Macroeconomic Consequences of Different Types of Credit Market Disturbances and Non-Conventional Monetary Policy in the Euro Area*

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Abstract

I estimate the effects of different types of credit market disturbances on the euro area economy since the introduction of the euro, i.e. exogenous credit demand shocks, innovations to the credit multiplier (e.g. shocks to risk taking by banks, securitization or financial innovations such as credit risk transfer instruments) and monetary policy shocks. In a second step, monetary policy shocks are further decomposed into traditional interest rate innovations and non-conventional policy actions. Overall, the macroeconomic relevance is considerable. Credit market disturbances account together for more than half of output variation and up to 75 percent of long-run inflation variability. The majority of these effects are driven by shocks to the credit multiplier. I further show that the dynamic effects crucially depend on the underlying source of the disturbance. Whereas surges in credit caused by innovations to the credit multiplier have a significant positive impact on economic activity and inflation, exactly the opposite is the case for exogenous credit demand shocks. Finally, both types of monetary policy instruments can influence the economy. The ultimate consequences on output and consumer prices are however more sluggish for non-standard policy measures, and the transmission mechanism via financial institutions - very likely the risk-taking channel - is different.

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1 Introduction

Since the global financial crisis, it has been widely believed that disruptions in credit markets can have serious consequences. There are, however, still a lot of uncertainties about the exact role and macroeconomic relevance of developments in these markets. The consequences may, for instance, depend on the underlying source of the disturbance. In particular, the dynamic effects of a rise in credit are likely to be different if the underlying shock is supply or demand driven, or if the surge is due to a shift in monetary policy versus an innovation in the financial sector. Unfortunately, macroeconomic evidence on this matter is rather sparse.[1] A better understanding of the impact of disturbances that are specific to these markets is not only essential for policymakers, it should also improve the construction of theoretical (DSGE) models that try to incorporate financial intermediaries. On the other hand, monetary authorities throughout the world have been responding to the crisis by cutting interest rates to historically low levels and by embarking on a series of non-conventional policy actions such as operations that change the composition of their balance sheets, measures that expand the size of the balance sheet or actions that try to guide longer term interest rate expectations. An extensive literature has already investigated the impact of traditional interest rate movements on real activity and inflation.[2] However, little is known about the macroeconomic effects and pass-through of non-standard policies and how they differ from conventional interest rate changes.[3]

In this paper, I attempt to address both issues for the euro area economy. More precisely, I use a structural vector autoregression (SVAR) framework to examine the dynamic effects and the relevance of different types of credit market disturbances. 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 for money and credit aggregates in the two-pillar strategy of the Eurosystem. Specifically, I disentangle disturbances that are specific to the credit market caused by respectively exogenous credit

[1] Gilchrist, Yankov and Zakrajsek (2009) examine the consequences of unexpected changes in credit market spreads or credit aggregates, but do not distinguish between disruptions in the supply or demand for credit. Ciccarelli, Maddaloni and Peydró (2010) disentangle monetary policy, loan supply and loan demand shocks. In contrast to the present study, they use bank lending surveys to do so.

[2] For instance Bernanke and Blinder (1992) and Christiano, Eichenbaum and Evans (1999) for the United States or Peersman and Smets (2003) for the euro area.

[3] A number of studies have examined the effects of a set of liquidity measures on money market interest rate spreads in the aftermath of the crisis, but not the ultimate impact on the real economy (e.g. Wu 2008; Taylor and Williams 2009; Christensen, Lopez and Rudebusch 2009). An exception is a recent study by Lenza, Pill and Reichlin (2010), who evaluate the macroeconomic consequences of non-standard policy measures in the euro area by conducting counterfactual exercises based on assumptions regarding how interest rate spreads would have evolved with and without the measures.

demand shocks, monetary policy shocks and innovations to the so-called credit multiplier. In a second step, monetary policy shocks are further decomposed into traditional interest rate innovations and other policy actions that ultimately influence the supply of credit beyond the policy rate, which should help to assess the effectiveness of the extraordinary response to the economic downturn following the crisis.

The credit multiplier represents the volume of bank lending 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 or financial innovations such as credit transfer instruments. The growth of securitization markets between the introduction of the euro and the financial turmoil was for instance remarkable. The issuance of euro-denominated asset-backed securities increased from around €50 billion in 1999 to almost €400 billion in mid-2007 (ECB 2008). This large 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. 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, securitization slowed down markedly as a consequence of the turbulence in credit markets beginning in the summer of 2007. At the same time, risk profiles and capital positions of banks deteriorated. The illiquidity of asset-backed securities markets and the other tensions in credit markets 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.

It is important to stress that I focus on disruptions that affect the banking sector and the transmission of unconventional monetary policy via bank lending. 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.[4] The non-standard policy measures taken by the Eurosystem as a response to the crisis were also primarily aimed at fueling the banking system. Even the limited outright purchases of covered bonds were intended to improve bank funding conditions (Lenza, Pill and Reichlin 2010). The fact that the ECB mainly acted via the banking sector is actually used to learn more about the effectiveness of the extraordinary policy measures.[5] Notice that the ECB's policy responses to the turmoil

[4] 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).

[5] This focus is different from e.g. Gertler and Karadi (2009), who define non-conventional monetary

were not fully "unconventional" in their essence (Borio and Disyatat 2009). In particular, most policy actions in the aftermath of the crisis were aimed at expanding bank reserves or influencing longer term money market and bank lending interest rates. For instance, there has been a shift from a variable rate tender to a fixed rate tender with full allotment, liquidity to banks has been provided at longer maturities and the pool of collateral accepted for refinancing operations has been enlarged. However, also in normal times, the ECB should have influenced interest rates in credit and money markets without a change in its main policy rate (e.g. by changing the signals in its communications). Furthermore, the usual management of liquidity by the Eurosystem should inherently also have resulted in shocks to liquidity offered to banks beyond the overnight interest rate (e.g. changes in the allocated volume of liquidity and errors in the estimation of so-called autonomous liquidity needs). In the estimations, I derive a generic series of monetary policy shocks between 1999M1 and 2009M12 that are orthogonal to interest rate innovations, which I label as non-conventional monetary policy shocks. The dynamic effects of these shocks could then be used as a benchmark to learn more about the effectiveness of extraordinary policy actions. Some caution when interpreting the results is obviously required. The estimated shocks are a mixture of different types of policy actions of which the effects are not necessarily the same. In addition, the composition, horizon and particularly the magnitude of some measures in response to the crisis were still unprecedented. It is also not clear whether the dynamic effects of shocks in normal times are similar as in a possible liquidity trap. Nevertheless, it should be useful as a starting point.

I estimate the SVAR model with monthly data and find a significant impact of all types of credit market disturbances on economic activity and inflation. The impact, however, crucially depends on the underlying source of the disturbance. While positive innovations to credit caused by credit multiplier and both monetary policy shocks have a significant positive impact on output and consumer prices, exactly the opposite is the case for innovations to credit that are the consequence of exogenous credit demand shocks. The latter can be rationalized by an upward impact of credit demand shocks on bank lending rates, in contrast to declining lending rates for shocks at the supply side of the credit market. Accordingly, rising credit aggregates do not always require a monetary policy tightening, an issue which is relevant in the context of the ECB's monetary analysis.

Overall, the macroeconomic relevance of the credit market disturbances is considerable, accounting for more than half of the forecast error variance in economic activity

policy as "direct lending by the central bank in private markets", which is more applicable for the United States. See also Borio and Disyatat (2009) for a classification of non-conventional monetary policy.

at the one- to three-year horizon. The majority of these effects, i.e. approximately 30 percent of output variation, are the result of shocks to the credit multiplier. As expected, positive disturbances to the credit multiplier boosted activity between 2005 and 2007, whereas negative innovations contributed significantly to the recession afterwards. Even more striking is the relevance for inflation fluctuations. The contribution of credit market disturbances 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, credit market disturbances matter from the one-year horizon onwards and explain up to 75 percent of the long-run forecast error variance. This stylized fact actually supports the implied horizons of the two pillars of the ECB's strategy, with the economic analysis aimed at assessing the short to medium-term determinants of price developments and the monetary analysis focusing more on a longer-term horizon. The bulk of inflation variability is again driven by shocks to the credit multiplier. Interestingly, fluctuations in credit aggregates contain much more information about future inflation than money aggregates. In particular, when I re-estimate the SVAR replacing credit by M3, i.e. identifying money demand, monetary policy and money multiplier shocks, the role of these disturbances for future inflation variability is substantially lower.

The results further reveal that the identified policy shocks that are orthogonal to the interest rate are characterized by a significant shift in the monetary base or the balance sheet size of the ECB, which is exactly what happened in response to the financial turmoil. When I compare the dynamic effects with traditional interest rate innovations, I find similar macroeconomic consequences. In particular, both monetary policy shocks have a hump-shaped impact on economic activity and result in a permanent higher level of consumer prices. Hence, both types of instruments can be used for policy purposes. The magnitude of the impact on economic activity is, for instance, similar for a 25 basis points decline in the policy rate or a 10 percent increase in the monetary base which is orthogonal to the policy rate. The effects of non-conventional policy actions on output and inflation are, however, more sluggish. In addition, the transmission mechanism is different. Specifically, whereas expansionary unconventional policy shocks are passed on to bank lending rates via a decline in bank's interest rate spreads, the spreads increase significantly after a traditional interest rate decline. Furthermore, the credit multiplier decreases significantly after a non-conventional policy disturbance. In contrast, the surge in the volume of credit after an interest rate innovation is mainly created by a rising credit multiplier. Both features suggest a stronger risk-taking channel of monetary transmission following interest rate shifts (Adrian and Shin 2010; Borio and Zhu 2008).

The rest of the paper is structured as follows. In the next section, I discuss the VAR model and data that will be used for the estimations. The identification strategy to disentangle respectively credit demand, monetary policy and credit multiplier shocks is presented in section 3, as well as the estimated macroeconomic relevance and consequences. In section 4, I further decompose monetary policy shocks into traditional interest rate innovations and less conventional policy actions. Finally, section 5 concludes.

2 Baseline VAR model and data

I start by presenting the baseline model and data that will be used for decomposing credit market innovations into mutually orthogonal components in the rest of the paper. Consider a monthly VAR for the sample period 1999M9-2009M12 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 of respectively output (y_t), prices (p_t), the volume of credit (c_t), the monetary base (b_t), the level of the interest rate on credit (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, Stock and Watson 1990). A more explicit analysis of the long-run behavior of the various variables is limited by the relatively short sample available. Based on standard likelihood ratio tests and the usual lag-length selection criteria, the estimations include four lags of the endogenous variables, which appears to be sufficient to capture the dynamics of the structural disturbances.[6]

All data are obtained from the ECB Statistical Data Warehouse. Since I am using monthly data, I proxy economic activity by the index of industrial production and prices by the HICP. Conclusions are, however, similar when the European Sentiment Indicator or unemployment are used as output measures, or when core HICP is used as a price measure. Extending the VAR with oil prices does also not affect the results.[7]

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

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

[7] All these and other robustness checks reported in the paper are available upon request.

are accommodated when the volume of bank credit is measured. More specifically, true-sale securitization could drive a wedge between actual fluctuations in bank credit and that derived from monetary financial institutions (MFI) balance sheet statistics due to the accompanying transfer of loans off the MFI balance sheet.[8] 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 credit in the estimations. Notice, however, that the results are similar when I use the non-adjusted series of loans to euro area residents or total credit (loans and securities) to euro area residents excluding the general government as alternative measures for the volume of credit. The correlation between those aggregates turns out to be high.

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 loans to households, non-financial corporations and non-MFI financial intermediaries (insurance corporations, pension funds and other non-MFI financial intermediaries including investment funds). Since January 2003, the ECB publishes monthly interest rate series for all these types of loans, as well as the corresponding volumes to calculate the weights. For the interest rate charged to non-MFI financial intermediaries, I take the 3-month money market rate. For the period 1999-2002, however, no volume data are available to calculate the weights. For this period, I use the average weights over the 2003-2009 period.[9] The constructed bank lending rate is shown in the top panel of Figure 1, together with the 3-month Euribor and the monetary policy rate. The latter is represented by the minimum bid rate of variable rate tenders or the rate applied to fixed rate tenders in the main refinancing operations. Generally, these rates seem to have fluctuated together since the introduction of the euro. Nevertheless, as can be seen in the bottom panel of the figure, the spreads have not been constant over the sample period suggesting they might have been influenced by credit market disturbances.

Finally, the monetary base is reported by the ECB with a monthly frequency and is

[8] 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.

[9] The weights haven't actually changed a lot between 2003 and 2009. I thank the ECB for providing the lending rates before 2003.

defined as the sum of banknotes in circulation and bank reserves (credit institutions current accounts and deposit facility). In this paper, I will also report results for estimations where the monetary base is replaced by respectively bank reserves, the volume of liquidity providing operations and the size of the overall balance sheet of the Eurosystem.

3 Consequences of credit market disturbances

3.1 Disentangling different types of credit market disturbances

In this section, I propose a strategy to identify different types of credit market disturbances 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 at the demand and supply side of the credit market. Notice that there are four credit market variables in the VAR while only three credit market disturbances are identified. Hence, all shocks which are specific to the credit market that do not have an impact on credit supply or demand are captured by the remaining innovation. 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 credit demand, monetary policy and credit multiplier shocks can be summarized as follows:[10]

Identification of different types of credit market disturbances

	y_t	p_t	c_t	i_t	b_t	s_t	$c_t - b_t$
Credit demand shocks	0	0	$\uparrow^{lagged}$	$\uparrow$			
Monetary policy shocks	0	0	$\uparrow^{lagged}$	$\downarrow$		$\downarrow$	
Credit multiplier shocks	0	0	$\uparrow^{lagged}$	$\downarrow$		$\uparrow$	$\uparrow$

Note: y_t = output, p_t = prices, c_t = credit, i_t = lending rate, b_t = monetary base, s_t = policy rate

First, shocks that are specific to the credit market need to be distinguished from other macroeconomic disturbances that could influence the credit market, in particular the demand for credit. These real economy disturbances, as well as non-identified credit market shocks, 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 credit market disturbances on output and prices, i.e. the contemporane-

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

ous impact on both variables is restricted to be zero. In contrast, innovations to output and prices are allowed to have an immediate impact on the volume of credit, 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.[11]

As an alternative, I have also considered identification strategies which do allow for feedback of disturbances that are specific to the credit 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 also introduce sign restrictions on the contemporaneous output and inflation effects of credit market shocks, the estimated magnitudes of the immediate effects are negligible and the impact becomes more or less the same after a few months.[12] On the other hand, the contemporaneous output and inflationary effects are insignificant when both variables are left unrestricted for the credit market shocks that move the volume of credit and bank lending rates in the opposite direction. An implicit assumption is then that shocks originating in the real economy all move the volume of credit and lending rates in the same direction or, in other words, a disturbance that boosts economic activity shifts the demand curve for credit to the right. Again, the conclusions of the paper are not affected.

Credit demand shocks Innovations to credit demand that are not driven by fluctuations in the real economy are referred to as *exogenous credit 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 credit demand shock is simply identified by a positive (or non-negative) co-movement between the volume of credit and the bank lending rate. Conversely, the shocks that lead to a negative (or non-positive) co-movement between the interest rate and the volume of credit are considered as shocks on the supply side of the credit market.

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

[11] E.g. Bernanke and Blinder (1992), Bernanke and Mihov (1995), Strongin (1995) 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, Eichenbaum and Evans (1999) or Peersman and Smets (2003).

[12] More precisely, I imposed the restriction that output moves in the same direction as prices and in the opposite direction as the interest rate for all credit market disturbances, which is a standard way of imposing sign restrictions for nominal disturbances (e.g. Peersman 2005).

of credit, 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, Lenza and Reichlin (2009) find that an unexpected interest rate hike only affects consumer loans and loans for housing purposes negatively on impact, while the component loans to non-financial corporations respond negatively with a lag, but positively on impact (see also Den Haan, Sumner and Yamashiro 2007). Firms could, for instance, still draw on their credit lines at a prespecified rate when the interest rate on new loans increases. 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.

Monetary policy shocks Credit market conditions could obviously be influenced by monetary policy. An expansionary *monetary policy shock* is expected to increase the supply of bank lending. 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 credit supply which is caused by a monetary policy shock.

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 lower than the MRO rate after September 2008. To capture these effects, I use the EONIA as the policy rate in the estimations. In section 4, I will extend the analysis by making an explicit distinction between interest rate innovations and unconventional policy actions.

It is important to mention that monetary policy shocks are only identified if they ultimately affect the supply of credit, 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.

Credit multiplier shocks Bank lending could also increase due to additional credit supplied by banks independently of a shift in monetary policy. I label such shocks as *innovations to the credit multiplier*. The latter can be calculated as the difference between the (log) responses of credit and the monetary base and captures the volume of credit that is generated by the financial sector with a specific amount of central bank money.

Consider, for instance, an innovation that makes it easier for financial institutions to securitize their loans. 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. Accordingly, the multiplier rises. 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 originated by banks. Other examples of disturbances that influence the supply of credit and the multiplier 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 bank's ability to expand their balance sheets. All that is required is that banks are somehow able to obtain extra funding in the market to finance additional loans, which could be either deposits or other liabilities. On the other hand, unfavorable shocks to the multiplier have very likely also played an essential role during the financial crisis. In particular, when bank's funding conditions deteriorate, their capacity 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.

Notice that credit 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, credit supply and the multiplier decline. In traditional textbooks, such disturbances are considered as the main driver of changes in the multiplier.[13] 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. By definition, a positive shock should increase the credit multiplier. I further impose the restriction that the ECB reacts to a positive innovation by tightening its policy stance. A policy tightening is consistent with

[13]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.

a central bank that tries to stabilize output and inflation fluctuations, and is sufficient to distinguish the shocks from monetary policy shocks at the supply side of the credit market.

3.2 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 3.2.1. The macroeconomic relevance is examined in section 3.2.2.

3.2.1 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 one standard deviation innovations. The figures also show the impact of the shocks on the credit multiplier and the interest rate spread. The former is obtained from the responses of credit and the monetary base for each posterior draw, while the latter is proxied by the difference between the response of the bank lending rate and the EONIA, as we may expect that the policy rate is pivotal in setting bank's funding conditions.

The identified credit market 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 monetary policy shock 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, Bernanke and Mihov 1995, or Christiano, Eichenbaum and Evans 1999). Interestingly, we observe a qualitatively similar output and consumer prices pattern when the rise in the volume of credit is driven by a credit 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, financial innovations leading to eased overall financing conditions do result in stronger aggregate spending.

The results further reveal that the underlying disturbance is crucial to determine the ultimate repercussions on the economy. In particular, when a surge in credit is driven by an exogenous increase in credit demand, there is a significant decline in economic activity and consumer prices after a while, which contrasts with both shocks at the supply side of the credit market. These opposing effects could be rationalized by the upward impact of credit demand shocks on bank lending rates, whereas the interest rate declines after credit supply shocks. Accordingly, an increase in credit growth does not necessarily requires a 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 credit demand and multiplier shocks, i.e. a tightening after an increase in the volume of credit. Only after a few months, the estimated responses of the monetary base to credit demand shocks show that the ECB does accommodate changes in demand by varying reserve supply, and the interest rate reaction is more in line with the stabilization of output and inflation consequences. Noticeable is also the slight increase of the interest rate spread after a rise in credit caused by an exogenous credit demand shock. In contrast, there is a persistent decline when the rise in credit is driven by positive innovations to the credit multiplier.[14] The latter shocks are also followed by a significant fall of the monetary base, which suggests that these disturbances are characterized by relatively easy alternative funding conditions for banks.

Finally, there is a so-called liquidity effect of monetary policy. More precisely, the money aggregate directly controlled by the central bank (monetary base) rises significantly, while the corresponding interest rate falls after a policy easing. Expansionary monetary policy shocks are also followed by a temporary decline in the credit multiplier and a short-run rise of the interest rate spread. Both features will be examined in more detail in section 4, when we distinguish between traditional interest rate innovations and non-standard policy measures.

[14] Note that a contemporaneous decline of the interest rate spread after a positive innovation to the credit multiplier is implicitly imposed by the identifying restrictions.

3.2.2 Macroeconomic relevance

Credit market disturbances and output fluctuations The relevance of credit market disturbances in explaining macroeconomic fluctuations is considerable, as can be seen in Figure 3. The left column of the figure shows the forecast error variance decompositions for respectively output, consumer prices and the volume of credit. To preserve orthogonality between the shocks and guarantee that variance shares sum to one, the figures show the variance decompositions obtained from the posterior draw which produces impulse responses that are as close as possible to the median responses from the posterior distributions.[15] 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 credit multiplier, accounting for approximately 30 percent of output variation. On the other hand, exogenous credit demand and monetary policy shocks explain each around 15 percent of expected output fluctuations in the medium term.

To further evaluate the relevance for economic activity, Figure 4 shows the historical contribution of the three identified credit market disturbances to the evolution of euro area industrial production. Panels A to C plot the deviation of actual annual industrial production growth from baseline, together with the estimated contribution of respectively credit demand, credit multiplier and monetary policy shocks. Baseline industrial production growth is measured by the (median) unconditional forecast of annual industrial production growth, i.e. 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, i.e. based on the estimated VAR over the whole sample period. The error bands are also relatively wide.

A number of interesting observations can nevertheless be made. The figures reveal that, until the beginning of 2004, the contributions of exogenous credit demand and monetary policy shocks to output growth were more or less in line with the actual output pattern. After 2004, however, this was almost never the case. This contrasts with the contribution

[15] An alternative would be to show the median values of the posteriors themselves. 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.

of credit multiplier shocks, who even made a significant positive contribution during the early millennium slowdown, and again in the second half of 2003. However, from 2004 onwards, innovations to the credit multiplier were clearly the dominant driving force of the actual business cycle. More precisely, disturbances to the multiplier explain why industrial production growth was below trend the first part of 2005, and in particular the expansion between the end of 2005 and the beginning of 2007. This pattern is very much in line with expectations. 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"*. The relevance of the innovations during that period can also be seen in panel D of Figure 4, which shows the evolution of the log-level of industrial production and its forecast from 2004 onwards conditional on credit multiplier shocks only. Put differently, the panel shows the forecast of output when all other shocks of the VAR are set to zero (or alternatively, they show the sum of the unconditional forecast and the contribution of credit multiplier shocks). Between the beginning of 2004 and the middle of 2006, innovations to the multiplier alone explain almost perfectly the evolution of actual industrial production. Finally, unfavorable multiplier shocks as a consequence of the turbulence in credit markets beginning in the summer of 2007 also made a significant, albeit not exclusive, contribution to the great recession of 2008-2009.

Credit, inflation and the money pillar of the Eurosystem The contribution of credit market disruptions to consumer prices volatility, also shown in Figure 3, 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, credit market disturbances start to matter for inflation. However, at longer horizons, and in particular from the one year horizon onwards, credit market disturbances clearly dominate, explaining more than two-thirds 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. Again, the bulk of long-run consumer price variability is explained by credit 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 the bottom panel of Figure 3 show, however, that exogenous shocks to credit demand are important contributors to credit variability in the short-run, for which actually no tightening is required. In contrast, from the impulse response analysis, we know that a surge in credit growth as a result of an exogenous credit demand shock has a downward impact on output and prices due to the accompanying interest rate hike. Accordingly, a comprehensive analysis of the composition of credit growth is crucial to assess the consequences for the outlook of price stability and to determine the appropriate policy response.

An interesting question in the context of the ECB's monetary analysis is the role of credit versus money for future inflation developments. To learn more about this issue, I have also re-estimated the VAR with money (M3) instead of credit, and the 3-month Euribor instead of the bank lending rate. The disturbances can be interpreted as respectively money demand (from the perspective of banks), monetary policy and money multiplier shocks. The contribution to the forecast error variance of output, consumer prices and money can be found in the right panels of Figure 3. A striking result is the much more limited overall contribution of money market disturbances to output and in particular consumer price volatility for the estimation with M3. Whereas credit market disturbances together account for more than 70 percent of long-run consumer price variability, this is less than 25 percent anymore for disturbances that are captured by M3. These results suggest that the evolution of credit aggregates provides more information about future price developments than fluctuations in M3. The same is true for output fluctuations.

4 Interest rate innovations versus other policy actions

To pursue its objectives, the ECB usually acts by steering the level of key interest rates, in particular the EONIA. The desired level is signalled by setting a minimum bid rate for the variable rate tenders or the rate applied to fixed rate tenders in its main refinancing operations. This instrument could, however, be complemented with other policy actions such as operations that change the composition of its balance sheet, actions that try to guide longer term interest rate expectations or measures that expand or reduce the size of the balance sheet or monetary base. Central banks throughout the world have been responding to the financial crisis by taking such additional policies partly because of hitting the zero lower bound of the interest rate. Unfortunately, little is known about the macroeconomic consequences and the efficiency of these actions. In this section, I attempt to examine this in more detail.

4.1 Identification of conventional and non-conventional policy shocks

To learn more about the macroeconomic effects of non-standard measures and how they differ from conventional policy, I use the same framework as the one presented in section 3, but now I focus solely on the supply side of the credit market and also identify non-conventional monetary policy shocks that are transmitted via the banking sector. In particular, I use the following set of restrictions to disentangle three types of credit supply shocks:

Identification of conventional and non-conventional monetary policy shocks

	y_t	p_t	c_t	i_t	b_t	s_t	$c_t - b_t$
Credit multiplier shocks	0	0	$\uparrow^{lagged}$	$\downarrow$		$\uparrow$	$\uparrow$
Interest rate innovations	0	0	$\uparrow^{lagged}$	$\downarrow$		$\downarrow$	
Non-standard policy actions	0	0	$\uparrow^{lagged}$	$\downarrow$		0	

Note: y_t = output, p_t = prices, c_t = credit, i_t = lending rate, b_t = monetary base, s_t = policy rate

To avoid a distortion in the identification of other disturbances at the supply side of the credit market, and given the important role found in the previous section, I still identify innovations to the credit multiplier in the estimations. On the other hand, I do not identify credit demand shocks anymore, to preserve that there are less credit market shocks identified than the number of credit market variables in the VAR. Accordingly, the remaining innovation in the estimations now captures credit demand shocks and other possible shocks within the credit market. Put differently, given the way that the sign restrictions are implemented, this remaining shock acts as a "sponge" shock for all other possible credit market disturbances.[16]

A credit supply disturbance caused by a traditional *interest rate innovation* is identified as a fall in the policy rate which is passed on to bank lending rates, whilst increasing the volume of credit with a possible lag. In normal times, the Eurosystem conducts monetary policy by setting the level of the MRO rate. In contrast to the VAR estimated in section 3, I now use the MRO as the policy rate, and exogenous innovations to the MRO rate will be interpreted as conventional monetary policy shocks. As discussed above, the overnight rate has been persistently below the MRO rate since the end of 2008 as an endogenous response to non-standard policy measures. The overnight rate is hence

[16] Note that the results are not affected when I do impose the restrictions of a credit demand shock on the remaining innovation. In section 4.2, I also report results for a VAR with an extra variable which does allow to also identify credit demand shocks separately.

not appropriate to disentangle both policy disturbances. On the other hand, all other policy measures that affect the supply of credit beyond the policy rate are labeled as "unconventional" or "non-standard". By construction, these actions are orthogonal to interest rate innovations. Hence, I identify *non-standard policy actions* as credit supply shocks with a zero contemporaneous impact on the policy rate, which is sufficient to disentangle the shocks from conventional interest rate innovations, but also from shocks to the credit multiplier as potential disturbances on the supply side of the credit market.

Some remarks about the identified non-standard policy shocks are worth mentioning. First, unconventional policy actions are only captured by this shock if they successfully affect the supply of credit, i.e. if they influence the volume of credit and bank lending rates (not necessarily economic activity). Non-effective policy measures are simply not identified, as well as policies that influence the economy beyond financial intermediaries, which could for instance be the case for outright purchases of government bonds.

Second, these shocks can be considered as a combination of several possible measures aimed at influencing financing conditions and the flow of credit beyond the main policy rate. For instance, as a response to the financial crisis, there has been a shift from a variable rate tender to a fixed rate tender with full allotment, liquidity to banks has been provided at longer maturities and the ECB has expanded its list of eligible collateral. To the extent that the outright purchases of covered bonds have influenced credit conditions of the banking system, these actions should also be captured by this shock. A further decomposition of the shocks and the analysis of the efficiency of specific non-standard policies are out of the scope of this paper. The aim of the present study is to assess whether actions beyond interest rate innovations could influence the macroeconomy. Once the SVAR is estimated, however, a closer inspection of the impulse response functions should help to interpret the source more carefully (reverse engineering of the underlying impulse).

Third, monetary policy shocks that are orthogonal to the main policy rate could also have occurred in normal times. In particular, a specific level of the MRO rate may always be associated with varying monetary conditions. A given policy rate may for instance be associated with a relatively flat or steep term structure of interest rates, which could be influenced by the communication of future policy intentions.[17] Whenever the supply

[17] Remark that communication effects are also an integral part of the transmission mechanism of the non-standard policy measures that were taken following the default of Lehman Brothers. For instance, an announcement that monetary authorities are prepared to engage in operations for certain assets may in itself boost confidence in those assets thereby reducing liquidity premia (Borio and Disyatat 2009). The same argument holds for an announcement that the central bank is prepared to accommodate liquidity

of credit is ultimately affected, such actions are identified as non-conventional monetary policy shocks. Furthermore, the management of liquidity by the ECB should inherently also have resulted in a series of generic non-conventional policy shocks before the financial turmoil. More specifically, in its main and longer term refinancing operations, the ECB usually decided on the total amount of liquidity to be allotted. Hence, changes in the allocated volume of liquidity and errors in the estimation of so-called autonomous liquidity needs could also have influenced the supply of lending. In particular, excess liquidity allocated by the ECB is not necessarily offered on the overnight interbanking market, it could also find its way to the credit market. Even the composition of the balance sheet has not been constant over time, i.e. there have also been shifts in the volume of main refinancing operations versus longer term operations before the crisis.

Finally, some of these shocks could be "demand-induced". Notice that disturbances which are specific to the banking sector and the related demand for central bank liquidity are already captured by credit multiplier innovations. An expansion of credit supply, however, could also be driven by additional liquidity that financial institutions obtain from the central bank without augmenting the multiplier. The accommodation of this demand is, however, still a policy decision. Moreover, the identifying restrictions require that the central bank does not react to the shock and its potential macroeconomic consequences by keeping the policy rate constant, which is obviously also a policy decision. A good example is the surge of the Eurosystem's balance sheet at a given policy rate as a consequence of the full allotment decision in September 2008.

4.2 Results

Estimation results are shown in Figure 5. To improve comparability, the impulse responses for both monetary policy shocks are shown within the same panel. Specifically, the shaded (light blue) areas represent the estimated responses to traditional interest rate innovations, whereas the dotted (red) lines those of non-conventional policy actions. The results for credit multiplier shocks are not shown since they are still the same as in section 3.

The effects of conventional interest rate innovations on output and consumer prices are broadly in line with the results for the monetary policy shocks reported above. An unexpected fall in the policy rate tends to be followed by a temporary rise in economic activity after a few months. The effect on output reaches a peak after one year and

shortages in the interbanking market. In this regard, the lengthening of refinancing operations to one year could also be interpreted as a signal of persistent low interest rates.

returns to the baseline afterwards. On the other hand, consumer prices rise permanently. Interestingly, also non-conventional monetary policy shocks have significant temporary output effects and a permanent impact on the level of consumer prices. The pass-through is, however, more delayed. Specifically, output and prices only start to rise significantly after about one year, and the peak effect on economic activity is at least six months later than for a conventional monetary policy shock.

It is striking how similar the ultimate effects of non-standard policy actions are, despite the lack of a short-run shift in the policy rate. To be sure that the effects of non-standard policy measures are not driven by deviations of the EONIA from the MRO rate, i.e. a non-conventional policy shocks could then just be another "interest rate" innovation within the corridor determined by the standing facilities, I have also re-estimated the VAR with the EONIA as the policy rate. The results for some key variables are shown in the second row of Figure 6. As can be seen, there is clearly an effect beyond the overnight interest rate. Other policy actions still have a significant effect on economic activity and consumer prices. A closer inspection of the response of the monetary base suggests that the identified alternative shocks mainly represent measures aimed at expanding or reducing the size of the central bank's balance sheet. In particular, a one-standard deviation non-conventional monetary policy shock is characterized by an increase in the monetary base that is orthogonal to the policy rate of approximately 2 percent. The source of the identified non-conventional policy shock is also confirmed by the estimation of an extended VAR-model. In particular, the third row of Figure 6 shows impulse responses obtained from a seven-variables VAR that also includes the spread between the 12-month and 1-month Euribor amongst the credit market variables.[18] If the underlying source of the identified shock would be a shift in expected monetary policy, this spread should decline significantly on impact, which turns out not to be the case.

In sum, monetary policy can potentially influence economic activity via the supply of bank loans beyond an interest rate shift, i.e. more than one instrument can be used for policy purposes. The impact on economic activity is for instance similar for a 25 basis points decline in the policy rate and an increase in the monetary base of 10 percent that is orthogonal to the policy rate. Even when the rise in the monetary base is purely demand driven, the accommodation of it and the absence of a shift in the policy rate can still be considered as a policy decision. The latter is exactly what happened in response to the financial crisis, e.g. the full allotment policy, but could also be the consequence of changes

[18] In this case, it is again possible to also identify credit demand shocks, since there is still a remaining innovation that could capture other credit market disturbances.

in the amount of liquidity allocated by the ECB in normal times.

To explore the occurrence and effects of the disturbances before and during the financial turmoil, Figure 7 shows the time series of both estimated policy shocks, as well as their cumulative levels since the start of the sample period. A rise can be considered as an innovation that caused a positive credit supply shock. In line with the results reported in section 3.2.2, both monetary policy shocks were rather restrictive around the early millennium slowdown, and stimulative between 2003 and the second half of 2006. Tight monetary conditions in the course of 2008 are also identified as restrictive interest rate innovations.[19] On the other hand, from the collapse of Lehmann onwards, both policy shocks were clearly supportive. Cumulative interest rate innovations increased by 4 standard deviations, and the cumulative level of non-standard policy shocks even by 8 standard deviations. Accordingly, the extraordinary policy measures in response to the crisis are also captured by the shocks. The figures further indicate that the shocks have generally been homoscedastic over the sample period. Not surprising, we do however observe an increase in the size of non-standard policy shocks towards the end of 2008.[20] As a robustness check, the VAR has therefore been re-estimated for a sample period that excludes the enhanced credit support period, i.e. until mid 2008. The impulse responses are shown in the fourth row of Figure 6. The dynamic effects of non-standard policy shocks in normal times turn out to be qualitatively similar. As expected, the size of an average innovation is smaller and hence also the macroeconomic consequences. The significant effects on output and consumer prices confirm the conjecture that non-conventional policy shocks also occurred in normal times. Surprising are the much less precisely estimated effects of traditional interest rate innovations over the shorter sample period, suggesting that the policy response to the recession has improved the identification of conventional monetary policy shocks.

Finally, the estimated effects of non-standard policy actions do not depend on the selected measure of central bank money. In particular, the bottom three rows of Figure 6 show the estimated impulse responses of the baseline VAR when respectively the amount of bank reserves, the volume of liquidity providing operations and the overall size of the

[19] Whereas the financial turmoil started in the summer of 2007, the ECB kept the interest rate at 4 percent, and even raised the policy rate to 4.25 percent in July 2008.

[20] I have also run a number of stability tests on the reduced form VAR. In general, the tests suggest that the coefficients have been rather stable over the sample period. Specifically, equation by equation Quandt-Andrews tests for one or more unknown structural breakpoints in the sample cannot reject the null hypothesis of no breakpoints (relying on the Hansen p-values). The cumulative sums of the recursive residuals (CUSUM tests), also indicate that the parameters have been stable. On the other hand, applying Chow forecast tests for a specific break in the summer of 2008 does reject stability, in particular for the policy rate and monetary base equations.

ECB's balance sheet are used as a proxy for central bank money. The volume of liquidity providing operations, obtained from the asset-side of the Eurosystem's balance sheet, should better capture policy decisions with respect to bank liquidity provision. However, in contrast to the monetary base, this aggregate does not capture changes of net assets in gold and foreign currency, which could also influence bank lending. In addition, part of the liquidity providing operations return to the Eurosystem in the form of central government deposits and other liquidity absorbing operations by the ECB. The latter also influences the ability of bank lending and is taken into account for the measurement of the monetary base. The macroeconomic consequences for the alternative liquidity measures are clearly very robust.

4.3 How are both shocks transmitted to the real economy?

Consider an increase in the monetary base due to an unconventional policy action (see Figure 5). The injection of liquidity results in a rise of credit supplied by banks, reducing lending rates and hence also the interest rate spread charged by banks. The fall in the interest rate spread is implicitly imposed for the first month, but seems to persist for more than two years. The credit multiplier declines significantly in the short run and gradually returns to its initial level after about one year. Hence, the rise in the monetary base is only proportionally transmitted to the volume of bank lending in the long run. In contrast, in case of a policy easing, a traditional innovation to the policy rate results in a significant rise of the interest rate spread charged by banks. More precisely, the interest rate decline of the ECB is passed on to bank lending rates, but less than proportional. The fall in bank lending rates and rise of interest rate spreads boost credit supply and demand, resulting in a relative quick pass-through to economic activity and inflation. In addition, there is hardly a change in the credit multiplier, nor a significant liquidity effect in the short-run.

The different response of the credit multiplier after both monetary policy shocks is particularly interesting. This difference could potentially be driven by the popular risk-taking channel of monetary transmission. Notice first that, according to traditional textbooks (e.g. Mishkin 2010; Walsh 2010), expansionary monetary policy is expected to have a downward impact on the credit multiplier. Specifically, when interest rates fall, households typically hold more currency relative to interest-bearing bank deposits. As a consequence, less liquidity returns to the financial sector, reducing its ability to supply loans and hence also the credit multiplier. Similarly, a lower interest rate reduces the opportunity cost for banks to hold excess reserves and vault cash, which also lowers the credit multiplier. On the other hand, monetary policy is expected to influence the lending capacity of banks and the credit multiplier via at least two other effects that are part of the risk-taking channel of monetary transmission (Borio and Zhu 2008; Adrian and Shin 2010). First, expansionary monetary policy increases the quality and value of outstanding bank loans through an increase in collateral and the expected associated repayment flows. Accordingly, the value of bank's marked-to-market equity rises leading to an increased balance sheet capacity and risk appetite of the banking system, resulting in greater loans supply. In particular, financial intermediaries will attempt to find ways to allocate their surplus capital. On the liability side, they take on more debt. On the assets side, they search for borrowers, which expands the credit multiplier. Second, the profitability and risk-taking capacity of financial intermediaries is more directly affected by bank's interest rate spreads. When interest rate spreads rise, the marked-to-market value of equity also increases, leading to more risk appetite of banks and a shift in the supply of credit. Very likely, this risk-taking channel of monetary transmission is much stronger for traditional interest rate innovations compared to non-conventional policy actions. On the one hand, the value of collateral is probably more affected when also the level of the risk-free rate changes. More crucially, the interest rate spread increases significantly after a conventional interest rate fall, whereas there is significant decline following non-conventional policy actions (see Figure 5). This channel could hence be the source of the substantial difference in the estimated response of the credit multiplier after both monetary policy shocks. Put differently, the same volume of loans is generated by the financial sector for roughly a 0.5 percent increase in the monetary base which also shifts the policy rate, as for a 2 percent rise of the monetary base without an accompanying shift in the policy rate. Interestingly, as can be seen in Figure 6, there is not even a liquidity effect for bank reserves after an interest rate innovation.[21] Such a liquidity effect is often used to identify monetary policy with sign restrictions (e.g. Uhlig 2005 or Canova and De Nicoló 2002). However, bank reserves seem to decline in the short run, while the corresponding multiplier increases significantly.

5 Conclusions

In this paper, I have examined the macroeconomic effects of different types of credit market disturbances in the euro area since the launch of the new currency. A number of interesting results came out of the analysis. First, the macroeconomic relevance of shocks

[21] An overview of the early literature on the existence of a liquidity effect can be found in Pagan and Robertson (1995).

that are specific to the credit 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 the credit multiplier, which represents the volume of credit that is generated by the financial sector with a specific amount of central bank money. Examples are financial innovations such as credit risk transfer instruments and securitization activities. These disturbances almost exclusively explain the strong output growth above its trend between 2005 and the beginning of 2007. On the other hand, unfavorable shocks to the multiplier since the summer of 2007 also made a significant contribution to the recession in 2008 and 2009.

Second, the underlying source of the disturbance is crucial to determine the economic consequences. In contrast to credit multiplier shocks, surges in credit which are driven by exogenous credit 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.

In the analysis, I have also identified credit market disturbances which are caused by two different monetary policy shocks. Specifically, I have identified credit supply shocks that are a consequence of traditional innovations to the policy rate, and credit supply shocks that are the result of unconventional policy actions. This exercise should help to learn more about the extraordinary policy measures taken by central banks around the globe as a response to the financial turmoil. I find that more than one instrument can be used to influence the economy. In particular, a policy action which raises the monetary base or the size of the central bank balance sheet without a change in the main policy rate, has a hump-shaped effect on economic activity and a permanent impact on consumer prices. Compared to a traditional interest rate innovation, the pass-through is somewhat more sluggish. Some caution is, however, required. A caveat of the analysis is that the estimations are based on a sample period that covers the turbulent period on financial markets, as well as normal times. An implicit assumption is hence that the parameters did not change dramatically as a consequence of the crisis.

Finally, whilst the effect of both policy instruments on output and inflation are comparable, the results suggest that the transmission mechanism is different. On the one hand, bank interest rate spreads increase significantly after an expansionary interest rate innovation, whereas spreads decline after a favorable non-standard policy shock. On the other hand, there is no significant short-run (bank reserves) liquidity effect for an interest rate shock, i.e. the rise in credit supply is generated by a greater multiplier. In contrast, the multiplier declines significantly for a non-conventional policy shock. A potential explanation for the different pass-through is a much stronger risk-taking channel of monetary transmission after an interest rate innovation, a feature which deserves more attention in future research.

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Figure 1 - A composite bank lending rate for the euro area

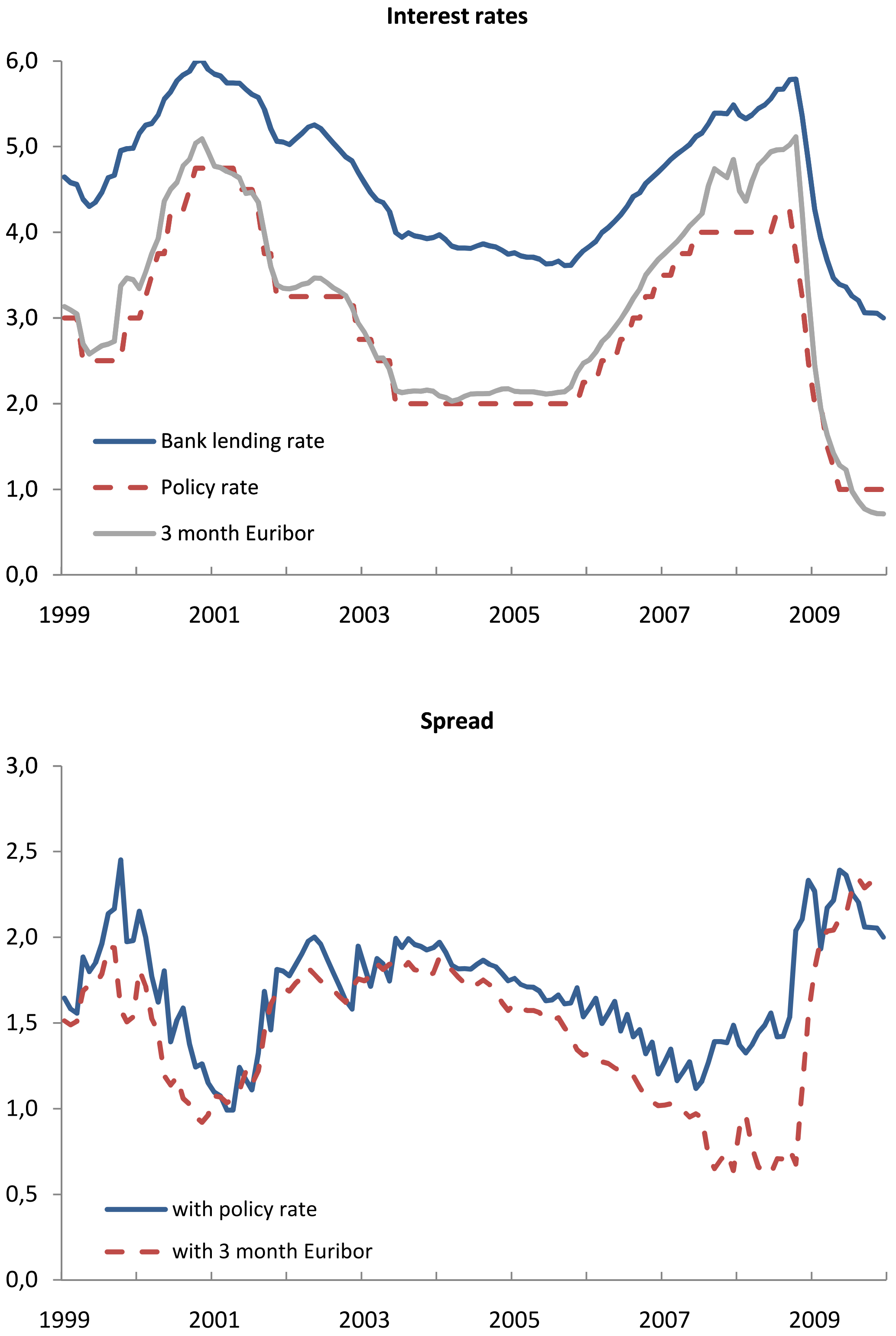
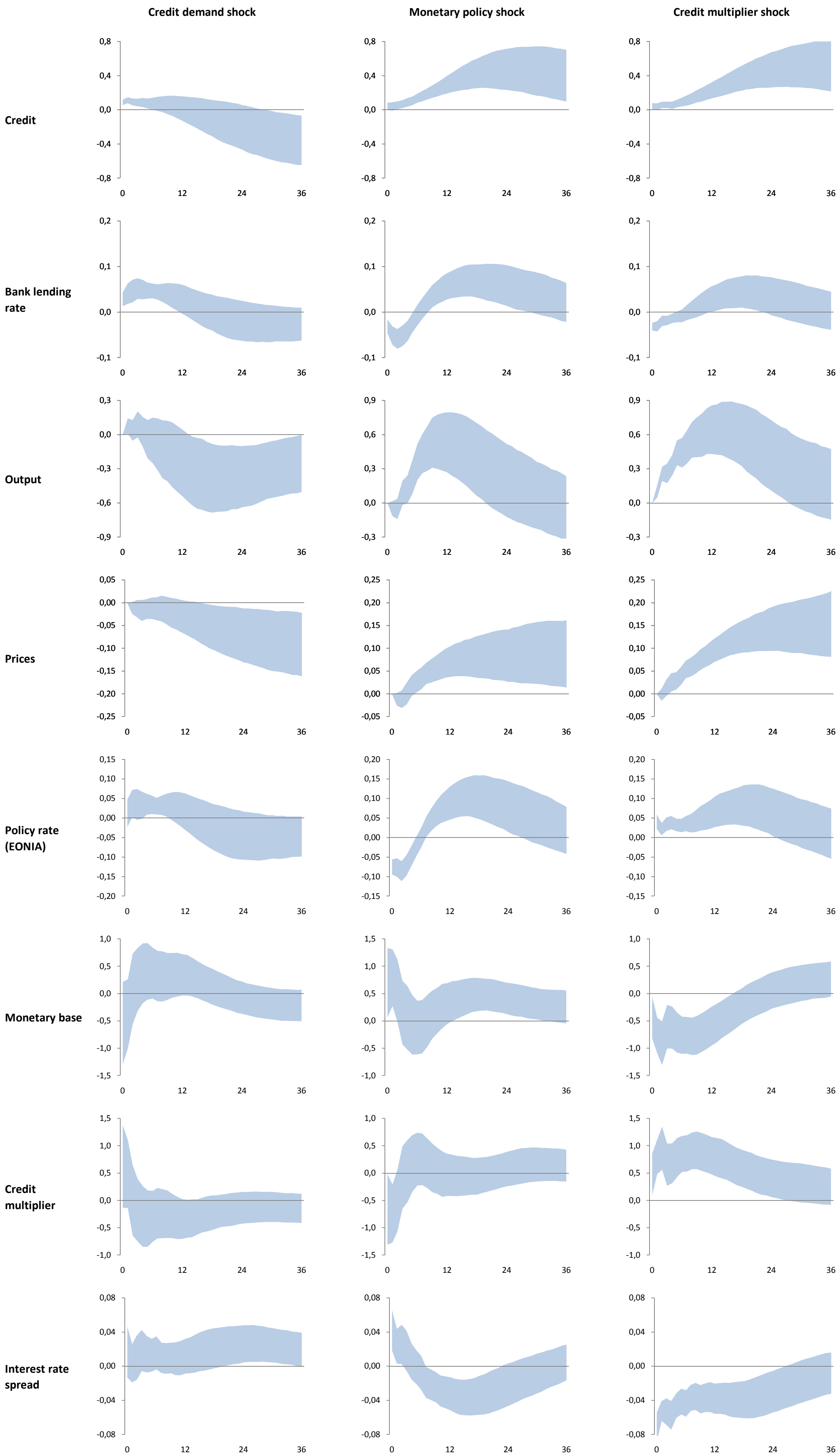
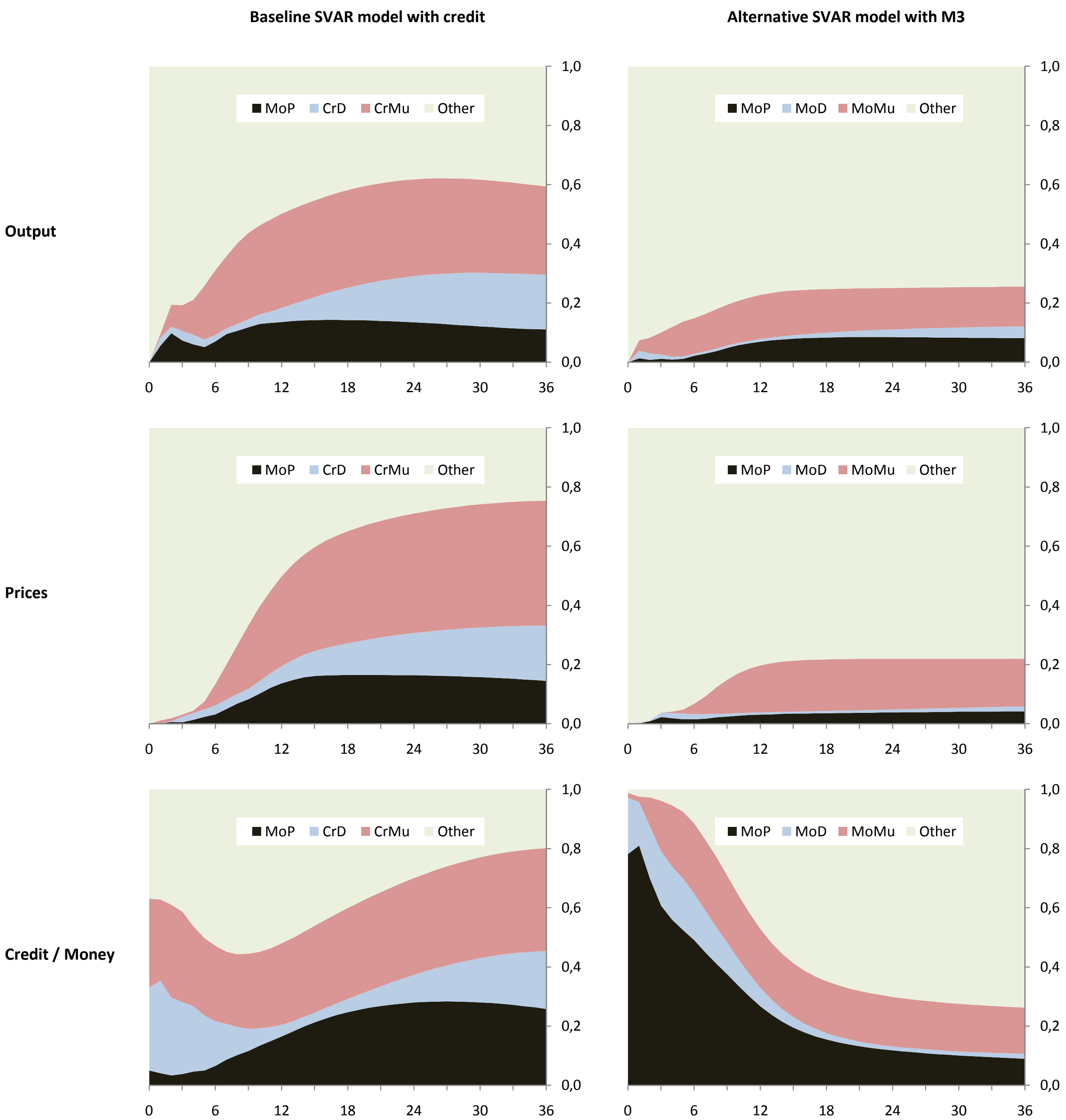


Figure 2 - Impulse responses to different types of credit market disturbances



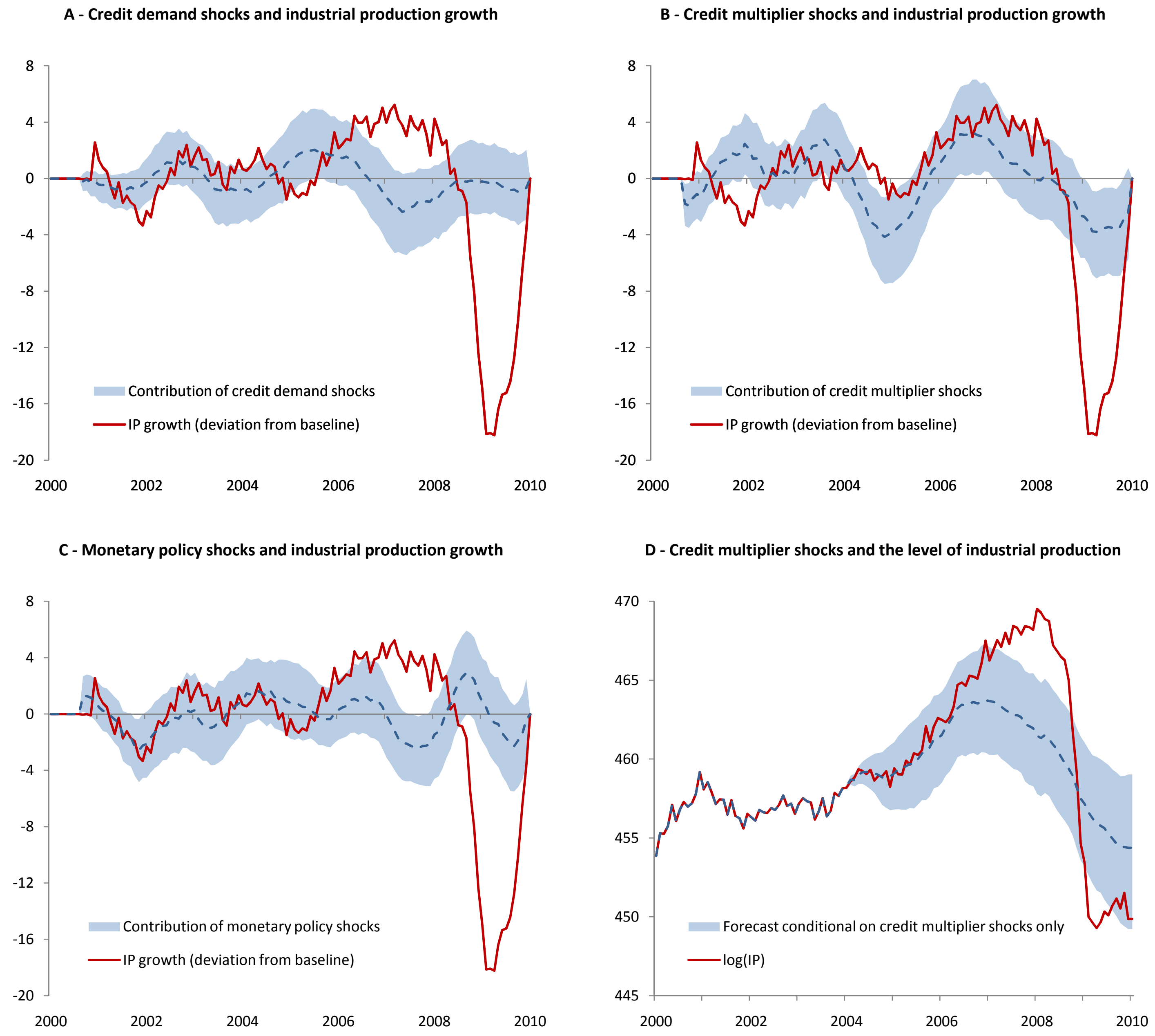
Note: *68 percent posterior probability regions of the estimated impulse responses to one standard deviation innovations*

Figure 3 - Forecast error variance decompositions



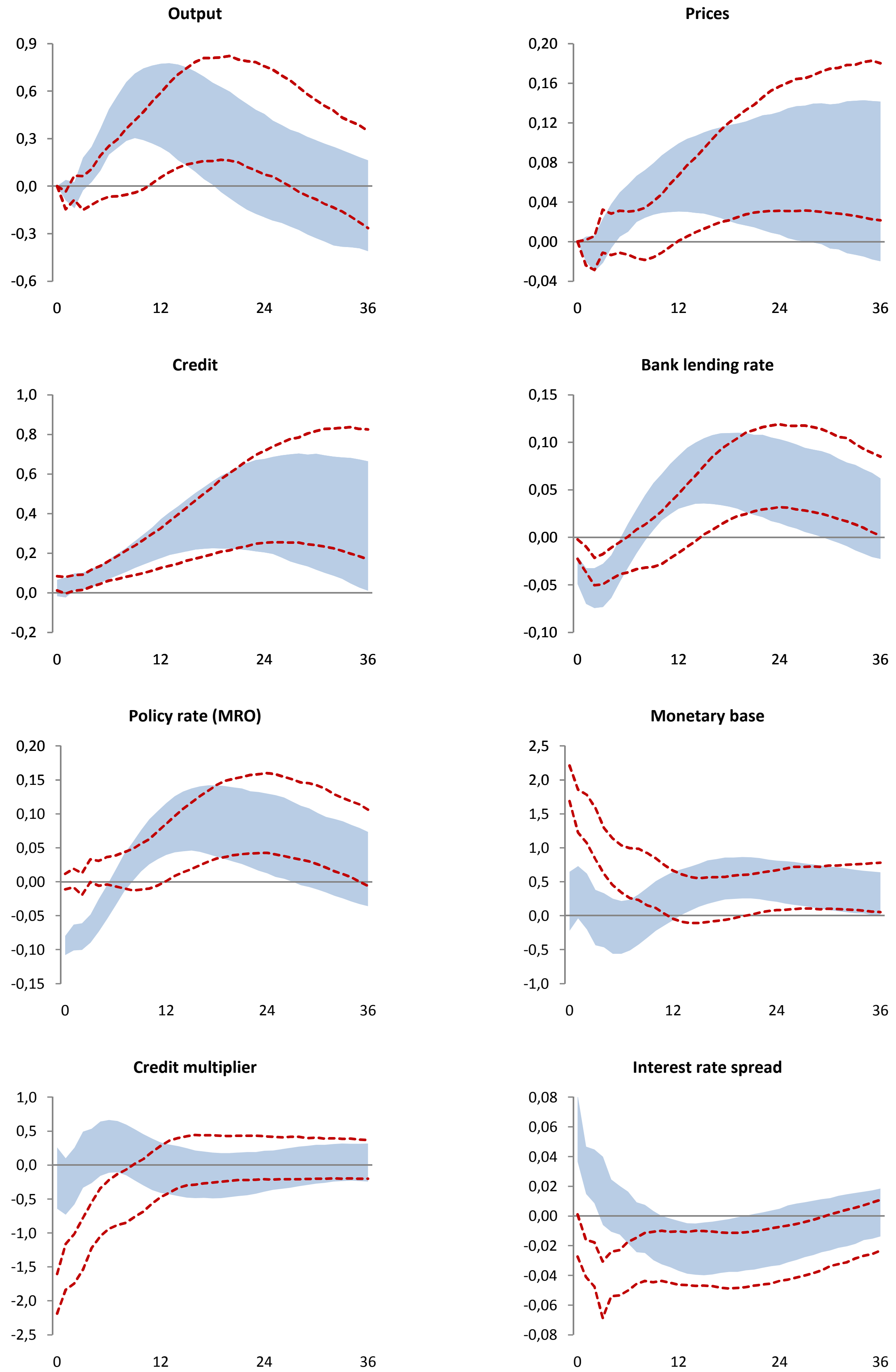
Note: Figures obtained from draw which minimizes the distance with the medians of the posterior; "CrD/MoD" = credit/money demand shocks; "MoP" = monetary policy shocks; "CrMu/MoMu" = credit/money multiplier shocks; "Other" = other shocks

Figure 4 - Credit market disturbances and economic activity in the euro area



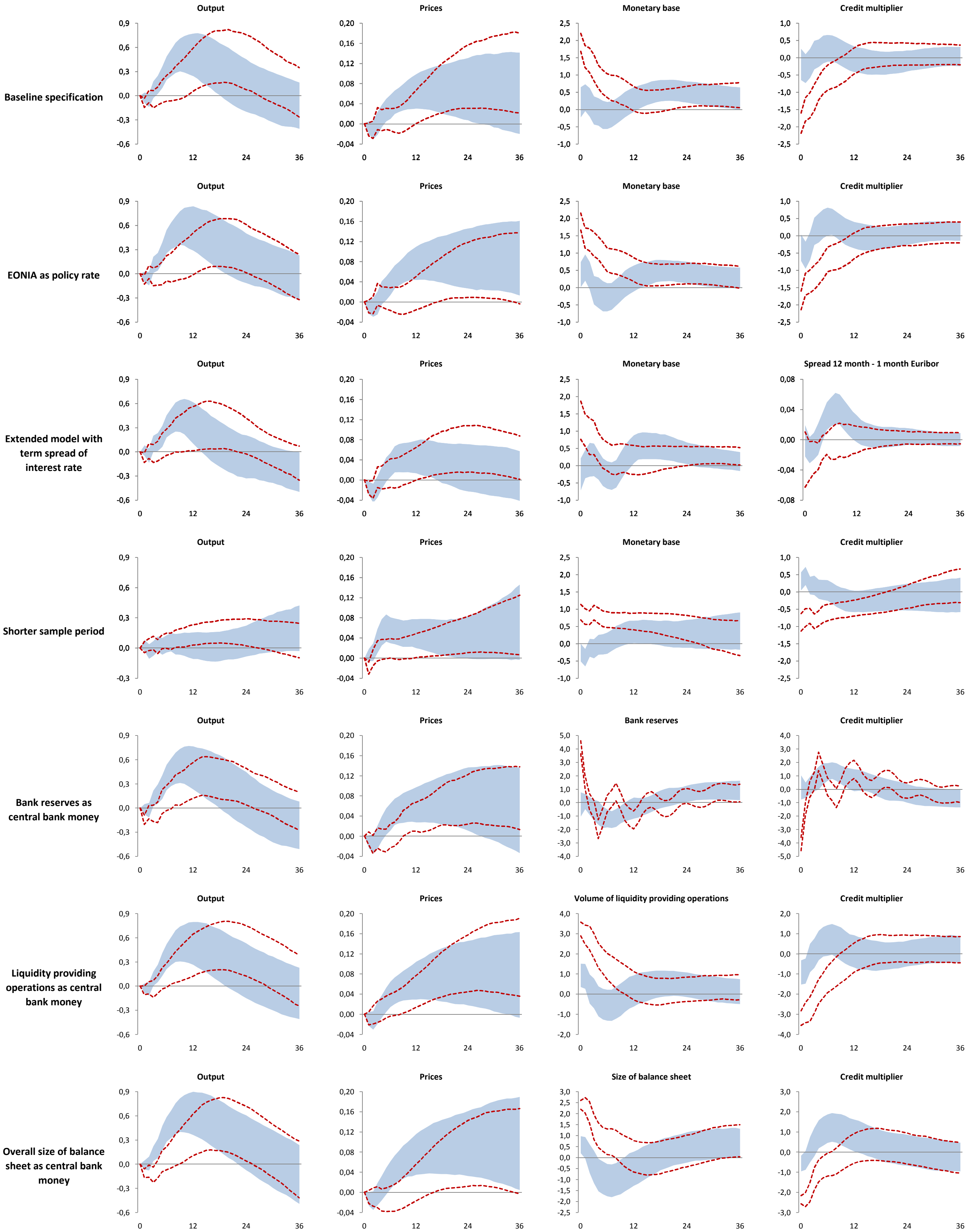
Note: baseline is unconditional forecast of annual Industrial production growth; contribution of shocks is calculated as difference between forecast conditional on the estimated series of shocks and unconditional forecast (medians: dotted blue lines, 68 probability regions: shaded blue areas)

Figure 5 - Impulse responses to conventional and unconventional monetary policy shocks



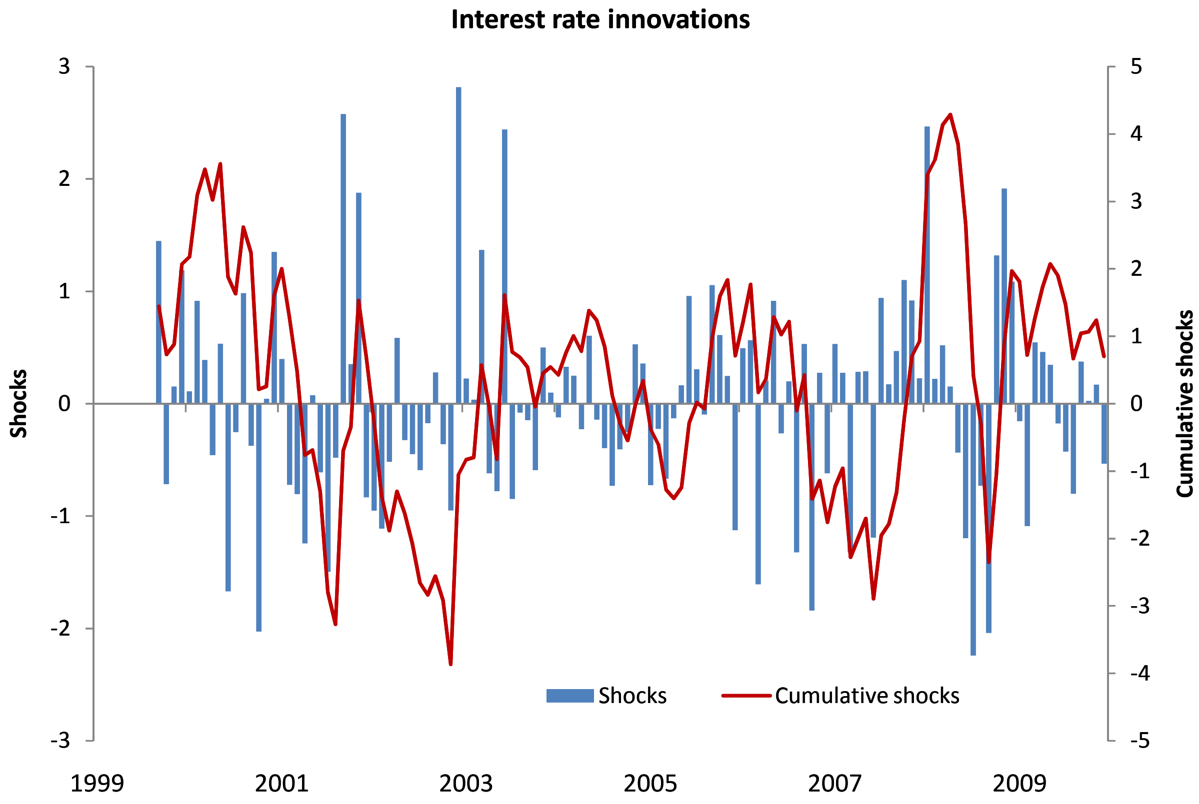
Note: *Interest rate innovations: 68 percent probability regions*
Non-standard policy actions: 68 percent probability regions

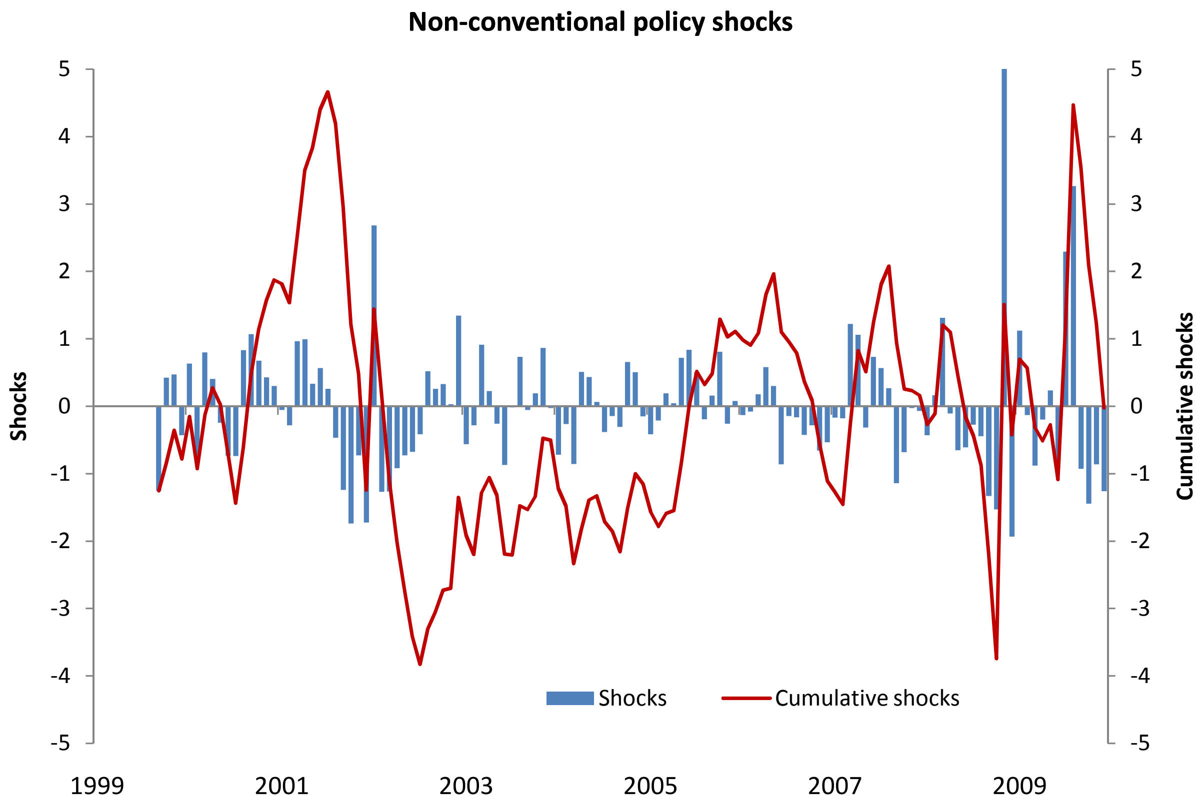
Figure 6 - Interest rate innovations versus other policy actions: alternative specifications



Note: *Interest rate innovations: 68 percent probability regions*
Non-standard policy actions: 68 percent probability regions

Figure 7 - Time series of conventional and non-conventional monetary policy shocks





Note: figures are medians of the posterior distribution