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Abstract

This paper employs a structural VAR framework with sign restrictions to estimate the effects of unconventional monetary policies of the European Central Bank since the Global Financial Crisis, mainly in their effectiveness towards bank lending. Using a variable for newly issued credit instead of the outstanding stock of credit, the effects on bank lending are smaller than found in previous similar studies for the Euro area.

Keywords: unconventional monetary policy, zero lower bound, bank lending, SVAR

JEL Classification: C32, E30, E44, E51, E52, E58

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1 Introduction

Since the *Global Financial Crisis* (GFC) of 2007/2008 central banks in many advanced economies have resorted to *unconventional monetary policies* (UMPs), as traditional monetary policy of steering market interest rates by calibrating the policy rate have become less effective due to the *zero lower bound* (ZLB). Central banks have since then relied more and more on policies like asset purchases, credit easing and forward guidance, to try to maintain working transmission mechanisms. The primary intention of these policies is to boost economic activity, through, amongst other channels, elevating bank lending.

Similar to other central banks, non-standard monetary policies by the European Central Bank (ECB) were mainly aimed at reviving bank lending in the aftermath of the Global Financial Crisis through more favourable lending conditions, especially for non-financial corporations (see Draghi (2011)). As bank lending is the main source of external finance for non-financial corporations in the Euro area (see ECB (2008), Trichet (2009)), a functioning transmission mechanism through the bank lending channel is vital for working credit markets.

Central banks try to affect bank lending through unconventional monetary policies by lowering market yields to make refinancing cheaper and by strengthening commercial banks' balance sheets through additional provision of further liquidity. While there is an extensive literature on the effects of unconventional monetary policies towards financial market yields and prices (see e.g. Borio and Zabai (2016) for an overview), less is known about the pass-through of non-standard policies towards bank lending. Bank lending is supposed to be stimulated through such policies by providing commercial banks with more liquidity than needed for reserve requirement reasons. Additionally, central banks might engage in outright purchases of securities (*quantitative easing*), to reduce impairments in specific financial market segments.

There are several theories, as to how these policies work through the bank lending channel. Most central bankers and more Keynesian-leaning economists see this channel working because the increased supply of reserves offers banks a cheap form of refinancing, and therefore enables banks to supply more loans because of lower riskiness and higher liquidity of their balance sheets, and better capital positions (see e.g. Borio and Disyatat (2009), Joyce et al. (2012)).

In contrast, more monetaristic-leaning scholars postulate that through the provision of central bank reserves, bank lending and hence inflation must consequently rise, given the static money multiplier theory and the quantity theory

of money. This argumentation is frequently brought forward in macroeconomic textbooks and the literature (see e.g. Freeman and Kydland (2000), Meltzer (2010)).

Previous studies are inconclusive to which extent UMPs in the aftermath of the Financial Crisis were able to spur bank lending. Some studies find a clearly positive impact of UMPs on bank lending, as for example Peersman (2011), Gambacorta et al. (2014), or Hachula (2016) for the Euro area, while others, like Butt et al. (2015), and Goodhart and Ashworth (2012) for the UK, find no clear cut positive impact of UMPs on bank lending and broader macroeconomic variables. But, what all of these mentioned studies have in common is that they consider the outstanding stock of credit or the change of it as the relevant credit variable. As this variable is consisting of several other factors besides newly issued loans, results of these studies might be distorted (see Behrendt (2016) for a discussion of this issue).

This insight shall be reviewed in this paper, while simultaneously attempting to answer two main questions. The first deals with the effectiveness of the unconventional monetary policy actions of the ECB since the beginning of the Global Financial Crisis of 2007/2008 towards stimulating bank lending to non-financial corporations. A main focus there is on policies which affect the size of the ECB's balance sheet. The second question picks up the critique of Behrendt (2016), namely if it makes a difference which lending variable is applied. Typically, empirical studies use a variant of the outstanding stock of credit as the bank lending indicator. But to quantify the transmission mechanism of monetary policy, the exact amount of new bank lending volumes is more important. To answer both questions, different structural vector autoregressive (SVAR) models for the Euro area are estimated using monthly data since the Financial Crisis on both credit variables.

Furthermore, this paper tries to account for another shortcoming in the literature. Most empirical studies which estimate effects of non-standard monetary policies that affect central banks' balance sheets, apply a measure of the size of the unconventional monetary policies which either corresponds to the total amount of the central bank's balance sheet or the monetary base. This has important effects on the estimation results, due to the inclusion of more than the amount of unconventional monetary policies into these series. Estimations of the effects of unconventional monetary policies which aim at the size of the central bank's balance sheet should only be concerned with the excess amount of liquid-

ity provided by the central bank. Taking for example the monetary base—which consists of currency in circulation, required reserves and excess reserves—as an UMP indicator, has several drawbacks. For one, the central bank does not have full control over the amount of currency in circulation, which the public wants to hold. Additionally, there are possible cointegration issues between currency in circulation and economic output variables. Further, required reserves can hardly serve as an indicator of the amount of additional liquidity, and there exist crucial feedback effects between required reserves and bank lending. Beyond that, the total balance sheet size of the central bank is influenced by even more factors, which have no link to UMPs. Revaluations of for example gold reserves on the central bank’s balance sheet certainly have no immediate effects on bank lending by commercial banks. The same can be said for provisions and non-distributed profits. All such examples have an effect on the size of the balance sheet, which would be incorporated into the UMP series and thus distorting the variable, but can hardly be ascribed to have an effect on lending decisions by commercial banks.

While analysing the effects of unconventional monetary policies, it needs to be accounted for that unconventional monetary policies were overlapping with interest rate decisions, at least in the beginning of the crisis. The crucial task is therefore to identify exogenous monetary policy shocks to quantify the effects on economic variables. To guarantee orthogonality of both conventional and unconventional monetary policy shocks, this paper resorts to estimation specifications within SVAR frameworks, which incorporate standard and unconventional monetary policy shocks via sign restrictions. Therefore, a model set-up similar to Peersman (2011) and Gambacorta et al. (2014) is estimated in this paper. This approach has the advantage that it imposes less rigid constraints on the underlying economic theory in contrast to a Cholesky decomposition. By applying a classical Cholesky decomposition, which orders the variables from fast to slow reacting (see e.g. Christiano et al. (1998)), it would be postulated that the unconventional monetary policy variable is not influencing most other variables contemporaneously within the shock period. Using sign restrictions on the other hand, specific effects, also of contemporaneous nature, can be modelled more stringently to the underlying economic theory (see Uhlig (2005)).

The paper highlights two important results. First, unconventional as well as conventional monetary policies during the Financial Crisis were not able to stimulate bank lending in the Euro area to a large extent, while on the other hand not leading to unintended consequences, especially on resulting in greatly

elevated inflation rates, as postulated by some monetarist models.¹ While several previous studies found significantly positive reactions of bank lending to unconventional monetary policy shocks, these findings cannot be confirmed here, as reactions of bank lending—specifically on newly extended loans—to unconventional monetary policy shocks are only showing a positive, significant response in the short-run, which dies out fast. Furthermore, there are slight differences between the reactions of the new lending and the stock variable towards (unconventional) monetary policy shocks, highlighting the relevance of the insights from Behrendt (2016). It can also not be confirmed either that the unconventional monetary policies have a clear-cut positive effect on output and inflation, as several previous studies found.

The paper is structured as follows. Section 2 gives a theoretical overview of the transmission process of unconventional monetary policies towards bank lending. The effects of such policies on bank lending shall be analysed on the basis of a SVAR model in Sections 3 and 4. Section 5 draws several conclusions from the empirical estimations.

2 Transmission of Unconventional Monetary Policies towards Bank Lending

Traditionally, monetarists see unconventional monetary policies as working through the supply of central bank reserves. This *money view* postulates that monetary policy decisions result in changes of bank lending through open market operations, which change the available amount of central bank reserves. Through unconventional monetary policies, which increase the amount of reserves, commercial banks are equipped with more reserves than required. The money view now postulates that banks put these reserves "to work". It is assumed that banks increase their lending activity as a consequence of the excess reserve provision. This will be done as long as there are excess reserves. The reserve provision by the central bank would therefore lead to a likewise increase in lending. This argumentation rests on the notion of a static money multiplier theory, which postulates that central banks set an amount for the high-powered monetary base and

¹ See also IMF (2013), White (2012) for a discussion on unintended consequences from UMPs.

then the stock of money is only a multiple of that (see for example Freeman and Kydland (2000), Friedman and Schwartz (1963), or Meltzer (2010)).

With excess reserves rising by a multiple, which by definition expands M0, M1 needs to rise simultaneously, according to this static view. From the rise in the money stock through higher lending, this theory is then being expanded through the quantity theory of money to a consequent rise in inflation, as the static quantity theory requires a rise in the price level if the money stock increases (at least in the long run). Taking the equation of exchange and the money multiplier in their static form seriously, one can only conclude that an over-allotment of reserves by the central bank leads to higher bank lending and consequently to a higher price level. Asness et al. (2010) for example certainly base their critique of the first quantitative easing programme of the Fed on these grounds.

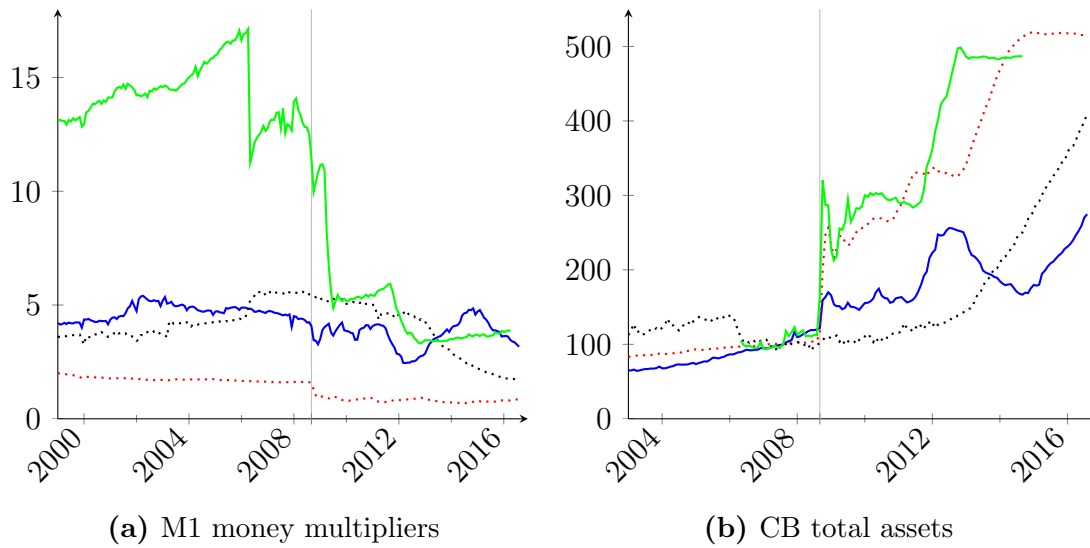
But what this theory overlooks is the fact that there is no causality in these equations. These are merely ex-post identities. In a fractional reserve banking system, as existing today, the causation does not go from the creation of bank reserves to credit expansion, but the other way around (see Werner (2014) for a real-world experiment and subsequent validation of this notion). If a bank extends a credit it acquires reserves afterwards, either on the interbank money market or through the standing facilities at the penalty rate, whenever there is a shortage in the money market (see Carpenter and Demiralp (2012)). As Dudley (2009) notes: "If banks want to expand credit and that drives up the demand for reserves, the Fed automatically meets that demand in its conduct of monetary policy. In terms of the ability to expand loans rapidly, it makes no difference whether the banks have lots of excess reserves or not." Hence, banks extend loans and acquire reserves afterwards to fulfil the average reserve requirement over the maintenance period. With abundant reserves, additional loans are only matched by extra deposits (the amount of reserves does not necessarily have to change). They are not mechanically multiplied into new loans, as predicted by the money multiplier theory. Additionally, as central banks will always allot enough reserves, commercial banks can therefore never be reserve constrained over the maintenance period, at least by amount. So there is no bottleneck on reserves, which would suddenly be lifted by higher reserve allotment.²

² If the central bank would shut down the reserve window, this could potentially lead to unwanted bankruptcies and market turmoil, as reserve allotment is no longer guaranteed.

A sudden increase in reserves does therefore not induce commercial banks to increase their lending for no apparent reason, although excess reserves might induce slightly more lending at the margin, as reserves become cheaper for banks, since interbank market rates most likely fall down to near the deposit facility with abundant reserves (at least in the Euro area, where there is an interest rate corridor). Additionally, banks do not need to pay the penalty rate, if they are not able to acquire reserves on the interbank market, as most central banks have resorted to a full allotment policy after the Financial Crisis. However, this slightly cheaper financing is not sufficiently large to make any lending reasonable. Banks still face an internal risk-return calculus on their lending decisions, which is based on the credit worthiness of the borrower, the cost of funding and capital requirements (see e.g. Georg and Pasche (2008), Jakab and Kumhof (2015), or Singh and Stella (2012)). Additionally, they have to find willing borrowers for their potential credit supply. It is therefore not reasonable to assume that the additional provision of reserves by the central bank drastically affects the incentives of commercial banks to lend to the public. Hence, the money multiplier is to be seen as an ex-post identity and not as a rigid ex-ante relationship (see also McLeay et al. (2014), Tobin (1963), von Hagen (2009)).

This is also confirmed by the fall of money multipliers in the aftermath of the Global Financial Crisis, as shown in Figure 1. Money multipliers have fallen distinctly since then in many economies, as broad money aggregates have not held up with the rise in the monetary base due to the over-supply of central bank reserves.

If central banks are not able to directly support lending and therefore economic activity through the transmission postulated by the money view, how might unconventional monetary policies work then? To answer this question, this paper predominantly concentrates on two policies that affect liquidity in the banking sector through the supply of additional reserves by the central bank, namely bank reserves policy and quantitative easing. These are the two unconventional policies on which the ECB laid its focus in the aftermath of the Financial Crisis.

Figure 1: Money multipliers and central bank assets

Note: Data for the Euro area (—), Federal Reserve (·····), Bank of England (—), Bank of Japan (·····)). The vertical lines indicate the time of the Lehman crash in 9/2008. Sources: ECB, Fed, BoE, BoJ.

Bank reserves policies are directly aimed at providing banks with large amounts of excess reserves via longer-term reverse-repurchase operations. After the Financial Crisis interbank markets experienced a drastic decline in overnight lending activity, because of mutual doubt of commercial banks about their financial health (see e.g. Frutos et al. (2016)). This led to a reserve shortage of some banks, who had to borrow these at the ECB with a penalty, while others built up large amounts of reserves without providing them on the interbank market. This in turn led to an increase in the interbank market rate, which made refinancing for reserve constrained banks more expensive. In order to lower market rates, the ECB supported liquidity in the interbank market by switching to a fixed-rate, full-allotment strategy. Furthermore, the ECB offered longer-term refinancing on several occasions and under different conditions to mitigate bottlenecks in the interbank market and give banks balance sheet relieve (see e.g. Rogers et al. (2014) for a short overview). The expansion of the ECB's balance sheet through these policies is due to an increased demand for liquidity, as banks requested higher amounts of additional reserves, while providing the ECB with the required collateral in exchange. The effects on commercial banks' and the central bank's balance sheets from reserve policies are illustrated in Table 1:

Table 1: Impact of reserves policy on balance sheets

Commercial Bank		Central Bank	
Assets	Liabilities	Assets	Liabilities
+ Reserves		+ Securities	+ Reserves
- Securities			

On the other hand, *quantitative easing* (QE) policies are purposefully supply driven by the central bank. Through such outright asset purchases, specific securities from banks and the non-bank public are bought and taken onto the central bank's balance sheet, via open market operations. Such purchases can consist of government bonds, covered bonds or asset backed securities, for example. Central banks aim to purchase these securities mainly from the non-bank public, such as insurance companies or pension funds. But since these are not eligible to transact with the central bank directly, such purchases have to be intermediated through depository institutions. The bank of the non-bank public credits them with a deposit in exchange for the asset. Then the central bank swaps this asset for newly created reserves with the depository institution. Banks therefore not only gain central bank reserves, but also a corresponding increase in customer deposits (see Table 2 for a schematic illustration, and Benford et al. (2009), McLeay et al. (2014), or Joyce et al. (2012) for a more in depth discussion). Thus, the difference is that through the intermediation activity of the banking sector, their balance sheets expand, while this is not the case for direct purchases or reserves policy. But in both scenarios, the private sector's net worth remains unchanged. QE can therefore merely be seen as an asset swap, which changes the composition of outstanding private sector assets. So, the aim of these purchases is to support liquidity in specific financial market segments, and not to add net financial assets, as often-times assumed by using the term *money printing* equivalently to QE purchases. Thus, QE is mostly aimed to provide liquidity to lower interest rates in specific financial market segments.³ Additionally, by buying securities from the private through the banking sector, central banks take risks off the balance sheets of the public onto their own balance sheet. The higher liquidity and

³ Further, through higher liquidity, non-banks shall be incentivised to invest their newly received deposits in higher yielding assets, such as bonds and shares. This in turn will raise the values of these assets and thus lower funding costs of corporations. This might then induce the private sector to spend more through wealth effects.

lower risk in turn might *indirectly* induce banks and the public to engage in more lending activity.⁴

Table 2: Impact of QE on balance sheets

Non-Bank		Commercial Bank	
Assets	Liabilities	Assets	Liabilities
- Securities		+ Reserves	+ Deposits
+ Deposits		+ Securities	
		- Securities	

Central Bank	
Assets	Liabilities
+ Securities	+ Reserves

So, while QE policies are designed to expand the liability side of the central bank balance sheet by a pre-defined amount, reserves policies are demand driven and (in the case of the ECB) are virtually without a limit.⁵ While differing in their implementation, both policies are supposed to affect the economy through similar transmission channels (see also Altavilla et al. (2016a)). In essence, both are designed to give balance sheet relief to banks and the public through lower interest rates and higher asset prices.

The following section shall empirically evaluate to which extend the UMPs by the ECB were able to revive the transmission of monetary policy, with a special focus of these balance sheet policies towards bank lending.

3 A SVAR Model for the Euro Area

3.1 Baseline Specification

Structural VAR models typically try to estimate effects of standard monetary policies towards economic variables (see e.g. Christiano et al. (1998), or Peers-

⁴ Whereas, bank lending could also potentially shrink due to QE measures, if companies issue more alternative funding (bonds and equity), to pay back bank credits (see McLeay (2014)).

⁵ Although there is an implicit limit by the amounts of credible collateral held by the public, which the central bank deems worthy for the operations.

man and Smets (2001)). In contrast to classical monetary policy SVARs using a Cholesky decomposition on the ordering, SVARs with sign restrictions are able to impose very little economic theory to the structure of the data, and are therefore more flexible in regard to the concrete research question.

SVAR models with sign restrictions estimate a simple reduced-form VAR model and then define a set of sign restrictions on specific variables in the impulse response functions (IRFs) to identify one particular shock. For the shock in question, a random draw of a given number (at least enough to be necessary to identify the model) of IRFs satisfying these restrictions is realised. If enough IRFs are estimated, the median response and the confidence bands can then be obtained through inference in a typical fashion (see Rubio-Ramirez et al. (2010), Uhlig (2005)).

The baseline reduced-form VAR model has the following representation (see Lütkepohl (2005), Kilian (2013) for the following):

$$y_t = \nu + A_1 y_{t-1} + \dots + A_p y_{t-p} + u_t \quad (1)$$

with y_t as a $k \times 1$ vector of the endogenous variables, $A(L)$ as the autoregressive lag order polynomal, $\nu = A(L)\mu_0$ as the vector of the intercepts, and u_t as the one-step ahead prediction error of the disturbances, with a zero mean, zero autocorrelation, and variance covariance matrix

$$\sum = E(u_t u_t'). \quad (2)$$

But as the elements of u_t might still be correlated across the equations, there is, in principle, no structural interpretation out of this system possible. This is accounted for in structural models, where the structural innovations are assumed to be mutually uncorrelated. A structural VAR model can then be represented by:

$$B_0 y_t = \nu + B_1 y_{t-1} + \dots + B_p y_{t-p} + \varepsilon_t, \quad (3)$$

with B_i , $i=0,\dots,p$, as a $k \times k$ matrix of parameters and ε_t as the structural, mutually uncorrelated shocks following a standard-Normal distribution with zero mean and unit variance. Without loss of generality and to keep the notation simple, let's assume that y_t is zero mean. Thus, the shocks are uniquely identified and can be interpreted in an economic context.

The reduced form Equation 1 and the structural model Equation 3 are linked by the matrix B_θ , which describes the contemporaneous relation between the variables. The link between both expressions is given by:

$$A_p = B_0^{-1} B_p. \quad (4)$$

The estimation of B_θ requires restrictions on some parameters, given that without these only $k(k+1)/2$ parameters can be uniquely identified. This is done by applying identifying assumptions on specific relations, so that the innovations and the IRFs are just-identified (see Lütkepohl (2005), Uhlig (2005)). Doing this, the mutually correlated reduced form innovations u_t are weighted averages of the structural innovations ε_t , with B_0^{-1} serving as the weights:

$$u_t = B_0^{-1} \varepsilon_t. \quad (5)$$

The structural innovations ε_t , which are obtained from Equation 5, are assumed to be orthonormal, i.e. its covariance matrix is an identity matrix

$$E(\varepsilon_t \varepsilon_t') = I. \quad (6)$$

The baseline model at hand contains six variables: the log of the industrial production index (IPI), the log of the consumer price inflation index (HICP), the log of bank lending (new lending and the outstanding stock, respectively) (Lending), MFI lending rates (MIR), the EONIA rate (EONIA) and the level of excess reserves (monetary base minus currency in circulation and required reserves (Reserves)).⁶ The model is estimated in log levels, since all variables are integrated of order one, and thus the estimators remain consistent and the marginal asymptotic distributions remain asymptotically normal (see Sims et al. (1990)).

Variable choices are mainly following the model of Peersman (2011), whose main interest is also on the effects of unconventional monetary policy on lending volumes. The frequency of the main model is monthly from 2007M08 to 2016M07. The start of the estimation period is restricted to the beginning of the liquidity-providing longer-term refinancing operations (LTRO) up to three

⁶ Data sources and details can be found in Table 6 in the Appendix on page 31.

months by the ECB in August 2007. Several robustness checks on different indicators for the UMPs are performed (specifically with the *shadow rate* proposed by Wu and Xia (2016), as well as monetary policy announcement effects on bond yields and on term spreads), although the main focus is on operations that affect the excess amount of liquidity through reserve accommodation and QE. The lag length is set to 2, according to the Schwarz Information Criterion (SIC), and is also in line with the majority of the related literature. The Akaike Information Criterion (AIC) proposes a longer lag length. Therefore, longer lag lengths are also considered as a robustness check.

For the output variable, industrial production (IPI) is applied, as the focus is on lending activity to the non-financial corporate sector. Prices are proxied by the Harmonised Index of Consumer Prices (HICP). The estimations contain bank lending and interest rates on lending to non-financial corporations. Two lending variables are applied for each specification and ultimately compared, to account for the insights of Behrendt (2016). For new lending, new business volumes of loans to non-financial corporations from the MIR statistics are taken. The stock amount of credit is the outstanding volume of MFI loans to the private sector. Lending rates are also from the MIR statistics and cover new business loans other than revolving loans and overdrafts, convenience and extended credit card debt. The policy rate is proxied by the EONIA rate, as the ECB conducts its policy by steering interest rates around the overnight money market rate. The EONIA thus captures standard monetary policy decisions (see also Ciccarelli et al. (2015) for example). It is justifiable to apply the EONIA rate instead of only the rate for main refinance operations of the ECB, as the ECB policy rate virtually approached the zero lower bound in 2014 and there would be no movement visible afterwards. Contrary, the ZLB is not binding for the EONIA rate. There was still sufficient movement in the EONIA down to almost the deposit facility rate since 2014, which further reflects the more expansionary stance of the ECB on its policy rate decisions to additionally lower the deposit facility while keeping the main refinancing operations rate constant—as for example done in December 2015. The movement in the EONIA can also be accounted through the extended forward guidance policies by the ECB, which were able to further suppress market rates, despite little movements in the policy rate (see Altavilla et al. (2016a)).

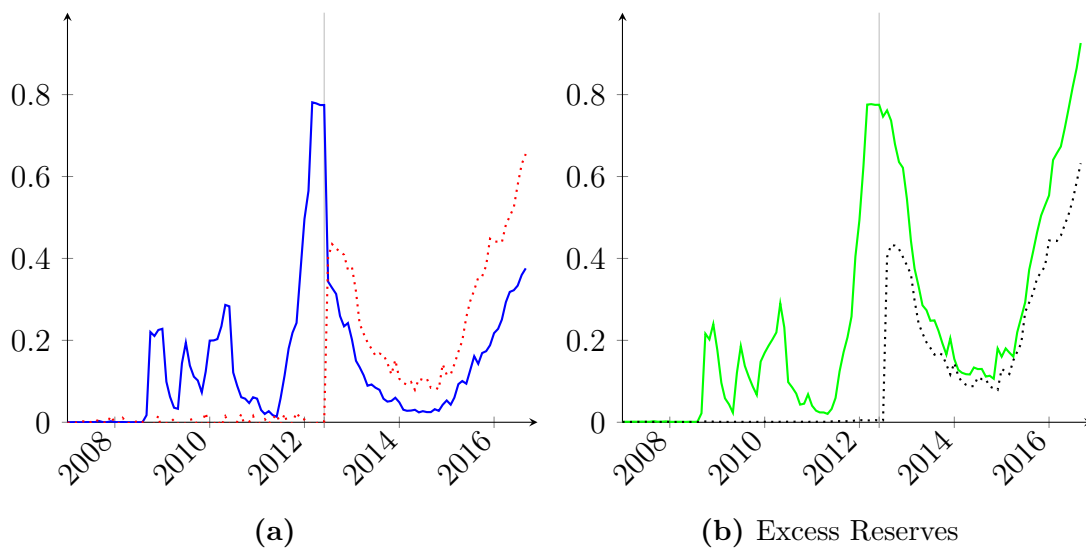
As the unconventional monetary policy indicator, excess reserves are taken in the baseline estimation. These are calculated as the monetary base less currency in circulation and required reserves. This stands in contrast to similar stud-

ies estimating the effects of unconventional monetary policies on bank lending. Peersman (2011) for example applies the monetary base as the UMP variable, while Gambacorta et al. (2014) and Boeckx et al. (2014) apply total assets of the central bank. The application of these broader definitions has several drawbacks. Firstly, the monetary base includes currency in circulation, which leads to a co-movement of the lending and UMP indicator before the Financial Crisis, as both grow similarly with economic activity. Further, as decisions of the private sector to hold cash are not really influenceable by monetary policy, it is not quite clear as to why to incorporate them into the UMP variable. Additionally, the monetary base also includes required reserves. As they need to increase with loan extension, because a certain percentage of each new loan needs to be underwritten with reserves, there is a feedback loop between lending and reserves, which further contributes to the co-movement of the stock of outstanding credit with the monetary base. A positive movement of the UMP variable induced by higher required reserves would have therefore by definition already increased lending, absent all other influences. Thus, by excluding required reserves from the estimation, the true unconventional monetary policy decisions, which affect additional liquidity provision, are reflected more compellingly. With regard to total assets, they include even more operations by the central bank, which have if any, then only a loose effect on additional intra-Euro area bank lending, as mentioned before in Section 1.

For the calculation of the excess reserves, the method as mentioned above is applied, which is the monetary base minus currency in circulation minus required reserves. Since the monetary base at the ECB is including reserves parked in the deposit facility and the current accounts, taking the excess reserves data directly from the ECB would be incomplete, as this statistic only incorporates amounts parked in the current accounts (less minimum reserves). With the reduction of the penalty rate to zero on the 11th of July 2012, banks transferred a large amount of excess reserves into the current accounts, to not have to book it anew into the deposit facility on each working day (see Figure 2 (a)). But as the amounts in the deposit facility do not appear in the excess reserves series of the ECB, this would then be reflected as an unconventional monetary policy easing, due to the sudden rise in the official excess reserves statistic. This would give an incomplete picture, as the amounts in the deposit facility are still representing excess liquidity which banks hold (and are also counting towards the monetary base). The transfer into the current accounts can therefore not

be seen as an unconventional monetary policy decision, but was only done by banks to avoid a re-booking of excess liquidity into the deposit facility at the end of each working day. Because of the zero penalty rate, this need vanished. By only taking the excess reserve statistic as provided by the ECB, this series would effectively be zero until July 2012 (see Figure 2 (b)), which does not reflect the expansive monetary stance by the ECB directly after the Financial Crisis adequately. Thus, the amounts in the deposit facility are also considered for the excess reserves variable in the estimation, to better cover the ample liquidity in the banking sector.

Figure 2: Excess reserves in the Euro area



Note: Figure 2 (a) depicts the deposit facility (—) and current accounts less minimum reserve requirements (·····). Figure 2 (b) compares the excess reserves statistics as calculated in this paper (—) and provided by the ECB (·····). The vertical lines depict the month when the ECB lowered the penalty rate to zero, thus inducing a large transfer of funds from the deposit facility into current accounts. All data are in trillion Euro. Source: ECB.

3.2 Identification Strategy

In recent years, SVARs using sign restrictions have become increasingly popular in response to some critical points about simple Cholesky orderings (see e.g. Rudebusch (1998), or Kilian (2013)). Sign restrictions are seen as superior to Cholesky decompositions, as they do not impose as rigid constraints on the underlying economic theory. With the added flexibility, it is possible to reflect the feedback effects more rigorously in comparison to the recursiveness assumption. To accomplish this, qualitative restrictions on certain shocks for some variables

are used as an identification scheme. Most notably is the restriction method proposed in a monetary policy setting by Uhlig (2005).

Due to the identifying assumptions, it is possible to isolate exogenous UMP shocks. To identify these exogenous innovations to excess liquidity, a mixture of sign and zero restrictions on a specific set of shocks in the contemporaneous matrix B_0 , as depicted in Table 3, is applied. These restrictions are similar to those in Peersman (2011).

Table 3: Sign restrictions for the shocks in the baseline estimation

	IPI	HICP	Lending	MIR	EONIA	Reserves
UMP/Reserves shock	0	0	≥ 0	≤ 0	0	≥ 0
Standard MP shock	0	0	≥ 0	≤ 0	≤ 0	

It is assumed that an unconventional monetary policy shock only impacts output and consumer prices with a lag. The contemporaneous impact is therefore set to zero for both variables. This assumption can be validated using monthly data in order to disentangle monetary policy shocks from disturbances originating in the real economy (see e.g. Christiano et al. (1998), or Peersman and Smets (2001)). On the other hand, innovations of output and prices can impose an immediate effect on excess reserves. Shocks in the real economy can therefore exert a contemporaneous impact on the credit market.

In the baseline specification, there is a non-negative restriction on the sign for bank lending in response to an UMP shock. Peersman (2011) restricts the response of bank lending to only the third and fourth lag after the disturbance. He validates this by the notion that lending to non-financial firms can potentially react positively to a policy rate hike in the short-run due to drawdowns of pre-existing credit lines in a worry of rising lending rates in the medium term. Giannone et al. (2012) confirm this by showing that lending to firms responds negatively only with a lag. But, for the estimation here, the specific lag restriction does not make a difference, as the immediate response is in line with the responses of the subsequent periods in the estimations. As only unconventional monetary policies which influence the volume of new lending in a positive way are of importance for this study, the imposing non-negative sign in only the first period can be validated. Negative innovations to lending are therefore captured by the other variables and shocks in the system. For example, if a fall in lending is due to a fall in output, these reactions should be visible in the data.

UMP shocks are further assumed to have a non-positive impact on bank lending rates, as looser monetary policies should lead to lower lending rates,

because of cheaper refinancing and lower financial risks (see Woodford (2003)).

To clearly identify non-monetary policy innovations, orthogonality between UMP and standard interest rate disturbances have to be ensured. By imposing a non-contemporaneous response of the EONIA rate (zero sign), orthogonality of both types of monetary policies can be guaranteed.

While looking at unconventional monetary policy shocks during the estimation period after the Financial Crisis and their effects on bank lending is helpful to understand the transmission mechanism of these policies, it might also be helpful to analyse if standard monetary policies were able to influence bank lending. Especially for the Euro area, where the zero lower bound on the policy rate was not reached until 2014, there were still enough movements in the policy rate to potentially have an effect on lending and economic activity in the earlier stages after the Financial Crisis. Such standard interest rate innovations—labelled *Standard MP shock* in Table 3—are represented by a fall in the EONIA rate, to have the signs corresponding to the easing of monetary policy by expanding excess reserves. The standard monetary policy shock is assumed to have a negative effect on lending rates, meaning a fall in the EONIA is identified with a likewise fall in lending rates. Conversely, credit volumes are assumed to not fall on impact. Responses to output and inflation are, like for the UMP shock, assumed to not react contemporaneously. These restrictions are also in line with those in Peersman (2011).

4 Estimation Results

4.1 Baseline Estimation

The benchmark VAR model is estimated from 2007M8 to 2016M7 using two lags on the endogenous variables. A Bayesian approach, as proposed by Uhlig (2005) and applied in a similar setting by Peersman (2011), is used for estimation and inference. Normal-Wishart prior and posterior distributions of the reduced form VAR are applied, as well as a random possible decomposition B of the variance-covariance matrix (see Baumeister and Hamilton (2015)). If the IRF of the specific draw satisfies the restrictions, it is kept. Otherwise, the draw is rejected. In total, 2000 successful draws from the posterior are applied to produce the IRFs, which show the median values, while also depicting the 68 percent posterior probability bands.

Figure 3 shows the impulse response functions for the unconventional monetary policy shock using the new lending variable. The blue straight lines show the median responses to an unconventional monetary policy shock, while the grey areas around it represent the 16th and 84th percentiles of the posterior distribution of the estimated responses.

The UMP shock is characterised by an increase of excess reserves between 0.5 and 2.5 percent. The shock is positively significant for up to about nine months, with a peak in the median response after three months. Output and prices are restricted to have a zero contemporaneous response for the first month after the shock. For the following months, this restriction is lifted. Instead of immediately positively contributing to economic activity, output falls for the first ten months after the shock, although turning positive in the medium term. Additionally, there is no significant impact on prices visible.⁷ For both variables, the results stand in contrast to estimations of similar studies for shorter time horizons after the Financial Crisis, as for example found by Boeckx et al. (2014) or Gambacorta et al. (2014).

Further, bank lending rates are falling for about one year and a half after an UMP shock. The response of the EONIA rate is characterised by a medium term fall after an UMP shock, with a low after about nine months.

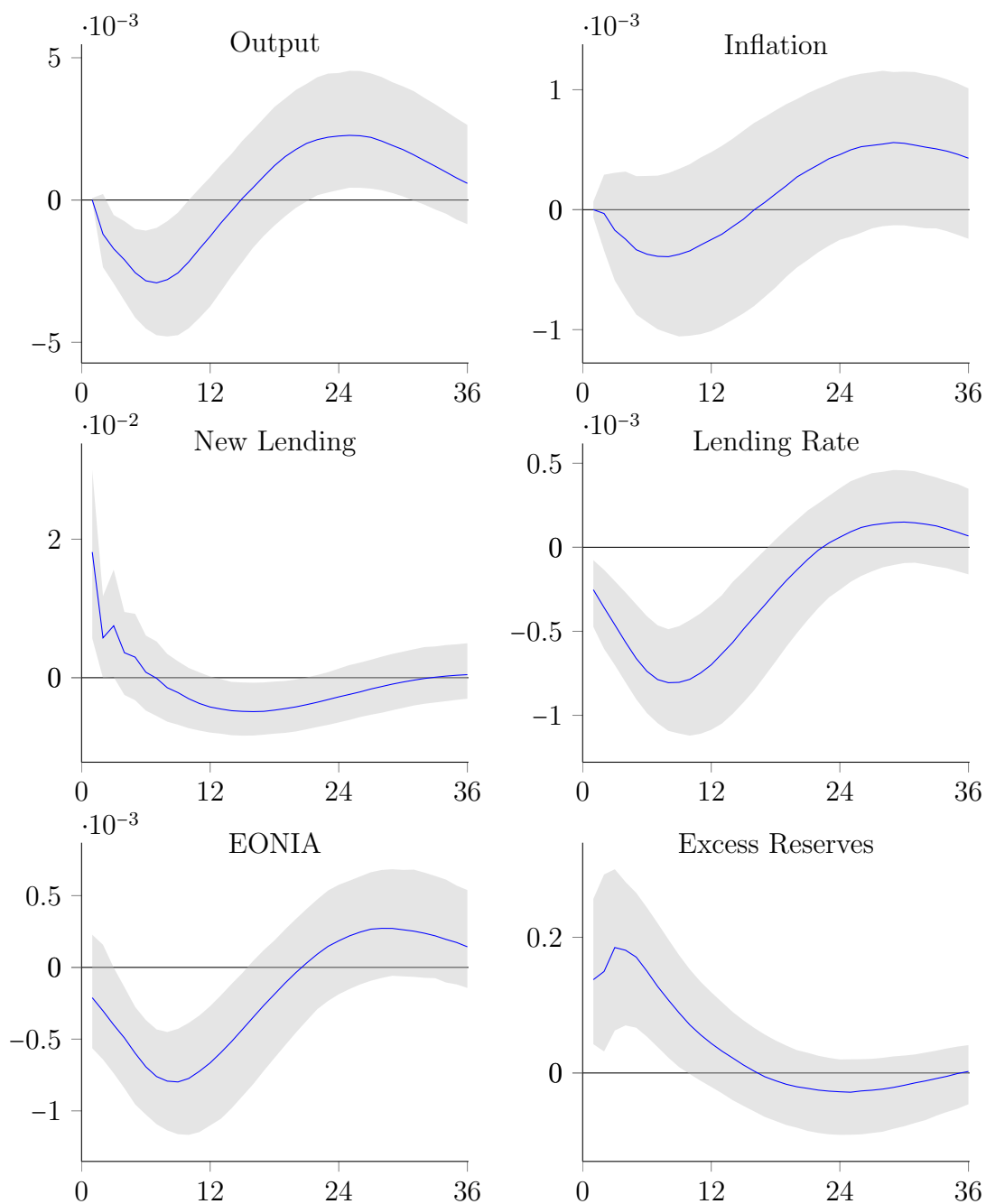
More interestingly for the aim of the paper is the response of lending to an UMP shock. Imposing a non-negative contemporaneous restriction, the new lending IRF shows a positive response for the first three months after the shock. While having no sign restriction for the new lending variable, the response becomes insignificant, although the median response is still positive for the first three periods after the shock.

Constraining the estimation period to the first few years after the Financial Crisis (until December 2012), the results qualitatively stay the same, only with a more pronounced negative median response of prices. The effect on all other variables, especially bank lending, stay qualitatively the same. Also, using longer lag lengths does not alter the general results of the estimation.

The IRF analysis here is able to show that the provision of excess liquidity by the ECB after the Financial Crisis has no significant long-term impact on

⁷ This holds also true if instead of consumer prices producer prices are applied.

Figure 3: UMP shock on new lending



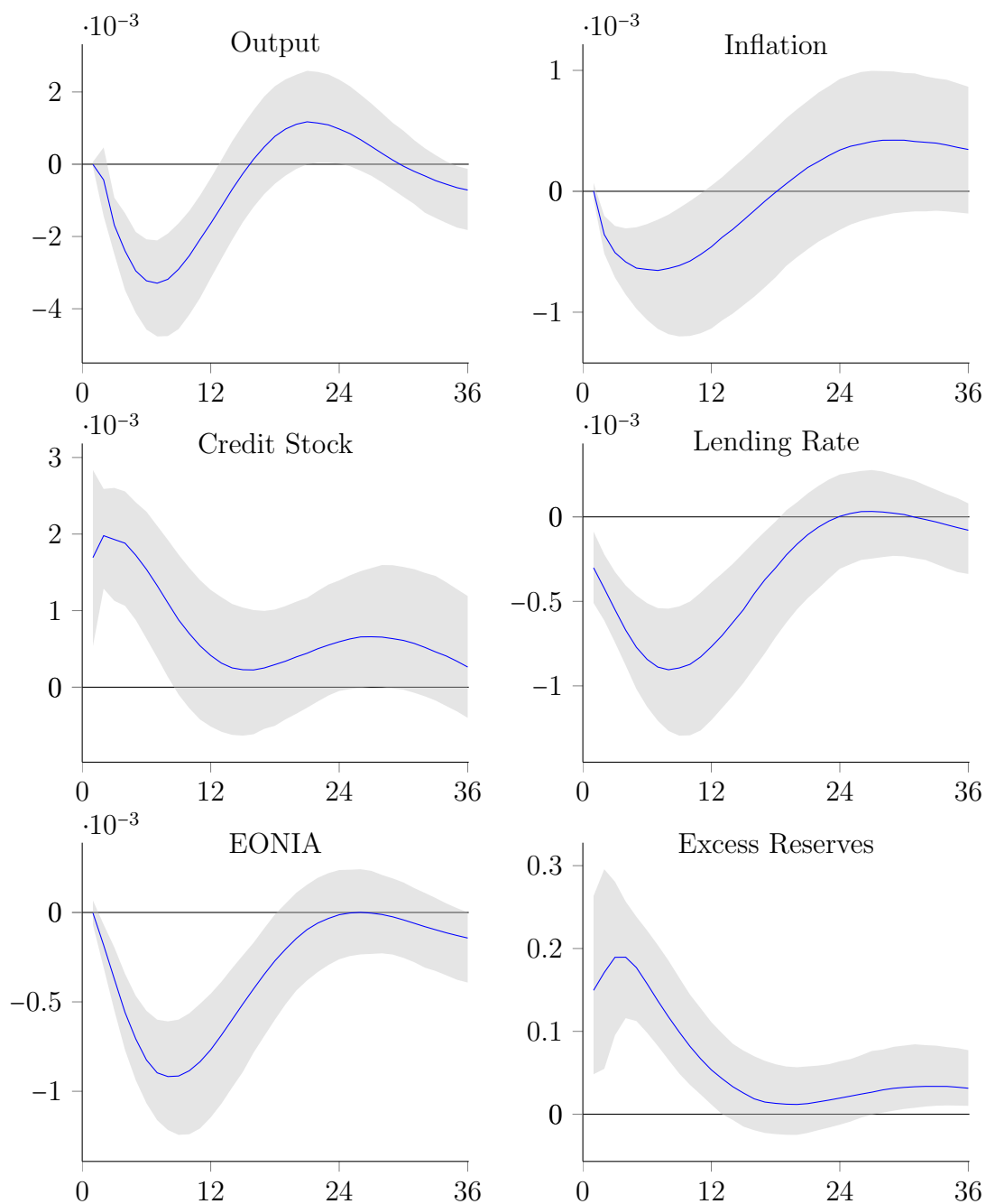
Note: Impulse responses from an UMP easing shock. 68% confidence intervals (2000 replications).

lending activity. Although these policies might have contributed to lower lending rates and higher liquidity on bank's balance sheets, they did not induce banks to significantly increase lending. This might be explainable by the high uncertainty after the Financial Crisis, as well as bad economic conditions constraining credit supply and demand. As shown by the ECB in their Bank Lending Survey (BLS), banks increased their credit standards significantly after the crisis, thus constraining the availability of bank loans. This was mainly due to worsening capital positions, as well as negative impacts of reduced general economic activity (see ECB (2014a)). Additionally, credit demand receded simultaneously after the crisis. The main factor for reduced credit demand was—as mentioned by enterprises in the survey of Access to Finance of Enterprises (SAFE)—given by concerns of finding customers and the subdued general economic outlook, while access to finance played an elevated role only in the beginning of the Financial Crisis. These constraints were especially pronounced in crisis hit countries. Respondents in these countries (mainly Greece, Italy, Portugal and Spain) were also discouraged to demand credit by too high interest rates, as this was the main reason for enterprises to not demand loans in these countries (see ECB (2014c)). Real economic impacts thus might have offset the positive effects of the UMPs by the ECB, resulting in only small short-run positive impacts of these policies on bank lending.

While using the outstanding stock as the lending variable, the response of the bank lending indicator is markedly more positive and for a longer horizon significant (for about eight months), with the median response being positive throughout (see Figure 4). Previous similar studies found a strictly positive response of the credit stock. But this result can also not be validated with this study. All other responses are qualitatively the same as for the specification with the new lending variable. Without a restriction on the credit variable, the response of the outstanding stock of credit to an UMP shock also becomes insignificant (although the median response is still distinctly more positive than for the new lending specification).

Comparing the responses of both credit variables, it is visible that the positive impact of an UMP shock on new lending dies out much quicker than for the stock variable. Analysing the effects of UMPs on bank lending using the stock might therefore overstate its impact, as the positive effect on new lending is not that long-lasting as the stock variable might indicate. Taking the same variable and lag restriction approach as Peersman (2011), i.e. the policy rate (MP Rate) instead

Figure 4: UMP shock on the credit stock



Note: Impulse responses from an UMP easing shock. 68% confidence intervals (2000 replications).

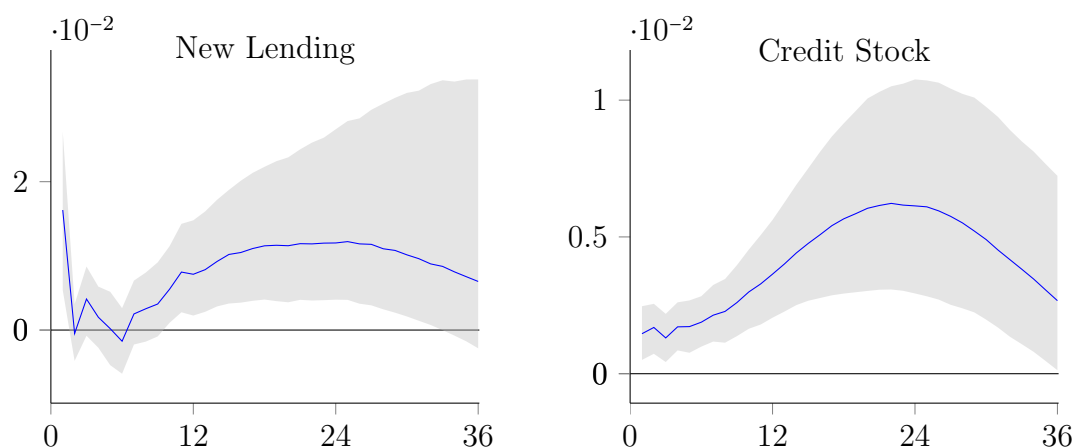
of the EONIA and the monetary base instead of excess reserves, the reaction of the stock would be positively significant for an even longer time (eleven months).

The responses to the conventional monetary policy shock are qualitatively the same for both lending variable set-ups (see Figure 11 and 12 in the Appendix on page 32 and 33). As for the QE shock, new lending responds positively for a significantly shorter period of time, in comparison to the credit stock. Likewise, output and inflation does also not react positively to a standard monetary policy shock.

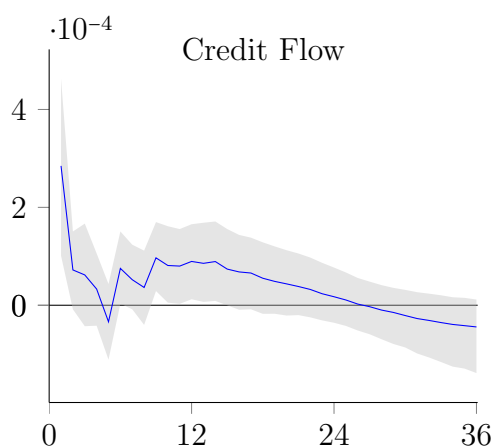
Three main insights come out of the IRF analysis. First, the clearly positive and increasing impact of UMPs on bank lending visible in other studies cannot be confirmed here. The positive reactions die out fairly quickly after the UMP shocks for the period after the Financial Crisis. Second, the positive reaction is even less pronounced while using the new lending variable instead of the stock variable. And lastly, monetary policy shocks after the Financial Crisis seem not to be able to stimulate output and elevate prices.

Taking the model set-up as in Peersman (2011) for the time-frame before the Financial Crisis (2003M01 to 2009M12; earlier data is not available for the new lending variable), but with new lending, the response of new lending is only positively significant in the third and fourth period, those where the restrictions apply. Taking the restrictions as in the baseline representation in this paper, the positive response already becomes insignificant in the second period, although lending recovers after about a year and becomes positive again for about another year and a half (see Figure 5). Applying the stock for this period yields quite the same results as in Peersman (2011). The positive credit response, especially in the short run, is thus mainly driven by the stock variable, mostly irrespective of before or after the crisis. Applying the new lending variable leads to a breakdown of this strictly positive result for lending to an UMP shock.

Consequently, using the flow of the credit stock yields similar results as for the new lending variable, as shown in Figure 6 (see Behrendt (2016) for a reasoning on this). The flow variable here only contains new loans, repayments and revaluations. Securitised and written-off loans do not fall into the estimation (see ECB (2012)). Thus, a large amount of the disturbances are already out of the estimation. Furthermore, repayments are probably distributed fairly evenly in the short-run, so they do not distort the flow too much. Additionally, revaluations might not even be that large in relation to new lending, thus probably also not distorting the flow variable that heavily.

Figure 5: UMP shock on bank lending for the period 2003-2009

Note: Impulse responses from an UMP easing shock. 68% confidence intervals (2000 replications).

Figure 6: UMP shock on the credit flow for the period 2003-2009

Note: Impulse responses from an UMP easing shock. 68% confidence intervals (2000 replications).

In essence, the positive response of lending in response to UMPs found in other studies is due to the choice of the credit variable. Taking new lending instead of the stock leads to a partial breakdown of these findings. Several reasons are responsible for this. For one, the use of the outstanding stock of credit might lead to stock-flow inconsistencies (see Biggs and Meyer (2013), or Huang (2010) for a discussion of this problem). This notion is validated by the fact that the response of the flow variable of the credit stock is showing similar results as the new lending variable. Further, results are also likely to be skewed by the other

factors except new lending comprising the change of the credit stock variable. And lastly, the high inertia in the stock, as newly issued credits make up only about 15 to 23% of the outstanding stock of loans to non-financial corporations in the Euro area, is contributing to the higher positive response of the stock IRF in the later periods after the shock.

4.2 Further Specifications

Effects of UMPs on bank lending only defining by the size of the amount of excess reserves might miss out on important central bank policies, which go further than interest rate decisions and manipulations of provided liquidity. In addition to these tools, central banks have also resorted to enhanced communication policies, better known as *forward guidance*. Their aim is to lower market rates on the longer end of the yield curve through credible communication strategies (see Filardo and Hofmann (2014)). The ECB for example resorted to forward guidance in a way as to promise to keep rates low for a long period of time, to reduce inflation premia on long-lasting contracts. This in turn should lead to higher credit demand, as lending becomes relatively cheaper.

Typically, announcement effects of monetary policy are accounted for by using high frequency financial market data and employing them on lower frequency data (see e.g. Rogers et al. (2014)). Such studies identify surprise components of monetary policy announcements, using changes in money market future rates around the days of ECB policy meetings. Due to the lack of market futures data to the author, a more simplified approach is taken here. The assumption here is that surprise announcements by the ECB of either unconventional monetary policies or enhanced forward guidance lead to a fall in risk free interest rates (Altavilla et al. (2016b)). Typically the prices of financial indicators who are associated with the policy rate already incorporate expected responses of the policy rate. But as above mentioned announcements are typically unforeseen, market rates typically do not incorporate such information. Variations on these surprise policy announcement days can therefore be seen as the response to these. They can then be treated as exogenous with respect to other economic events (see Gürkaynak et al. (2005)). According to Altavilla et al. (2016b), changes in two-year government bond yields can be seen as a reasonable proxy to reflect such announcements, as the target horizon of these announcements lies in the medium-term. Here, only two-year German Bund yields are considered, as they can be seen as relatively risk free (see also Hachula et al. (2016)). Subsequently,

the change of the yield of the closing date before the announcement day to the closing yield on the announcement day is considered to be the effect due to the policy announcement.⁸ Decreasing yields are seen to be associated with a further monetary easing. Therefore, signs are as for the UMP shock in the baseline specification, except that the announcement here has a non-positive sign.

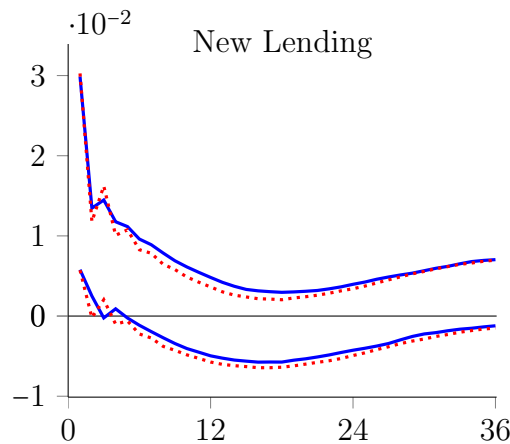
Alternatively, Meinus and Tillmann (2014) take another approach, in which they determine the policy announcements as a binary system. In a month with a further easing announcement, the variable takes the value 1, in all other months it is set to zero.⁹ The reason for such a strategy is that announcements of unconventional monetary policies might have already been incorporated into yields before the announcement, if market participants expect such announcements, even though most announcements can still be seen as surprising. A movement on the day of the announcement can thus not represent a surprise response to such an event. On some announcement days yields rose, even if a fall would have to be anticipated. This might be because market participants expected further easing than ultimately announced, and therefore revised their expectations. Only taking this simple approach can mitigate such anticipated movements before the announcements. The same dates as in the above mentioned methodology are taken here, too. The sign for the announcement is non-negative, meaning a positive response is associated with a policy easing.

Results for new lending to both announcement shocks can be seen in Figure 7. The blue straight lines depict the 68% probability bands for the first announcement variable (daily changes), while the red dotted lines show the bands for the second announcement methodology (binary values). Both estimations show a similar pattern as the baseline specification for the reserves shock. For the first three months, responses are significantly positive, while dying out quickly. Responses to the other variables are also similar (not being reported here).

An alternative methodology applies spreads between long- and short-run interest rates. Here, specifically the difference between the 12-month and 1-month Euribor rate is considered. This term spread is supposed to decline with en-

⁸ The dates are taken from Rogers et al. (2014) and Hachula et al. (2016). Until August 2016 there were no further announcements, which would validate the addition of another event.

⁹ There are no contractionary announcements. Thus no event has been identified with a value of -1.

Figure 7: Announcement shocks on new lending

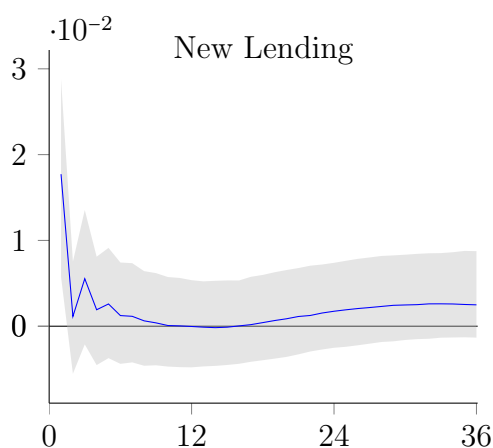
Note: Impulse responses from an UMP easing shock. 68% confidence intervals (2000 replications). Shock 1 (—) and Shock 2 (.....).

hanced forward guidance policies, as longer rates react considerably stronger to announcements to keep interest rates low for a longer period of time, than short-run rates (see ECB (2014b)). The term spread is added into the system instead of the reserves variable and is restricted with a non-positive sign. All other signs are as in the baseline specification (see Table 4). New lending is reacting to this shock only in the impact period positively, which is due to the restriction (see Figure 8). Without the restriction, new lending is insignificant throughout all lags. All other variables are again similar in their response, instead that the output variable is not reacting negatively significant all throughout.

Table 4: Sign restrictions for the shocks in the term spread estimation

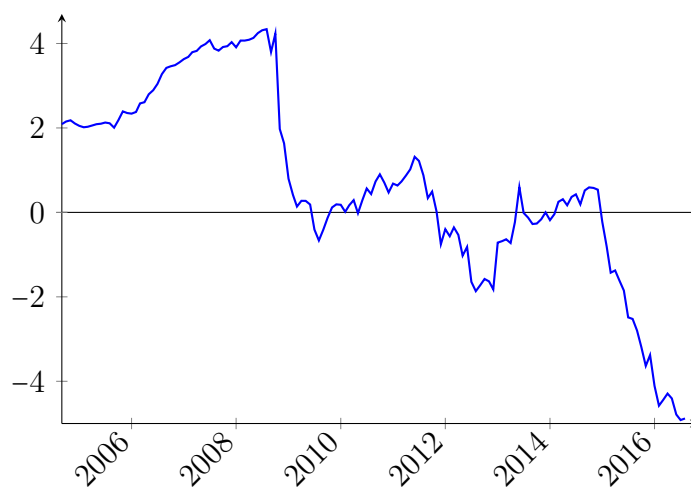
	IPI	HICP	Lending	MIR	EONIA	Spread
UMP shock	0	0	≥ 0	≤ 0	0	≤ 0

Furthermore, a different approach of modelling UMPs is added. Generally, there is the challenge of modelling standard and unconventional monetary policies together. With policy rates approaching the zero lower bound, they no longer contain information about the monetary policy stance. Thus, typically two separate indicators have been applied to capture additional monetary policy actions. One way, which is presented in the models before, is to use an indicator for standard policy rate decisions (e.g. the EONIA rate) and to add another indicator for unconventional measures (e.g. excess reserves).

Figure 8: UMP shock using the term spread

Note: Impulse responses from an UMP easing shock. 68% confidence intervals (2000 replications).

Wu and Xia (2016) try to combine both policy measures by constructing a single indicator which captures both kinds of monetary policies. It subscribes amounts of quantitative and qualitative easing policies in a way to add them to the policy rate once they reach the ZLB via a shadow rate term structure model (SRTSM)—first proposed by Black (1995). Since the UMPs provide the economy with further monetary easing, their indicator can fall below the ZLB. They call their indicator the *shadow rate*. This indicator can then better capture the more expansionary monetary policy stance than only taking the central bank refinancing rate, which is constrained by the zero lower bound (see Figure 9).

Figure 9: Shadow rate for the Euro area

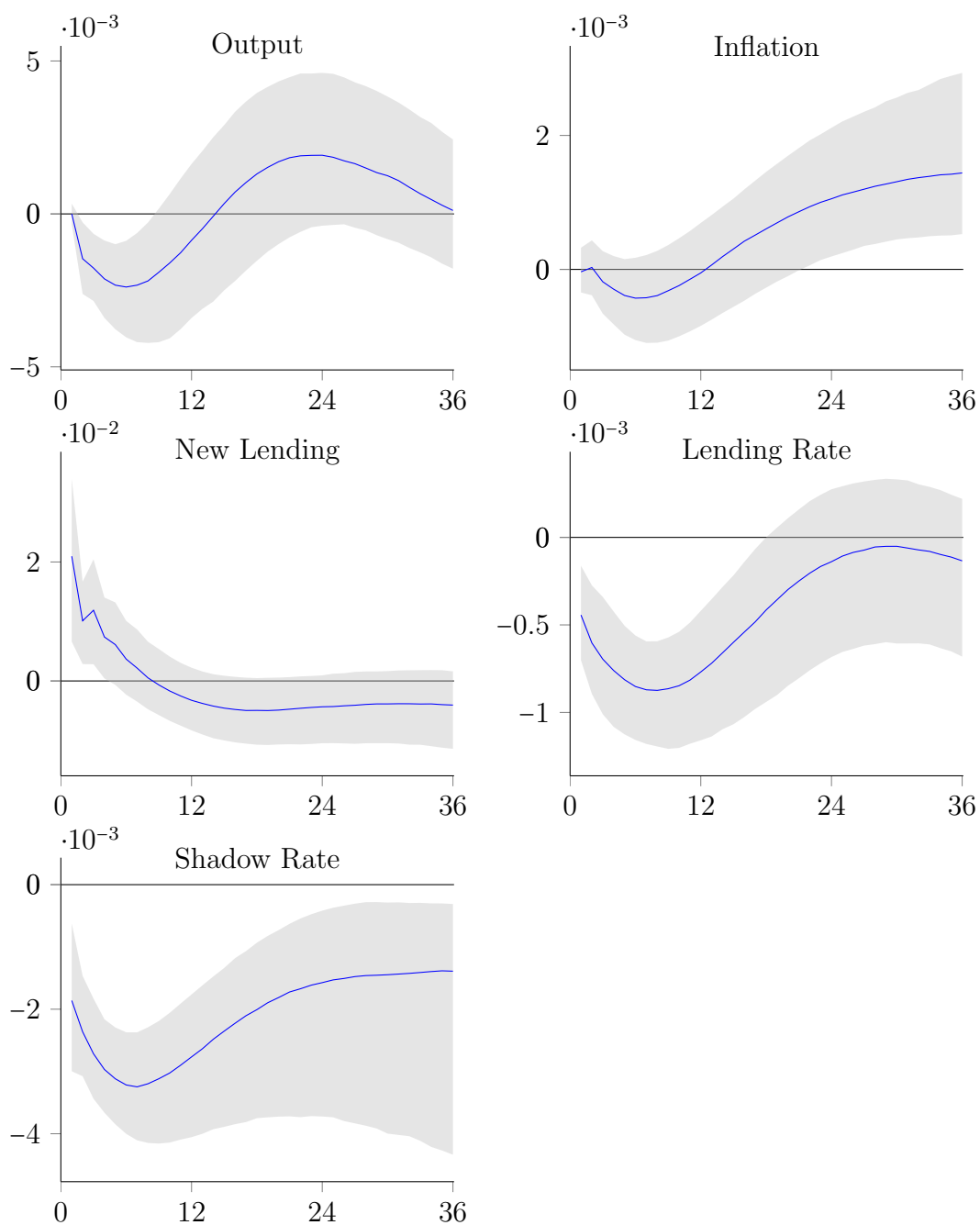
The benchmark model here is then estimated with the shadow rate as the only policy tool, leading to a SVAR model with five variables. The sign restrictions are the same as in the baseline model for the other four variables. The sign for the shadow rate is assumed to be non-positive, to also estimate a policy easing (see Table 5). Results are again almost the same as for the other specifications. New lending reacts positively for the first three periods and is insignificant afterwards (see Figure 10). Output shrinks for the first eight periods after the shock, while inflation is not reacting significantly for the first two years after the shock, and becoming positive afterwards. Further, the lending and shadow rate are reacting negatively, which is in line with the further monetary easing.

Table 5: Sign restrictions for the shocks in the shadow rate estimation

	IPI	HICP	Lending	MIR	Shadow
UMP shock	0	0	≥ 0	≤ 0	≤ 0

Irrespective of the specific unconventional policy variable applied in this section, lending reacts similarly to all of them. All responses of the other variables are also qualitatively the same in comparison to the baseline specification.

Figure 10: UMP Shock using the shadow rate as the policy indicator



Note: Impulse responses from an UMP easing shock. 68% confidence intervals (2000 replications).

5 Discussion

This paper identifies effects of the unconventional policy measures taken by the European Central Bank after the Financial Crisis on bank lending on the basis of a structural vector autoregressive model using sign restrictions. While taking some improvements to the estimation set-up in contrast to the existing literature, it is shown that the impact of the UMPs on bank lending had no significant long-term impact on new credit issuance. One reason is given by the application of the credit variable. By taking a measure of the outstanding stock of credit, as previous studies did, the response of lending to UMP shocks is significantly greater, than for the new lending variable. Furthermore, it is demonstrated that taking an indicator as the monetary base or total central bank assets for unconventional monetary policies could lead to distorted results.

Additionally, the mechanical money multiplier perspective could be refuted from a theoretical standpoint and is also not confirmed by the empirical findings. The notion that bank lending can be driven by an over-allotment of reserves can thus not be affirmed. Rather, the propositions as postulated by the endogenous money view, that lenders still have to find willing borrowers, even though they might be excessively equipped with reserves, is endorsed in this paper. There is still a certain risk-reward analysis prior to loan extension at banks, to which the cost of further acquisition of reserves plays only a minor role. Thus, by lowering the price and increasing the availability of bank reserves, central banks are not able to mechanically control private credit issuance.

Although the unconventional monetary policies taken by the ECB were able to lower market yields and provided balance sheet relieve, they did not significantly boost economic activity (at least in the short-run; see also Mallick (2017) for similar findings for the US) and bank lending. They probably had a stabilising effect directly after the Financial Crisis, but were not really able to sustainably affect economic activity in the long-run. This argument is also similarly stressed by Goodhart and Ashworth (2012), for example.

Furthermore, bank lending in the Euro area remains subdued due to the fall-outs of the Financial Crisis. While the UMPs of the ECB have given banks some balance sheet relief, they were not able to lift economic expectations sufficiently to induce significantly more bank lending. One major problem for banks after the Financial Crisis was to find willing borrowers. A reason for the lacking credit demand can be seen in the deleveraging activities by many private and also public sector agents, as they were still highly indebted for the most part. This obser-

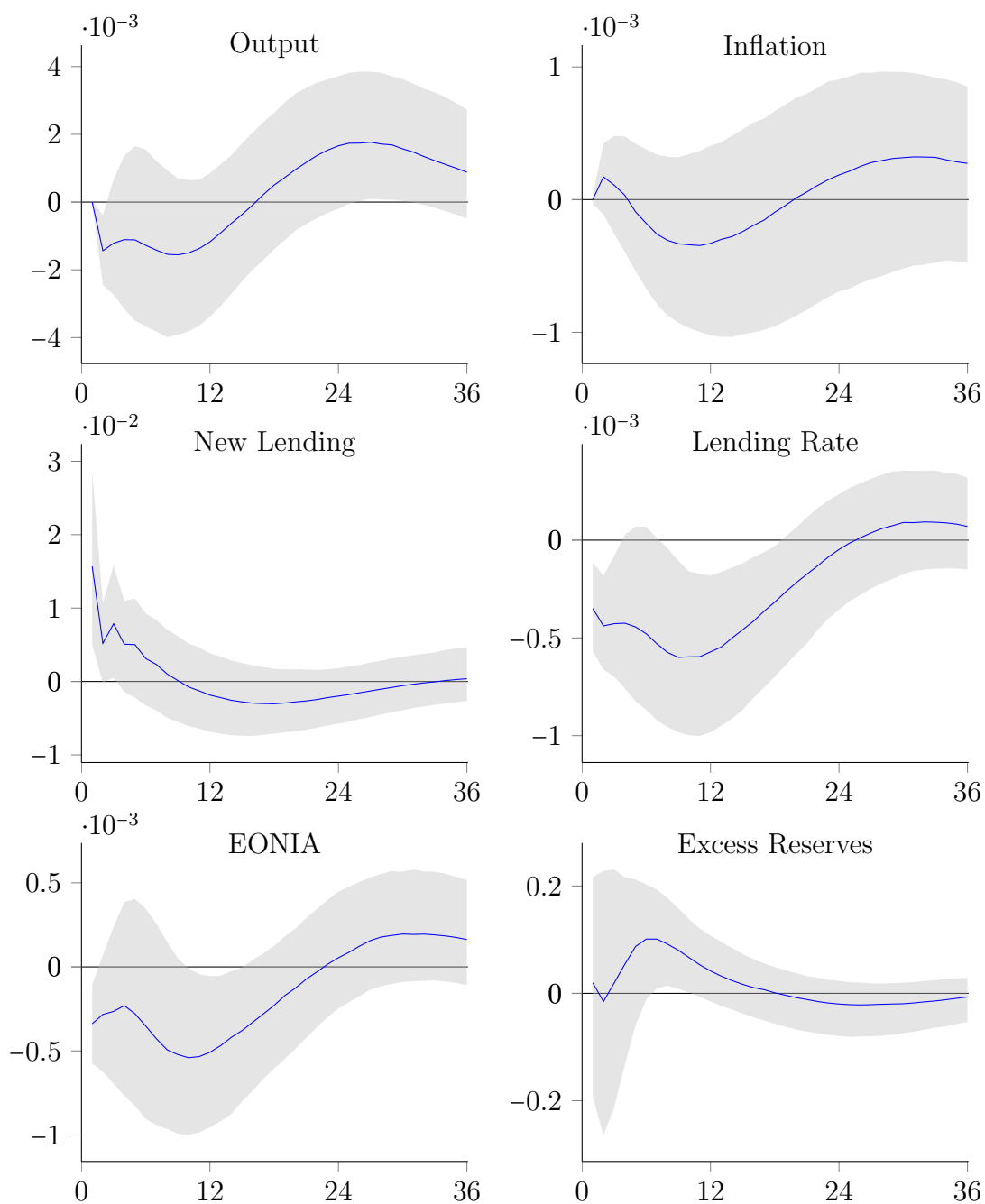
vation is also similar to the one Koo (2009) made for Japan and also stressed for the Euro area in Koo (2011, 2013), that after a debt-induced recession, loan origination cannot be jump-started by monetary policy to a large extent, since many economic agents still try to pay down their debts (a so called *Balance Sheet Recession*). Additionally, uncertainty about the recovery prevailed during the first years after the Financial Crisis subsequently constrained bank lending.

Appendix

Table 6: Summary statistics for the baseline SVAR model

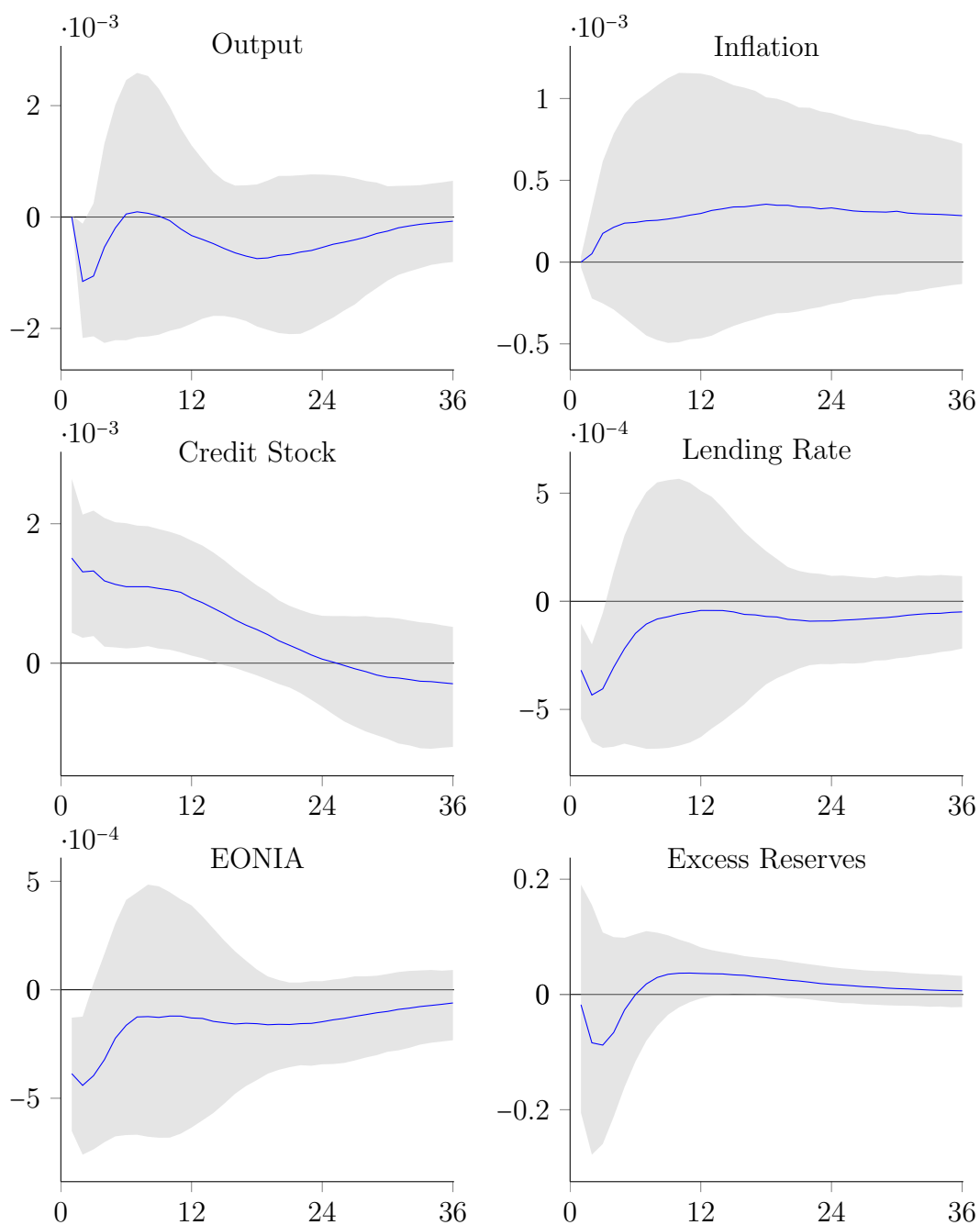
Variable	Obs.	Mean	Std. Dev.	Min.	Max.
IPI	108	4.618	0.050	4.539	4.754
HICP	108	4.566	0.039	4.486	4.609
New Lending	108	4.420	0.207	4.143	4.900
Credit Stock	108	4.772	0.045	4.690	4.844
MFI Rate	108	0.030	0.011	0.017	0.057
EONIA	108	0.009	0.014	-0.003	0.043
Reserves	108	11.560	1.871	6.837	13.614
Monetary Base	108	14.093	0.250	13.637	14.569
MP Rate	108	0.012	0.013	0.001	0.043
Shadow Rate	108	0.001	0.022	-0.049	0.043
Spread	108	0.551	0.253	0.082	1.052
Announcement	108	-0.003	0.032	-0.219	0.144
Announcement2	108	0.250	0.435	0	1
2-yr Bund Rate	108	0.020	0.024	-0.004	0.136

Figure 11: Standard monetary policy shock on new lending



Note: Impulse responses from a standard monetary policy easing shock. 68% confidence intervals (2000 replications).

Figure 12: Standard monetary policy shock on the credit stock



Note: Impulse responses from a standard monetary policy easing shock. 68% confidence intervals (2000 replications).

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