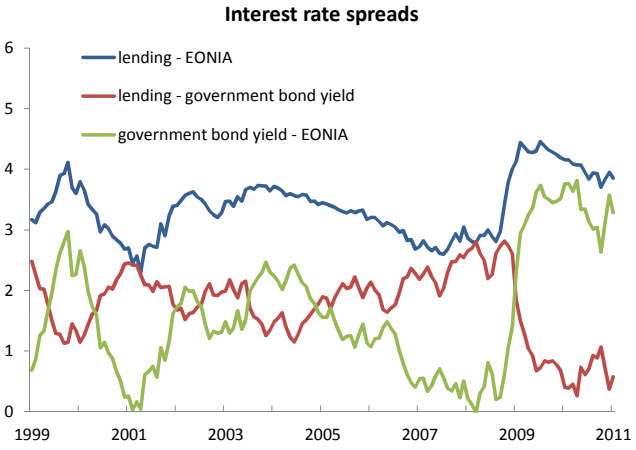
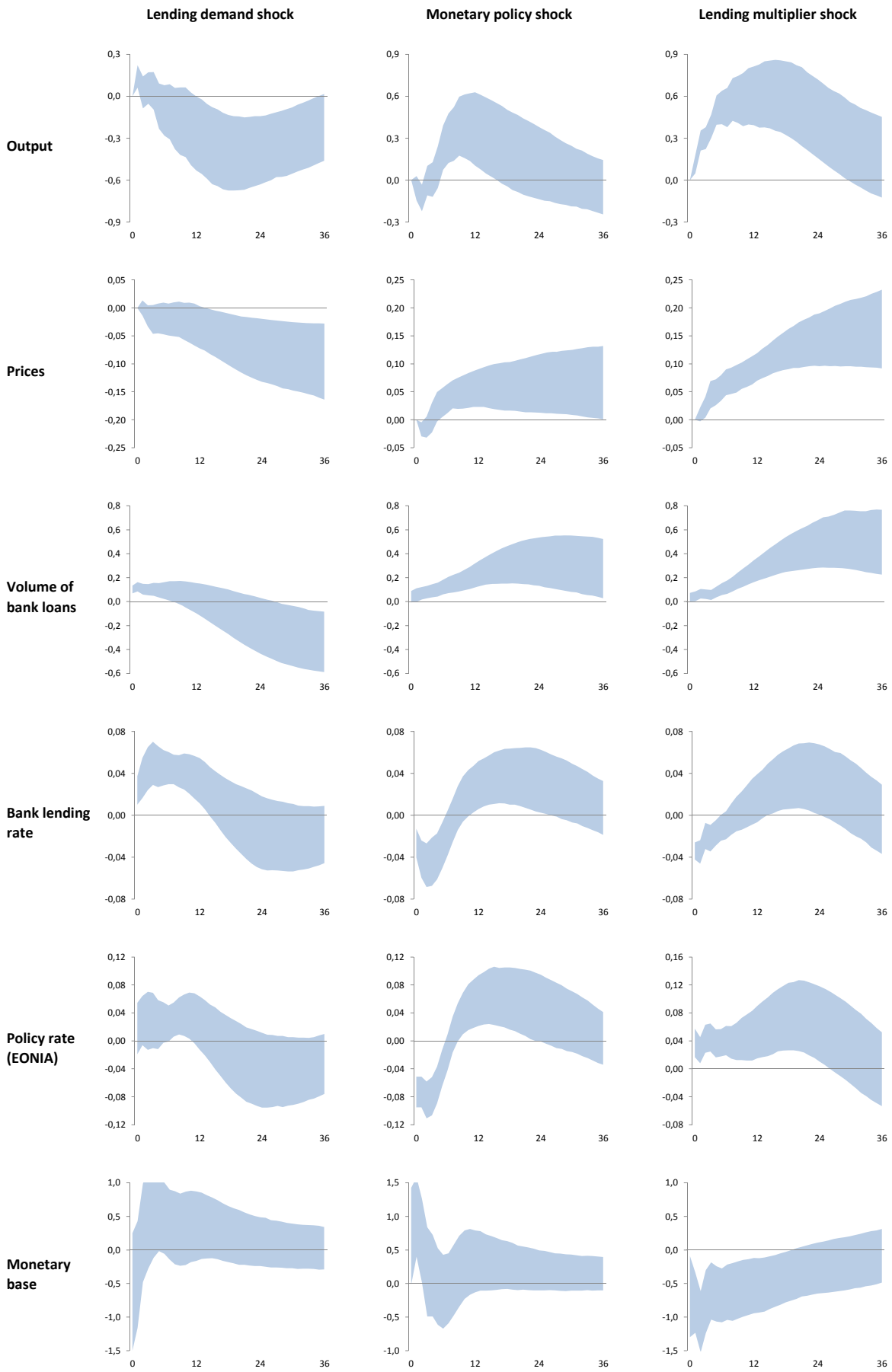
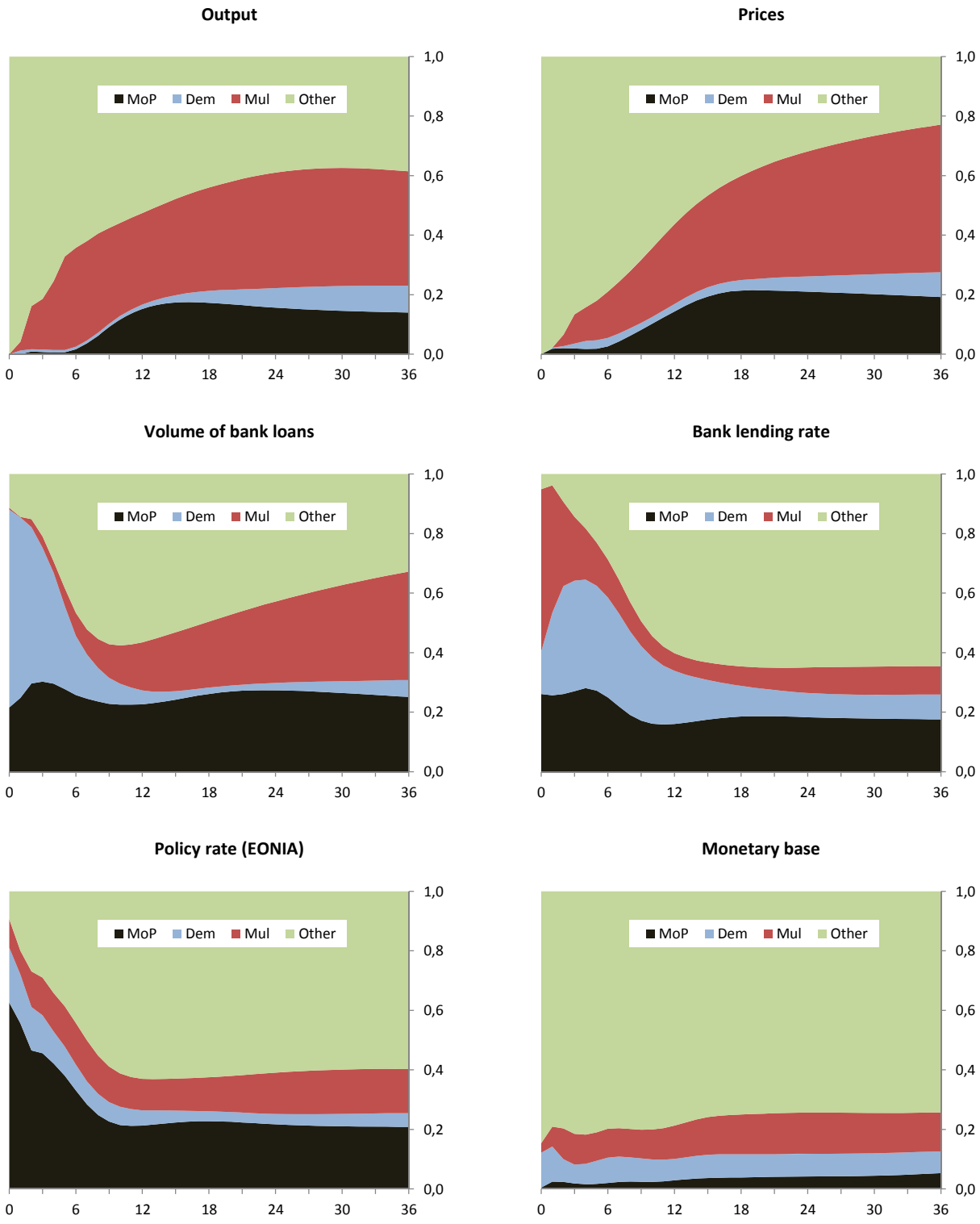


Figure 2 - Impulse responses to different types of bank lending shocks



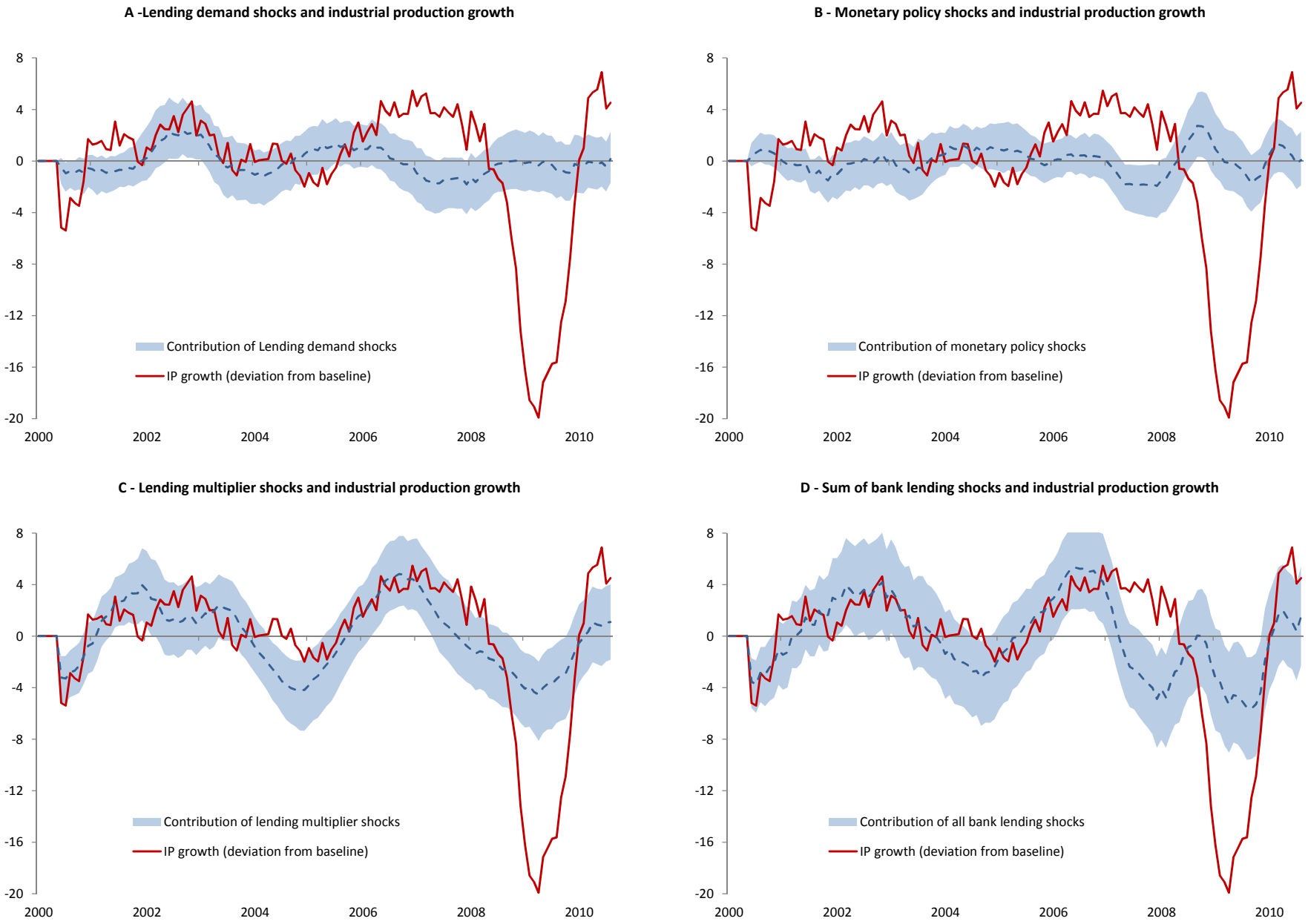
Note: *68 percent posterior probability regions of the estimated impulse responses to one standard deviation innovations, monthly horizon*

Figure 3 - Forecast error variance decompositions



Note: Figures obtained from Fry and Pagan's median target draw; "Mop" = monetary policy shocks; "Dem" = lending demand shocks; "Mul" = lending multiplier shocks; "Other" = other shocks

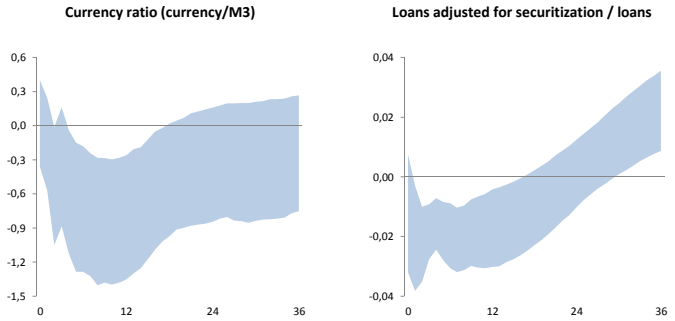
Figure 4 - Bank lending shocks and economic activity in the euro area



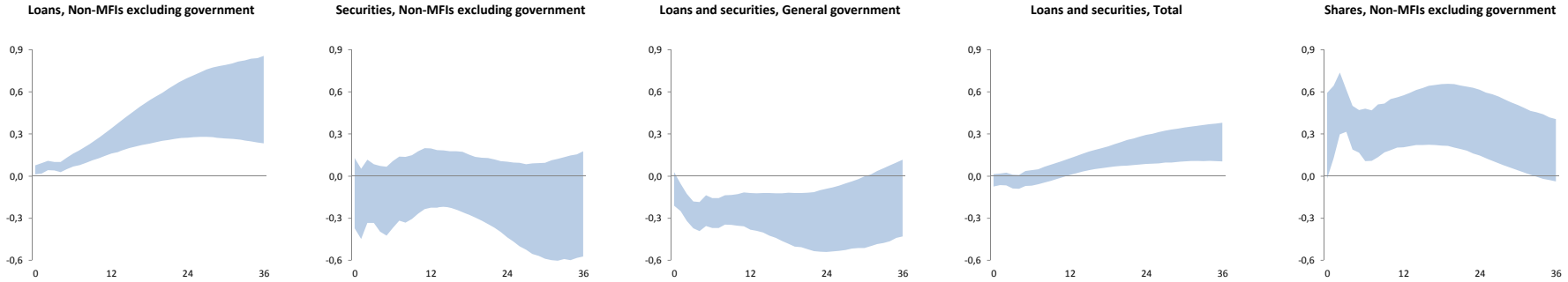
Note: baseline is unconditional forecast of annual Industrial production growth; contribution of shocks is calculated as difference between forecast conditional on the estimated series of shocks and unconditional forecast medians: dotted blue lines, 68 probability regions: shaded blue areas

Figure 5 - Impulse responses of additional variables to lending multiplier shocks

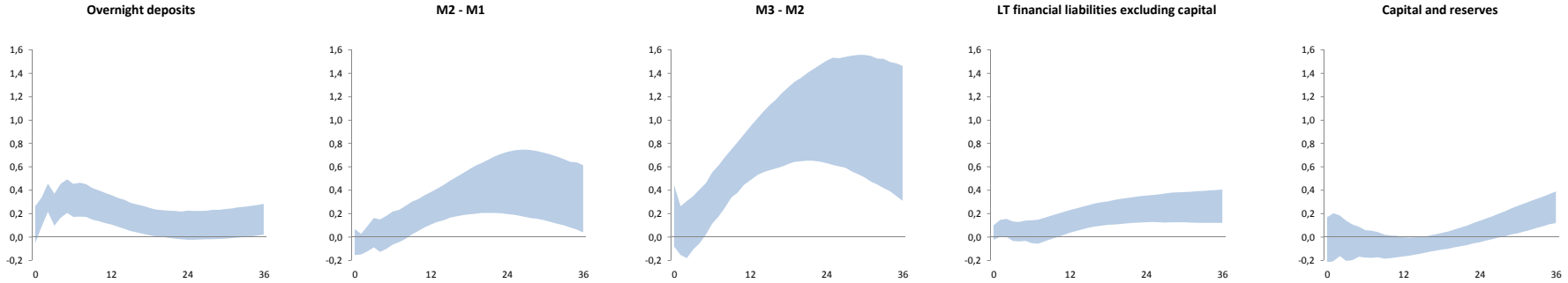
Panel A - Currency ratio and securitization activities



Panel B - Asset side components of MFI balance sheets

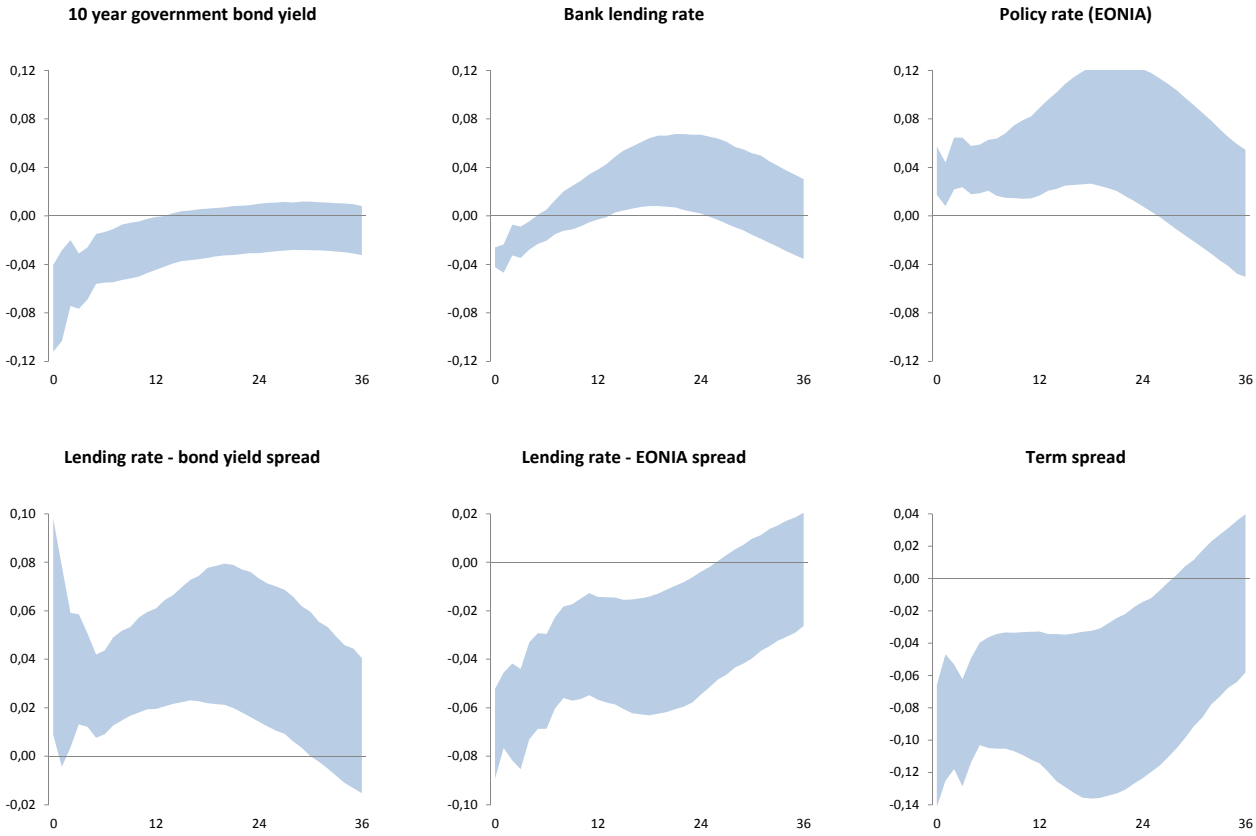


Panel C - Liabilities side components of MFI balance sheets



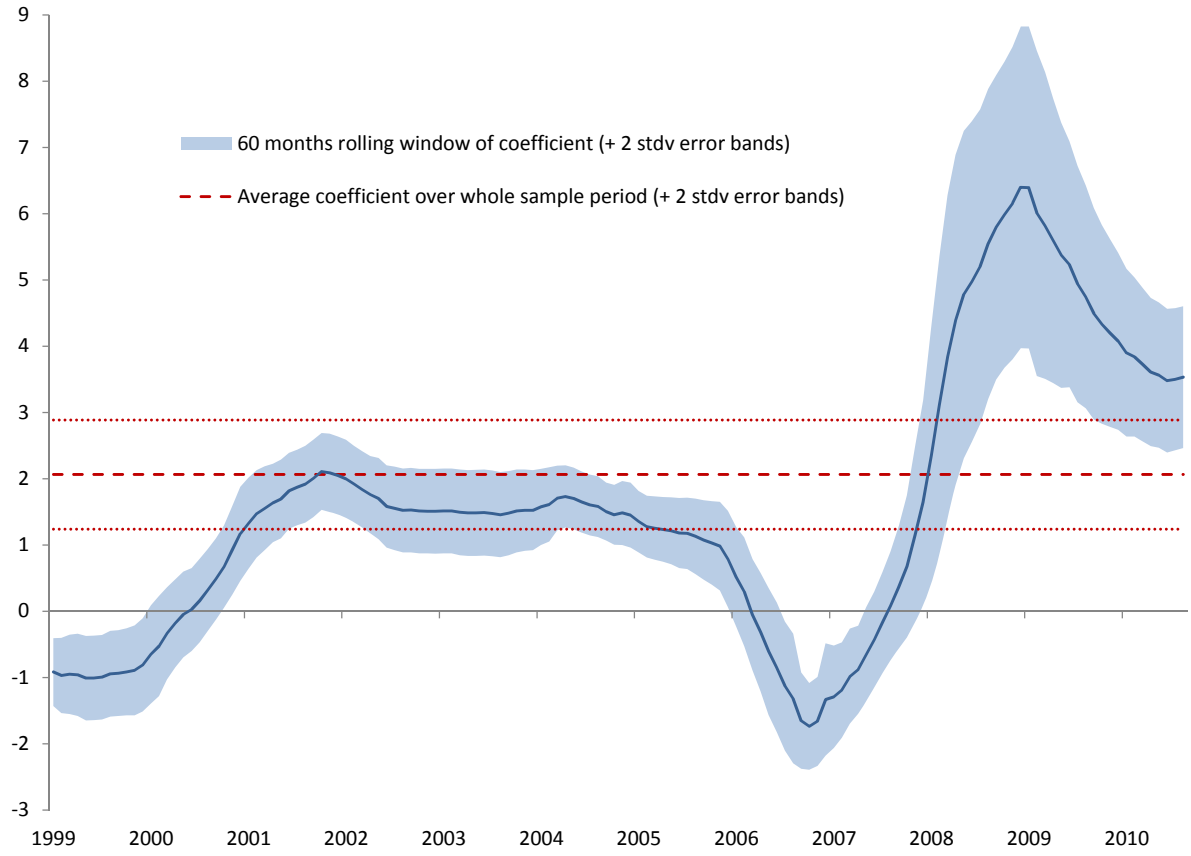
Note: *68 percent posterior probability regions of the estimated impulse responses to one standard deviation innovations, monthly horizon*

Figure 6 - Impulse responses of interest rate (spreads) to lending multiplier shocks



Note: *68 percent posterior probability regions of the estimated impulse responses to one standard deviation innovations, monthly horizon*

Figure 7 - The term structure as a predictor of euro area economic activity



Note: Estimated coefficient term spread prediction of economic activity one year ahead (Newey West standard errors)