OECONOMIA COPERNICANA

VOLUME 9 ISSUE 4 DECEMBER 2018

p-ISSN 2083-1277, e-ISSN 2353-1827
www.oeconomia.pl

ORIGINAL PAPER

Citation: Pažický, M. (2018). The consequences of unconventional monetary policy in euro area in times of monetary easing. *Oeconomia Copernicana*, *9*(4), 581–615. doi: 10.24136/oc.2018.029

Contact: martin.pazicky@fm.uniba.sk, Department of Economics, Faculty of Management, Comenius University, Odbojárov 10, 82005 Bratislava, Slovakia
Received: 10 June 2018; Revised: 22 November 2018; Accepted: 29 November 2018

Martin Pažický
Comenius University, Slovakia

The consequences of unconventional monetary policy in euro area in times of monetary easing

JEL Classification: *E52; E58; C22; C58*

Keywords: *unconventional monetary policy; credit multiplier; interest rate; quantitative easing*

Abstract
Research background: In this research paper, an attempt is made to evaluate the impacts of ECB's unconventional monetary policy which has been applied after Global Financial Crisis. Because of the new economic and monetary conditions, the effectiveness of conventional monetary tools has been questioned.
Purpose of the article: Designed models examine the consequences of unconventional monetary policy for macroeconomic variables, monetary variables and interest rates in the euro area. Particular attention is paid to the response of the price level, represented by HICP, to various monetary policy innovations. Except a shock in credit multiplier and asset purchase programme (APP), also the effectiveness of a conventional monetary tool, such as main refinancing operation (MRO) interest rate, is inspected.
Methods: Use has been made of impulse responses from structural VAR models to analyze a large sample that covers the time horizon of 1999 to 2016. Several econometric tests are performed to provide a profound analysis. The conclusions from baseline models are verified in multiple robustness check models, which are specified under alternative conditions.
Findings & Value added: It has been found that, in the aftermath of the Global Financial Crisis, conventional monetary instruments are effective in the short-run. In the long-run, unconventional monetary policy has a greater potential to stabilize the economy than the traditional interest rate transmission channel. The conclusions from the baseline models are

verified in multiple robustness check models, which are specified under alternative conditions.

Introduction

The severity of the financial recession in the last decade has forced central banks in advanced economies to apply new monetary tools in order to stabilize the economy and secure the price level. As the economy began to decay amid the Global Financial Crisis in the fall of 2007, the Federal Reserve in the US responded in the conventional fashion by lowering its short-term interest rate. However, by the end of 2008 the short-term rate was practically zero and the economy and the financial system were still in trouble. As a consequence, the Federal Reserve adopted an unorthodox programme known as quantitative easing (QE). The motivation behind these policies was the combination of a financial crisis and zero nominal interest rates, together with the desire to increase liquidity and lower long-term yields (Bernanke, 2015). The programme made use of three different channels. The main, interest rate channel, leads to the lowering of long-term interest rates, which stimulates investments and disincentives savings. The second, the so-called portfolio rebalancing channel makes long-term assets relatively safe, which drives investors into riskier investments. Finally, the exchange rate channel benefits from weakening of the exchange rate. To carry out QE, the Federal Reserve embarked on three rounds of purchases of long-term securities that increased its balance sheet more than fourfold, to about 4.5 trillion USD in 2015 (Yu, 2016). The European Central Bank (ECB) has rapidly increased its balance sheet since their asset purchase programme (APP) in March 2014. The balance sheet of the ECB reached 5.1 trillion USD in August 2017 (Yardeni & Quintana, 2017). Also the Bank of Japan (BoJ) injected a substantial amount of cash to the economy, which enlarged the level of its balance sheet to 4.7 trillion USD in August 2017 (Yardeni & Quintana, 2017). The Bank of England (BoE) has also significantly boosted its balance sheet since 2008. Over the period of March 2009 to January 2010, 200 billion GBP of assets were purchased (Joyce, Tong and Wood. 2011).

Though many central banks have adopted massive purchases of a wide range of securities, the effectiveness of QE as a policy is questioned. DeMertzis and Wolf (2016) identify three main sources of criticism related to the QE. First, the authors claim that QE is unlawful in a monetary union without a joint treasury. Their second criticism stems from their opinion that the programme is ineffective and unnecessary. Last, the authors suggest that the programme should be linked to negative side effects in terms of financial stability and inequality. Many studies and research papers have, therefore, sought to evaluate the effectiveness of quantitative easing. The objective fact is the reluctant response of financial markets and economic indicators to monetary policy in advanced economies. Although the US economy has been recovering faster than the European economy, it is not certain whether the improvements are sustainable. Because of strong data from labour market and inflation converging to targeted 2 per cent level, the Fed fund rate was possible to increase first time in December 2016. In August 2017, the Fed fund rate was 1.16 per cent, which means that the short-term interest rate is currently above zero lower bound in the US. At the beginning of 2017, the inflation was even higher than the target (i.e. 2.7 per cent in January 2017). However, the level decreased to 1.7 per cent in July 2017. It is therefore questionable whether the effect is sustainable over a long term. The response of the European economy to the monetary policy is vaguer than in the US. The level of inflation in the euro area was 1.5 per cent in August 2017 and converges to the targeted level of 2 per cent reluctantly, which is mirrored in zero short-term interest rate of the ECB. The consequences of unconventional monetary policy are crucial for the bank sector. Low interest rate environment systematically hampers the profitability of banks by narrowing their margins.

Although the current responses of various economic indicators to the unconventional monetary policy are of crucial importance, it is inevitable to consider the possibilities that central banks have in the future. Adopting new, non-traditional tools, central banks have lost their conventional tools, such as interest rate and money base. These are simply not feasible when the economy is at the zero lower bound. Thus, in the future central banks will be forced to cope with serious problems stabilizing the economy. Interest rate targeting or changing the money stock have been used for many decades and the policy makers were familiar with their consequences. On the opposite, unconventional tools that enlarge the balance sheet of central banks can have ambiguous impacts. Lael Brainard, a member of US Federal Reserve's Board of Governors, described the new economic environment as the "new normal" in September 2016 in her speech in Dovish (Brainard, 2016). Brainard identified several reasons why the rules of the game have become different. Mainly, the inflation has been undershooting, and the Phillips curve has flattened. Second, consequence of "new normal" is the fact that the labour market slack has been greater than anticipated. Foreign markets have become a very important factor. Brainard came to a conclusion that the neutral rate is likely to remain very low for some time. Low interest rate reduces the room for moderation of the inflation and unemployment rate in case of future severe downturns.

In the light of importance of the unconventional monetary tools, such monetary policy requires to be reviewed for its effectiveness. In particular, the consequences in the euro area turn out to be very important. Although the ECB's asset purchase programme has been enacted only recently (e.g. March 2014), the effects and consequences are crucial not only for the euro area, but also for the global economy.

The scope of our paper contributes to the research topic from various perspectives. First, the study examines the effectiveness of unconventional monetary tools focusing on the asset purchase programme. Although the topic is highly relevant these days, there are not many comprehensive studies using the econometric properties of vector-autoregressive (VAR) model. Especially, in the euro area there is room for further research in this field. Secondly, the model designed upon this research examines the consequences not only for the well-known macroeconomic variables, but also for the variables which are investigated rather rarely (i.e. monetary base, credit, Eonia, tem premium). For example, term premium is a measure that is relatively new in the economy and there is only a limited number of term premium simulations. Therefore, the term premium was simulated for the purposes of this research. Thirdly, the issue of conventional monetary tools effectiveness is becoming a hot topic in the light of coming era of monetary tightening across the advanced economies in the world. As it has been pointed out by multiple policymakers, it is extremely important how the central banks can react in case of a next severe economic recession. Therefore, it is necessary to look at the conventional monetary tools, like short-term interest rate, and evaluate its current performance. Although the interest rates are currently slightly above zero, it is expected to improve in the future. Thus, it is necessary to assess the contemporary effectiveness of the interest rate. Our model, therefore, evaluates the power of the interest rate in the current period and defines the possibilities of the ECB for the future. On top of that, conclusions from baseline models are verified in multiple robustness check models, which are specified under alternative conditions.

The aim of this paper is to evaluate the impacts of monetary policy of the ECB in the euro area economy under the circumstances of current unconventional monetary policy. Particularly, the effects of the APP are of crucial interest in this study. APP has been adopted since March 2014. Although the time period is rather compressed to perform a profound econometric analysis, it is assumed that the economy has already responded to acertain extent. The wide outright purchases undoubtedly have consequences for the entire economy. The key motivation of this study is to analyse how the conventional monetary tool (e.g. interest rate) is effective in the current era. As Yellen (2016) declared, the interest rate is still a powerful tool of the central banks. In the light of threat of next severe crisis, it is of crucial importance to evaluate the alternatives open for the ECB. Although the effective interest rate is currently low, it is expected that the central bank will be again able to use this well-known tool. Thus, one can formulate the first central research question as follows:

"How effective are the conventional monetary tools of the ECB in the current periods?"

Once the effectiveness of the conventional monetary tools has been inspected, it is equally important to evaluate how the APP is impacting the economy. The programme injects an enormous amount of liquidity into circulation and its impacts should be assessed. Therefore, the second research question is as follows:

"What is the impact of unconventional monetary policy on the euro area economy?"

The innovativeness of this paper stems from the evaluation of the current monetary policy similar to Peersman (2011). His study was performed before the APP was enacted. The economy was responding in a different way and, what is more important, effective interest was not at the zero lower bound. At that time, there was no need to investigate the possibilities of traditional monetary tools. Therefore, this study includes some innovations compared to a similar research conducted by Peersman (2011). The next important novelty is the APP evaluation using the VAR model. This category of econometric models is used for a long period of time dataset. The APP has started relatively recently, being a reason why there have not been many studies estimating the effects of the APP using VAR models. However, the data should already absorb at least some information. Moreover, our model investigates the impacts on multiple economic variables (monetary base, credit, term premium), which are not commonly inspected. Finally, our analysis checks for the effectiveness of interest rate, which is becoming a very important issue in connection with the future severe recession.

The reminder of this paper is organized as follows. Literature review is outlined in Section 2. Section 3 explains data and methodology used in the empirical analysis, introduced in Section 4. Section 5 presents the results yielding from the analysis. The robustness is tested in Section 6. Section 7 then discusses the results in comparison with similar studies. Finally, Section 8 concludes our results.

Literature review

Monetary policy has been standardly applied by central banks to maintain economic stability. Since the Global Financial Crisis hit the economy in 2007, the discussions are more centred on the topic of unconventional monetary policy of central banks in advanced economies. Several papers investigate the consequences of financial crisis for labour market at the country level (Kajanová, 2011). Various studies investigate the influence of monetary tools on the economy — for example Peersman (2011), Trichet (2012), Fratzscher *et al*. (2014), Tomann and Stöppel (2016), Andrade *et al*. (2016) and Conti *et al*. (2017) for the euro area. Other authors focus on the US or other areas — for example Yardeni (2017) or Joyce *et al*. (2011). The main areas of interests are focused on responses of macroeconomic variables, monetary variables and interest rate to conventional and unconventional monetary tools.

The impacts of monetary policy on various macroeconomic indicators have been inspected by number of studies and economists. The consequences of monetary policy on GDP size were studied by Ridhwan *et al.* (2010) using meta-regression estimates based on the OLS robust standard errors. Authors have documented a positive coefficient for the size of GDP using the maximum effect of the policy shock as the dependent variable. The coefficient has been statistically significant at the five per cent level. The effect on exports as a percentage of GDP has the same sign, but the coefficient is not significant any longer. Peersman (2011) found that the policy leading to the increase of monetary base or the size of the central bank's balance sheet for a given policy rate, has a hump-shaped effect on economic activity. Using the SVAR model, the author documented that the impulse responses are longer pronounced in case of unconventional policy actions than in case of conventional interest rate innovations. The more recent research was performed by Andrade *et al.* (2016), who also designed the VAR model. Their study has confirmed the impulse of output to interest rate innovation documented by Peersman (2011). Their estimate shows a strong response until the fifth period after the shock, but the response dies out very fast later on.

Based on the Law of Okun, a conclusion can be made that the impact on unemployment is somehow comparable. However, the Law of Okun has been questioned by many economists since the Global Financial Crisis. A possible explanation for why the monetary policy does not seem to be as effective for the unemployment rate as it used to be was given by Lael Brainard (2016), who introduced the "new normal" concept after the recent Global Financial Crises. Andrade *et al.* (2016) included in their VAR model the response of employment to interest rate innovation. They found an increase in the response, which dies out relatively fast.

The next macroeconomic variable that appears to have been highly relevant since the Global Financial Crisis is term premium. The term premium is considered an essential component in the term structure theory. Moreover, it is also viewed as a reliable predictor of a business cycle. Praet (2016), ECB's Chief Economist, used reducing long-term interest rates and pushing investors into higher yielding assets via lower term premia as a central argument for unconventional monetary policy.

Monetary variables, such as money aggregates, currency in circulation or credit, are considered as conventional monetary tools. However, in the environment of unconventional tools implementation, it might be reasonable to inspect how these variables respond to innovation in an unconventional monetary policy. Such analysis was performed by Peersman (2011) for the euro area using his SVAR model. In his study, he compared the responses of credit and monetary base to interest rate innovations and to non-standard policy actions. While the responses of credit (e.g. which was estimated as M3 aggregate) to traditional rate innovation and to non-standard innovation were the same, the responses of monetary base were different. The response function of monetary base to interest rate innovation had less impact compared to non-standard policy actions. Based on the results of this study, it is possible to conclude that the unconventional monetary policy is more effective than standard tools. This holds mainly for monetary base. Another study has proved that real monetary base growth is a significant determinant for economic activity in the UK and the US, controlling for the short-term real interest rate (Nelson, 2002). Peersman (2011) modelled also the credit multiplier shock to different variables (i.e. macroeconomic and also monetary). In his model, evidence was found that also the credit multiplier shocks have a hump-shaped output pattern whilst prices rise persistently. Monetary variables have the potential to explain the issue of so-called liquidity trap. Liquidity trap is a phenomenon when lending institutions have the liquidity, but they fail to transmit it into the economy. The lending institutions do not have satisfactory incentive to transmit the credit to lenders, because it is not profitable enough. They rather deposit this new liquidity, because it is more convenient for them.

The most powerful conventional monetary policy tool is interest rate. However, unconventional monetary policy (e.g. APP) might have a significant impact on the interest rate. Currently, the intention of the ECB is to keep the level of the short-term interest rate as low as possible. The idea is that the expected short-term interest rate can influence longer-term interest rate (e.g. the key idea of so-called forward guidance). Especially Eonia, the overnight interest rate in the euro area, can be influenced by the official interest rates. Therefore, it is important to inspect the responses of the short-term interest rate to various credit shocks. Janet Yellen (2016) asserts that the decline over the past decade in the long-run neutral real rate of interest is a key factor in conducting monetary policy. As Rosengren (2016) pointed out, the low long-run neutral rate of interest in conjunction with somehow subdued labour data and signals about low economic growth may lead to financial instability. As it has been already mentioned, the inflation is converging to targeted level very reluctantly, in spite of the great effort put in by the central bankers. The inflation rate approaching two per cent, is a slow process, viewed as not sustainable. The lowered neutral real rate of interest can create difficulties for conducting monetary policy in the future. As Janet Yellen (2016) remarked, the interest rate remains an important tool for conducting monetary policy. However, if the interest rate is low, the policy makers have no room for decreasing the interest rate in case of a next serious economic downturn. Policymakers (for example Yellen, 2015 or Brainard, 2016) argue that central banks will not be able to use interest rate for monetary easing. The effects of ultra-low interest rates are discussed and inspected by multiple economists, researchers and policy makers. For example, Juselius *et al.* (2017) claim that low real interest rates together with other financial factors reflect a decline in the natural rate of interest. The recent effectiveness of monetary policy of the Federal Reserve was checked by He (2017). His analysis covers the wide range period of 1871–2013. The main contribution of his research is the evidence that the evolution from unmanaged monetary policy to managed short-term interest rate as a key monetary policy tool results in much higher price and output gap stability (He, 2017).

The complex SVAR model designed by Peersman (2011) has proved that the response of prices to the interest rate innovation is less persistent than the response to non-standard policy action. The results are comparable for bank lending rate, which Peersman approximates with a three-month Euribor. These conclusions again confirm the assumption that unconventional monetary policy is more persistent than conventional tools. Although such conclusions appear to be favourable, we must remind that this research was done in 2011, before APP was adopted. A similar recent study is offered by Andrade *et al.* (2016). Their VAR model also includes the period of APP applicability. The authors found that the response of inflation to interest rates innovation is rather small and dies out in two periods after the shock. In case of the real interest rate, the response starts from negative area and continuously approaches zero upper bound. Conti *et al.* (2017) claim that asset purchase programme of the ECB is an appropriate policy for stabilizing the economy in the euro area. A slightly different analysis has been conducted by Fratzscher *et al.* (2014) who found that SMP (securities markets programme) boosted overall equity prices and bank equities by more than plus five per cent across advanced and emerging markets in the euro area. An interesting piece of research has been conducted by Hosny only recently. Using so-called propensity score matching, the author has shown that inflation targeting (IT) has a causal effect on inflation. The research thus confirmed the effectiveness of traditional inflation targeting (Hosny, 2017). Meinusch and Tillmann used social media data for analysing monetary policy of Federal Reserve. They estimated structural VAR-X model to identify a belief shock using data set covering the entire Twitter volume on Federal Reserve tapering in 2013. Their results show that shocks to tapering beliefs have non-negligible effects on interest rates and exchange rates (Meinusch & Tillmann, 2017).

Data

Careful data preparation and specification must be made before embarking on a profound econometric analysis. In total, 31 variables have been used, which have been sorted into five categories (i.e. macroeconomic variables, monetary variables, price variables, interest rate variables and the APP variables). All these variables were obtained from ECB Statistical Warehouse. Time series dataset contains also APP dummy variables and two generated variables — credit multiplier and ten-year term premium for German market. As the entire dataset starts from January 1999 and covers the period till December 2016, the monthly frequency yields, in general, 216 observations for each variable (i.e. for data overview, consult Table 1, where also the information about adjustment methods is available). All the data are seasonally adjusted.

Statistical characteristics of all included variables are available in Table 2. Specifically, one can observe the mean, standard deviation, maximum, minimum, skewness and kurtosis. Moreover, information about measurement units is also provided. The descriptive statistics reveal essential information about the nature of the data. For instance, one can conclude that the average rate of unemployment in the euro area during the inspected period was 9.47 per cent. The maximum unemployment rate was 12.08 per cent, while the minimum value was 7.26 per cent. The values are, in general, higher than the unemployment rate in the US. The descriptive statistics of HICP variable show the essential dynamics for the central bank. It is evident that the average level of inflation is 1.8 per cent, which is below the target of two per cent. One can also observe that the minimum value is zero per cent, which corresponds to the most severe times during and after the sovereign debt crisis in the euro area. The same level of importance attaches to information about interest rates. One can clearly observe that the average MRO rate is subdued, only 2.0 per cent. The maximum value of 4.8 per cent corresponds to the times of exuberance before the Global Financial Crisis. On the other hand, one can clearly see the negative minimum values almost for all the interest rates. This finding, in accordance with the zero lower bound of interest rates (i.e. neutral rates of the interest), points to serious problems for next economic downturns. The information about skewness and kurtosis gives interesting details about data distribution. From skewness and kurtosis, it can be concluded that most data barely follows the normal distribution.

The *APP dummy* variable takes the value of one if the APP was provided in the euro economy in that particular month and zero otherwise. Because of the fact that the APP has been enacted since March 2014, the APP dummy variable takes the value of one since this month onward.

Ten-year term premium variable has been generated given the following equation:

$$TP_{10y} = \frac{(1+r_{10})^{10}}{(1+r_1)(1+f^{1Y2Y})\ldots(1+f^{9Y10Y})} - 1 \ , \qquad (1)$$

where r_{10} denotes ten-year bond yield, r_1 is a spot rate represented by a one-year zero coupon bond yield, f^{mYnY} represents the forward rate with particular tenor and TP_{10y} denotes ten-years term premium. For the estimation purpose, German market data has been used. In this case, the German term premium represents the term premium for the entire euro area. The summary statistics of the data used for term premium calculation is available in Table 3.

Credit multiplier variable has been calculated following the procedure proposed by Durlauf and Blume (2010):

$$c = \frac{CC}{D} \ , \qquad (2)$$

where c is currency ratio, CC denotes currency in circulation and D chequable deposits.

$$r = \frac{RR}{D}\,, \tag{3}$$

where *r* denotes the required reserves ratio and *RR* stands for required reserves.

$$e = \frac{ER}{D}\,, \tag{4}$$

where *e* is excess reserves ratio and *ER* denotes excess reserves.

Using equation 2, 3 and 4, it is possible to estimate money multiplier with the following equation:

$$m = \frac{1+c}{r+e+c}\,, \tag{5}$$

where *m* denotes money (or credit) multiplier.

The summary statistics of the variables for credit multiplier calculation is available in Table 4.

After data specification, additional data checks should be performed. First, the data are measured in various units, which could compromise the final results. For example, macroeconomic data about the economic condition are expressed in millions of euro, while interest rates are measured in percentage. A methodologically correct procedure for coping with these differences would be to rescale the dataset using the first differences of natural logarithm. Therefore, the data that are measured in euro are made to transfer in the first differences of their natural logarithm. Second, given that the data represent time series, only stationary data should be included in the models. For this reason, an augmented Dickey-Fuller (ADF) test has been performed for all the variables. ADF test has verified the presence of unit root. The dynamic testing procedure using univariate and multivariate hypothesis tests of Enders (2010) have been applied. A commonly used remedy to tackle the non-stationarity issue is to transform the level of variables into the first difference. Finally, based on the inspection of the scatter plots and histograms, the data do not exhibit any presence of substantial outliers.

Research methodology

The common method for testing the impacts of monetary policy on economy is the so-called vector-autoregressive (VAR) model. Because of the favourable features of the model, VAR is broadly used by central banks around the globe. VAR allows to model the contemporaneous impact of one variable on the other, while all variables are treated as endogenous (Enders, 2010 and Gujarati & Porter, 2009). We use standard ML (maximal likelihood) estimation algorithm as an estimation method. The baseline VAR model which will be used for decomposing various credit supply innovations into mutually orthogonal components is represented as follows:

$$Z_t = \alpha_0 + A(L)Z_{t-1} + B\varepsilon_t \ , \qquad (6)$$

where Z_t represents a vector of endogenous variables containing:
a) Three-month Euribor – $\Delta(Euribor\_3)_t$,
b) Term premia – $\Delta(Term\_premia)_t$,
c) Money base – $\Delta(log\_base\_money)_t$,
d) Credit – $\Delta(log\_Credit)_t$,
e) Prices – $\Delta(HICP)_t$,
f) Unemployment – $\Delta(Unempl)_t$,
g) Output – $\Delta(log\_GDP)_t$,
α_0 represents the vector of constants, *A(L)* is a matrix polynomial in the lag operator *L*, *B* is the contemporaneous impact matrix of the mutually uncorrelated error terms ε_t, ε_t represents an error term at time *t* following white noise *i.i.d* process.

The VAR model defined in Equation 6 contains seven systematic shocks that are orthogonal. However, the analysis presented in our study focuses on three systematic shocks — MRO interest rate innovation, credit multiplier shock and APP innovation. The MRO interest rate innovation represents the conventional monetary policy action and the credit multiplier shock represents the shock independent from interest rate changes. Since credit multiplier shock should be orthogonal to interest rate, it is considered as unconventional monetary policy action. Finally, the APP innovation represents an alternative unconventional monetary policy measure to credit multiplier shock. However, as the dataset is rather compressed (i.e. 27 observations), it is highly probable that the responses yielding from the VAR model will not be really valuable in case of APP innovation.

VAR model has been estimated for the entire sample period from January 1999 until December 2016. Based on the SIC (Schwarz information criteria) lag-length selection criteria, the estimations include seven lags of endogenous variables. The selection criteria combine the most precise and the most parsimonious specification. Therefore, the baseline model has been selected as VAR(7) model. The issue with low number of observations in the case of the APP innovation results is an issue with identification. VAR(7) model consumes a lot of degrees of freedom, which is even higher than the number of observations (i.e. 27 observations for APP).

Therefore, it is not possible to design VAR(7) for modelling APP shocks, which has resulted in VAR(2) model in the case of the APP innovation. It should be mentioned that the reliability of the model is disputable because of the low number of observations.

The VAR model specified under equation 6 allows to design a Granger causality test and impulse response functions. The impulse response functions can be estimated from the VAR model using Cholesky decomposition. The correct order of variables in Cholesky decomposition is crucial for a reliable specification of impulse responses. The order follows the economic reasoning and was chosen based assuming that changes in short-term interest rate should lead to changes in term premium. This potentially affects the money base and credit subsequently, which could drive the changes in the level of inflation and unemployment. Finally, the economic output should be impacted. Therefore, the order imputed in Cholesky decomposition is as follows:

$$\Delta(Euribor\_3) \rightarrow \Delta(Term\_premia) \rightarrow \Delta(log\_base\_money) \rightarrow \Delta(log\_Credit) \\ \rightarrow \Delta(HICP) \rightarrow \Delta(Unempl) \rightarrow \Delta(log\_GDP)$$

The above order is not the only one possible, and various other orders would also be possible.

The outputs for the baseline model will be presented in the following section. Moreover, more models have been specified that focused on impacts, in particular on macroeconomic variables, monetary variables and interest rate variables. Finally, various robustness checks were performed. In total, 21 various responses and 56 additional responses were estimated as robustness checks. The main results will be presented in the following sections.

Results

The baseline VAR model estimates the impacts of the innovations in MRO interest rate, credit multiplier and the APP on various macroeconomic, monetary, price and interest rate variables. Coefficients of the impulses responses to MRO interest rate innovation are available in Table 5. Coefficients corresponding to lower bound are documented in Table 6 and coefficients corresponding lo upper bound are presented in Table 7. Similarly, impulse responses to credit multiplier shock are shown in Table 8. Lower bound coefficients are available in Table 9 and upper bound coefficients in Table 10. For better transparency and readability, the results are also documented in less formal way in Figure 1. Figure 1 shows the impulse responses of selected economic variables to MRO interest rate innovation and to credit multiplier shock. To improve comparability, the impulse responses for both shocks are displayed within the same figure. The blue line represents the MRO interest rate innovation and the blue area represents the two standard error probability regions of the estimated regression. The solid red line represents the credit multiplier shock, and the dotted red line represents the two standard error probability regions of the estimated regression. Credit multiplier can be seen as the control variable for unconventional monetary instruments. Thus, MRO interest rate represents the conventional monetary policy actions and credit multiplier represents the unconventional monetary policy of the ECB.

The first graph describes the impulse response of HICP to interest rate and credit multiplier shocks. The response to conventional tool (i.e. MRO rate) has a slightly stronger impact in the first periods after the shock, but this turns out after the tenth period. The innovation in credit multiplier dies out gradually with the slower tempo. These findings could be interpreted as a positive, but not stable, response of inflation to conventional monetary policy. One can thus conclude that the interest rate does not have enough power to ensure a sustainable price level without further actions. As a result, it is currently very difficult for the ECB to ensure price stability using only the interest rate. The graph reveals that an unconventional monetary policy (i.e. credit multiplier shock) has a more persistent effect on the price level in the long-run. The graph provides the evidence that unconventional monetary policy tools have a better potential to stabilize the price level on the short- and medium-term horizons.

The next graph suggests that both innovation in MRO interest rate and credit multiplier shocks have a hump-shaped response of output. The response of output to the interest rate appears to be weaker and approaches the negative area after the fifth period, while the response of GDP to the credit multiplier innovation vanishes more slowly. The response functions indicate that the response of GDP to credit multiplier is more stable. Moreover, the impulse response function does not touch the negative area in the case of credit multiplier shock. This finding confirms that unconventional monetary instruments have more pronounced effects on the output compared to conventional instruments.

Drawing from the responses of unemployment rate to monetary policy, it was found that both response functions have a very similar shape and comparable scales. Although the immediate response of unemployment to both innovations is negative, it converts to the zero very fast, and the final response at the end of the 36th period after the shock is positive. This pattern is true especially for the credit multiplier shock.

The next graph in Figure 1 describes the responses of money base to monetary policy. One can observe a positive and pronounced response of money base to interest rate shock at the beginning, followed by a very fast dying out effect later, and a negative response at the end. On the opposite, the response to credit multiplier is indeed stable. An intuitive expectation is that unconventional monetary tools should have a much higher positive impact on money base in the economy. The next graph that displays the response of credit to monetary policy offers complementary information. One can observe negative responses in both cases. The negative response of credit in the economy to interest rate shock appears to be unintentional, but it is rational. Higher interest rate lowers the money supply, and thus the credit is lower. The response of credit to credit multiplier shock is a little bit more confusing, though. The purpose of quantitative easing is to inject additional liquidity into the economy. A reasonable explanation for such a low (or even negative) response is the so-called liquidity trap, as a result of which the credit has not been transmitted into the economy.

It appears that the impulse responses of three-months Euribor are in line with expectations. Euribor should respond much stronger to changes in MRO interest rate than to credit multiplier shocks. Both rates are considered as short-term rates, and they are used for longer-term interest rates formation through expectations. In both cases, there are apparent negative responses in later periods.

Finally, the responses of term premium seem to be comparable in the case of MRO interest rate innovation and in the case of credit multiplier shock. After the negative initial responses, the response functions converge to the zero and both are slightly positive in later periods. These patterns are reasonable due to the negative term premium in the recent periods, which also signalize an inverted yield curve.

An alternative model that simulates the responses of given variables to APP innovations has been identified as VAR(2). It should be reminded that the estimation took into account only 25 observations, which is indeed limited in comparison with previous estimations. The reason is the fact that the APP has been enacted in March 2014, so the entire period of this programme is really short. As the direct consequence, predictability of results is rather low and responses are volatile and biased. As the results are not meaningful from an economic perspective, the responses are not presented in this paper.

Robustness

A profound economic analysis requires verifying the initial results that follow from the baseline model. To confirm the results of the baseline VAR model, various models have been designed that serve as a robustness check. On top of 21 specifications in the baseline model (including responses also to APP innovation) 56 robustness check models have been specified that examine the responses of the variables introduced in Table 1. It means that the responses of macroeconomic variables, monetary variables, interest rates and price variables to MRO rate innovation and credit multiplier shock were all verified. As the robustness checks confirmed the initial results coming from baseline models, to save the space here, we will only present a selected sample of these results.

The ECB's key variable is the price level in the euro area. In the baseline model, the price level is specified as HICP, which is the targeted measure of the central bank. However, a similar measure of the price level should be determined. In the robustness check model, the responses of PPI (Producer Price Index) and industrial production, as alternative specifications of the price level, have been verified. Moreover, consistency over time has also been tested. The initial time horizon was shrunk to one half, which means that instead of the original 216, only 108 observations were included. The responses of these price level specifications to MRO rate innovation and to credit multiplier shock are displayed in Figure 2.

The first graph in Figure 2 confirms the shape of HICP response to the MRO interest rate innovation in the baseline model. There is an increase after the shock, which inverts after ten periods. The response to the credit multiplier is also similar, albeit not so pronounced. At the end of the 36th period, there is still a slightly stronger impulse to the credit multiplier shock than to MRO rate innovation. This finding confirms the fact that unconventional monetary policy has a higher potential to stabilize the economy than conventional policy.

The second graph in Figure 2 shows the same impulse response of the PPI to MRO interest rate innovation and also to credit multiplier shock. However, PPI does not exhibit as strong response to unconventional tools as HICP does. Yet, the shapes of these responses are the same, which confirms that the estimation in Figure 1 is robust.

Finally, the last graph displays the response of industrial production to credit supply shocks. Clearly, the impulse responses yield the expected pattern, which confirms the estimation specified under the baseline model.

Although the inflation estimate in the baseline model has been already proven to be robust, other variables and their stability also need verification. For that reason, the second set of robustness checks investigates the robustness of interest rate measure. The ECB defines three interest rates as the key rates, and thus it is useful to simulate the shock not only in the MRO interest rate, but also the innovation in MLF (main lending facility) interest rate and DF (deposit facility) interest rate. This robustness check should clarify the effectiveness of interest rate as a monetary tool. The impulse responses specified by VAR(7) process are available in Figure 3. Again, the graphs combine the responses of the vector of endogenous variables to the MLF interest rate innovation and to the DF interest rate innovation.

The first graph in Figure 3 confirms the shape of impulse response of the HICP to changes in MRO interest rate, estimated in the baseline model in Figure 1. Mainly the response to MLF interest rate appears to follow the same pattern. Also, the graph about the response of GDP seems to confirm the hump-shaped pattern as it was observed in the baseline model. The same conclusion can be made about the responses of unemployment. Again, here we have a slow increase, which graduates in the later periods and then dies out. This finding confirms that interest rate has a positive impact on unemployment and that the ECB can use this instrument for stabilizing the unemployment rate. The impulse responses of money base and credit are similar to those in the baseline model. The robustness specification makes it also clearly visible that interest rate has a negative effect on money base and on credit in the economy. Shapes of the curves representing the Euribor responses are very similar to those in the baseline model. After a small increase right at the beginning, the responses die out. Finally, the same inference can be made about the impulse responses of term premium to the MLF and DF interest rate changes as to the MRO interest rate changes.

Following all robustness checks that were performed, it can be concluded that strong evidence was found for supporting the robustness of the baseline model. The parameter stability test over time also appears to yield stable estimates.

Discussion

The empirical research, conducted by ECB's Peersman in 2011, comes closest to the model performed and introduced in this paper. However, the latter incorporates a number of novelties and innovations. Firstly, the APP has been enacted in March 2014, which means that the model estimated by Peersman did not measure this programme's impacts. Although our model includes the period when the APP has been injected, the time horizon is rather subdued. This can potentially distort the results of a profound analysis. Secondly, the ultra-easy monetary policy conducted in the last periods makes interest rate ineffective as a monetary tool. For this reason, the results of our VAR model appear to be questionable. In spite of current ineffectiveness of interest rate, the time period imputed in the model is much longer, which should give sufficient information about the exogenous shocks in the interest rate. Thirdly, the model offered by Peersman did not examine the shock in APP variable, because the APP programme did not exist. On the other hand, although the APP response has been checked in this paper, the results were not really valuable. Fourthly, it could be argued that the results of our response functions are insignificant in some cases (for example, GDP, money base, credit) compared to the results of Peersman (2011) and Conti (2017). Indeed, the coefficients of our responses are lower, which is caused by the different adjustment method of the inputted variables. While Peersman (2011) and Conti (2017) used data in log-transformations in levels, we used the log-transformation in first differences. Both Peersman (2011) and Conti (2017) argue that estimating the VAR in levels implicitly allows for the possible presence of cointegrating relationships in the data. Both authors refer to the approach used by Sims *et al.* (1990). We used instead Augmented Dickey Fuller test to verify co-integration issues. And finally, the various specifications and robustness checks confirmed the main finding from the baseline model.

As for comparison of results with respect to GDP, it can be concluded that the same shape in response of GDP curve has been found by Peersman (2011) who also referred to the hump-shaped pattern. However, he found a positive response of GDP also to interest rate innovation. His findings concerning the response to credit multiplier confirm the findings from the VAR model, as specified in our model. An alternative assessment is offered by Andrade et al (2016) who found a similar response of GDP to interest rate innovation. However, their model shows a strong positive response until the fifth period after the shock. Thereafter, the response vanishes but remains in the positive area.

The findings of our research related to unemployment are consistent with the conclusion made by Andrade *et al.* (2016), who found that the response of employment slightly increases but quickly dies out.

The M1 aggregate is represented in our VAR model by money base. It is obvious from the baseline model that the response of money base to credit multiplier shock is negative, while the response of monetary base to MRO interest rate is mixed. Immediately after the shock, there is a positive effect that reverses after eight periods and the response deteriorates to negative values. Peersman (2011) found a slightly different response of money base to credit multiplier shock. In his VAR specification, the response is initially negative but then increases to positive value, so creating a “U” shape.

A clear observation from the VAR impulse response function is that the credit multiplier shock has, in the end, a positive impact on HICP, which inverses approximately after 13 periods when the response starts to decrease even into negative values. However, the response to the MRO interest rate shock is even more pronounced, which means that unconventional monetary tools are more capable of stabilizing the inflation. Thus the decision about the impact of unconventional monetary policy on HICP is not straightforward. While it is true that the impact is positive first, the positive effect starts to die out, meaning that the effect is not sustainable. Other authors, such as Peersman (2011), find the positive response of prices (i.e. defined by the industrial production variable) to both credit multiplier shock and interest rate innovation. Moreover, the response seems to be sustainable over all periods. The main reason behind these findings is the time period when the research was conducted. A different conclusion was made by Andrade *et al*. (2016), who also found a comparable result as in the VAR model introduced in this study. In their case, the response of inflation is increasing until the fourth period, with the curve decreasing later at the zero lower bound. This evidence is much more realistic for the recent period.

The expected impact of unconventional monetary policy on the overnight Eonia was negative. The baseline model suggests that the response of comparable short-term interest rate to credit multiplier shock is rather neutral at the beginning, but tends to decrease slightly in the later periods. Peersman (2011) found the increasing response of the bank lending rate. The impulse response function begins from the negative area and then increases. A very similar pattern was found by Andrade *et al*. (2016) for the ten-year interest rate.

Examining the responses to MRO interest rate shock gives an answer to our first research question concerning the effectiveness of conventional monetary tools in current periods. We can conclude, from the responses of various variables, that the interest rate is an effective monetary instrument in the short run, because it has a stronger immediate impact (at least on HICP). The ECB is able to stabilize the price level via short-term interest rate. Although the current short-term rates are at the zero lower bound, the central bank can affect the longer-term interest rate by applying so-called “forward guidance”. Thus, the expected path of short-term rate can influence the longer-term rate, which has an impact on the expected inflation in the future. Moreover, after the economic conditions are stabilized and interest rates are again higher, the ECB would be able to perform its monetary policy again using the interest rate. An example is the situation in the US, where the Federal Reserve improved the economic outlook already in September 2017. The expected inflation should converge to the target 2 per cent level, which allowed Federal Reserve to inform about reducing quantitative easing and increasing Fed fund rate with the intention to tighten the economy.

The APP's effectiveness, questioned in our second research question, is possible to measure from the baseline model. Although the responses to APP shock are biased and not reliable, the effect can be tested by looking at the responses to credit multiplier. However, we should remind that the shock in credit multiplier measures the effect for all unconventional monetary policy measures. From the impulse response functions, it is obvious that the credit multiplier shock has more persistent and more stable responses in the long-term horizon. Thus, one can conclude that the unconventional monetary policy has a much stronger impact on the euro area economy from the long-run perspective. Therefore, the unconventional monetary policy conducted by the ECB is a valid approach that has higher potential to stabilize the economy than the traditional interest rate.

Conclusions

Effectiveness of unconventional monetary policy has been a topic for a number of studies. While the procedures of this programme are rather clear, its effectiveness and consequences for the economy in the long-run are questioned. The aim of the presented paper was to measure the effectiveness of unconventional monetary tools in the euro area with an emphasis on the APP. Using the VAR model approach, a couple of remarkable impacts of unconventional policy on economy have been documented.

Strong and pronounced responses of many economic variables to credit multiplier have been found. In particular, HICP seems to be sensitive to changes in credit multiplier as a measure of unconventional monetary policy. The responses of credit to credit multiplier shocks confirm what is known as liquidity trap phenomenon, which compromises the effectiveness of the unconventional monetary policy. In spite of the liquidity trap, the unconventional policy appears to be more persistent in the long-run. A very important conclusion is made about the effectiveness of interest rate in the current era of monetary easing and interest rate on zero lower bound. It has been proven that unconventional monetary policy has a higher potential to stabilize the economy than the traditional interest rate transmission channel.

However, the interest rate is seen as a powerful monetary instrument in the long-run, although at the present it is ineffective. These findings have been confirmed through various robustness specifications.

Although our results are stable and robust, the specified models have some limitations. First, the models do not take into consideration some important elements that are commonly used in other similar studies. For example, imposing sign restrictions on structural VAR models are frequently used method in a comparable literature. It would be further beneficial to design a VAR model using Bayesian estimation techniques or factor VAR model that could incorporate much richer dynamics. Secondly, the data limitation is crucial for specifying a reliable model. Unfortunately, the time period of the ECB´s unconventional monetary policy is relatively short. It would be therefore interesting to focus on approximations of the forward guidance or term premia. All mentioned limitations are the source of the inspiration for further research.

The last economic turmoil was extremely severe and impacted economy on the global scale. As a direct consequence, the central banks around the globe adopted new unconventional monetary tools, known as quantitative easing. Although the effectiveness of this policy has been questioned, the research described in this study has proven that unconventional monetary policy works sufficiently for the euro area. The economy is slowly converging to the targets. While, on the one hand, the economy is recovering, on the other hand, the question remains whether these improvements are sustainable. Moreover, the conduct of monetary policy in any future economic downturn could be a complicated matter. Therefore, the possibilities open to the ECB in any next economic crisis should be investigated, which undoubtedly is a valid research topic for a future study.

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Annex

Table 1. Specification of the data used in regression and VAR models

Variable	Source*	Start date	End date	Frequency	Observations before adj	Observations after adj	Adj method**
			Macroeconomic variables				
Consumption	ECB	1.1999	12.2016	Quarterly	72	216	Extrapolation
Government expenditure	ECB	1.1999	12.2016	Quarterly	72	216	Extrapolation
Export	ECB	1.1999	12.2016	Quarterly	72	216	Extrapolation
Import	ECB	1.1999	12.2016	Quarterly	72	216	Extrapolation
GDP	ECB	1.1999	12.2016	Quarterly	72	216	Extrapolation
Unemployment	ECB	1.1999	12.2016	Monthly	216	216	NA
Term premia	Pažický, Tomsin	1.1999	12.2016	Monthly	216	216	NA
			Monetary variables				
Currency in circulation	ECB	1.1999	12.2016	Monthly	216	216	NA
Money aggregate M1	ECB	1.1999	12.2016	Monthly	216	216	NA
Money aggregate M3	ECB	1.1999	12.2016	Monthly	216	216	NA
Credit	ECB	1.1999	12.2016	Monthly	216	216	NA
Chequable deposits	ECB	1.1999	12.2016	Monthly	216	216	NA
Base money	ECB	1.1999	12.2016	Monthly	207	216	Extrapolation
Excess reserves	ECB	1.1999	12.2016	Monthly	205	216	Extrapolation
Required reserves	ECB	1.1999	12.2016	Monthly	205	216	Extrapolation
Required reserve ratio	own processed	1.1999	12.2016	Monthly	NA	NA	NA
Currency ratio	own processed	1.1999	12.2016	Monthly	NA	NA	NA
Excess reserves ratio	own processed	1.1999	12.2016	Monthly	NA	NA	NA
Credit multiplier	own processed	1.1999	12.2016	Monthly	NA	NA	NA
			Rate variables				
MRO_rate	ECB	1.1999	12.2016	Daily	135	216	Extrapol, Avg
Deposit facility_rate	ECB	1.1999	12.2016	Daily	216	216	Average
MLF_rate	ECB	1.1999	12.2016	Daily	216	216	Average
			Price variables				
HICP	ECB	1.1999	12.2016	Monthly	216	216	NA
PPI	ECB	1.1999	12.2016	Monthly	216	216	NA
Industrial production	ECB	1.1999	12.2016	Monthly	216	216	NA
			APP variables				
ABSPP	ECB	11.2014	12.2016	Monthly	26	26	NA
CBPP3	ECB	10.2014	12.2016	Monthly	27	27	NA
CSPP	ECB	6.2016	12.2016	Monthly	6	6	NA
PSPP	ECB	3.2015	12.2016	Monthly	22	22	NA
APP	own created	10.2014	12.2016	Monthly	27	27	NA
APP dummy	own created	1.1999	12.2016	Monthly	216	216	NA

**Adjustment method – for obtaining continuous monthly dataset, the extrapolation was used in case of quarterly or missing data; average in case of daily data.
APP dummy equals to 1 in the month when the APP was provided, 0 otherwise.

Source: own prepared based on data from ECB Statistical Warehouse (2017).

Table 2. Specification of the data used in regression and VAR models

Variable	Unit	Average	SD*	Max	Min	Skew**	Kurt**
				Macroeconomic variables			
Consumption	MEUR	1 246 274	160 203	1 484 681	922 106	-0.47	1.89
Government expenditure	MEUR	453 287	73 899	560 223	315 989	-0.35	1.73
Export	MEUR	874 897	213 328	1 258 918	491 069	0.05	1.79
Import	MEUR	826 697	189 804	1 155 030	467 778	-0.15	1.67
GDP	MEUR	2 228 149	301 436	2 712 543	1 627 546	-0.4	1.92
Unemployment	Percentage	9.47	1.33	12.08	7.26	0.38	2.19
Term premia	Percentage	0.27	0.11	0.58	-0.03	0.07	2.85
				Monetary variables			
Currency in circulation	MEUR	635 902	254 222	1 075 192	234 097	0.09	1.64
Money aggregate M1	MEUR	3 940 695	1 481 379	7 190 135	1 787 354	0.33	2.12
Money aggregate M3	MEUR	7 968 743	2 092 647	11 372 997	4 438 087	-0.24	1.64
Credit	MEUR	387 583	330 620	1 749 013	107 419	1.88	6.92
Chequable deposits	MEUR	3 304 793	1 231 553	6 117 047	1 470 271	0.38	2.27
Base money	MEUR	955 873	468 987	2 366 303	415 566	0.81	2.96
Excess Reserves	MEUR	71 998	153 435	706 484	573	2.34	7.67
Required Reserves	MEUR	145 816	41 601	221 056	98 341	0.65	1.84
Required reserve ratio	Ratio	0.05	0.02	0.07	0.02	-0.81	1.98
Currency ratio	Ratio	0.19	0.02	0.22	0.12	-1.28	4.53
Excess reserves ratio	Ratio	0.01	0.03	0.12	0	2.11	6.23
Credit multiplier	Ratio	4.73	0.44	6.15	3.57	0.1	3.69
				Rate variables			
MRO_rate	percentage	2	1.4	4.8	0	0.19	1.86
Deposit facility_rate	percentage	1.2	1.2	3.8	-0.4	0.49	1.98
MLF_rate	percentage	2.8	1.7	5.8	0.3	-0.01	1.85
				Price variables			
HICP	Percentage	1.8	0.9	4.1	0	-0.25	2.42
PPI	MEUR	95	10	109	76.6	-0.22	1.62
Industrial production	MEUR	102	5	115	90.2	0.46	3.55
				APP variables			
ABSPP	MEUR	670	554	1 928	-226	0.42	2.28
CBPP3	MEUR	7 336	3 376	13 033	1 011	-0.06	2.07
CSPP	MEUR	1 900	3 404	9 872	0	1.33	3.05
PSPP	MEUR	44 820	25 817	79 673	0	-0.78	2.43
APP	MEUR						

*SD – standard deviation
**Skew (skeweness) and Kurt (kurtosis), third and fourth moment, provide us (together with average and standard deviation) the essential information about the distribution.

Source: own prepared based on data from ECB Statistical Warehouse (2017).

Table 3. Summary statistics of the variables for term premium calculation

Variable	Source	Average	SD	Max	Min	Skew	Kurt
GER_Bond_Yield_1Y	Bloomberg	1.87	1.74	5.12	-0.84	0.12	1.64
GER_Bond_Yield_2Y	Bloomberg	1.99	1.74	5.17	-0.82	-0.01	1.65
GER_Bond_Yield_5Y	Bloomberg	2.48	1.71	5.17	-0.55	-0.30	1.76
GER_Bond_Yield_10Y	Bloomberg	03.1	1.57	5.54	-0.09	-0.51	2.06
GER_Forward_1Y2Y	Bloomberg	2.32	1.79	5.24	-0.72	-0.22	1.70
GER_Forward_2Y3Y	Bloomberg	2.86	1.74	5.58	-0.48	-0.48	1.90
GER_Forward_3Y4Y	Bloomberg	3.35	1.70	6.07	-0.26	-0.61	2.18
GER_Forward_4Y5Y	Bloomberg	3.66	1.57	6.16	0.14	-0.69	2.41
GER_Forward_5Y6Y	Bloomberg	3.93	1.48	6.24	0.41	-0.79	2.66
GER_Forward_6Y7Y	Bloomberg	4.15	1.43	6.13	0.53	-0.91	2.91
GER_Forward_7Y8Y	Bloomberg	4.29	1.41	6.22	0.64	-0.97	3.05
GER_Forward_8Y9Y	Bloomberg	4.36	1.40	6.25	0.72	-0.96	3.02
GER_Forward_9Y10Y	Bloomberg	4.43	1.44	6.41	0.73	-0.90	2.89

Source: own prepared based on data from ECB Statistical Warehouse (2017).

Table 4. Summary statistics of the variables for credit multiplier calculation

Variable	Source	Average	SD	Max	Min	Skew	Kurt
Required reserves	ECB	145816	41601	221056	98341	0.65	1.84
Currency in Circulation	ECB	635902	254222	1075192	234097	0.09	1.64
Excess reserves	ECB	71998	153435	706484	573	2.34	7.67
Chequable deposits	ECB	3304793	1231553	6117047	1470271	0.38	2.27
Required reserve ratio	own	0.05	0.02	0.07	0.02	-0.81	1.98
Excess reserve ratio	own	0.01	0.03	0.12	0	02.11	6.23
Currency ratio	own	0.19	0.02	0.22	0.12	-1.28	4.53
Money multiplier	own	4.73	0.44	6.15	3.57	0.1	3.69

Source: own prepared based on data from ECB Statistical Warehouse (2017).

Table 5. Impulse responses to MRO rate innovation

Period	HICP	GDP	UNEMPL	BASE MONEY	CREDIT	EURIBOR	TP
1	0.0370	0.0001	-0.0002	-0.0038	-0.0012	0.0496	-0.0064
	(0.0144)	*(0.0001)*	*(0.0003)*	*(0.0020)*	*(0.0017)*	*(0.0070)*	*(0.0024)*
3	0.0922	0.0005	-0.0010	-0.0008	-0.0056	0.1077	-0.0038
	(0.0259)	*(0.0002)*	*(0.0007)*	*(0.0037)*	*(0.0033)*	*(0.0173)*	*(0.0044)*
5	0.1136	0.0009	-0.0022	0.0010	-0.0029	0.1417	-0.0051
	(0.0343)	*(0.0003)*	*(0.0012)*	*(0.0045)*	*(0.0046)*	*(0.0258)*	*(0.0051)*
7	0.1088	0.0009	-0.0020	0.0117	-0.0035	0.1259	0.0006
	(0.0397)	*(0.0004)*	*(0.0015)*	*(0.0051)*	*(0.0056)*	*(0.0327)*	*(0.0056)*
9	0.0934	0.0006	-0.0007	0.0091	-0.0043	0.0977	0.0067
	(0.0421)	*(0.0005)*	*(0.0019)*	*(0.0055)*	*(0.0064)*	*(0.0379)*	*(0.0057)*
11	0.0530	0.0001	0.0004	0.0061	-0.0053	0.0802	0.0090
	(0.0413)	*(0.0005)*	*(0.0023)*	*(0.0055)*	*(0.0068)*	*(0.0408)*	*(0.0058)*
13	0.0362	-0.0003	0.0014	0.0023	-0.0083	0.0578	0.0088
	(0.0395)	*(0.0006)*	*(0.0028)*	*(0.0057)*	*(0.0073)*	*(0.0429)*	*(0.0059)*
15	0.0149	-0.0006	0.0026	-0.0016	-0.0108	0.0423	0.0075
	(0.0377)	*(0.0007)*	*(0.0033)*	*(0.0057)*	*(0.0078)*	*(0.0451)*	*(0.0058)*
17	-0.0144	-0.0009	0.0034	-0.0065	-0.0138	0.0363	0.0077
	(0.0377)	*(0.0008)*	*(0.0038)*	*(0.0059)*	*(0.0085)*	*(0.0477)*	*(0.0058)*
19	-0.0324	-0.0010	0.0042	-0.0091	-0.0163	0.0297	0.0068
	(0.0389)	*(0.0009)*	*(0.0043)*	*(0.0062)*	*(0.0093)*	*(0.0504)*	*(0.0057)*
21	-0.0511	-0.0012	0.0048	-0.0109	-0.0187	0.0177	0.0060
	(0.0409)	*(0.0010)*	*(0.0047)*	*(0.0064)*	*(0.0102)*	*(0.0529)*	*(0.0057)*
23	-0.0656	-0.0014	0.0052	-0.0133	-0.0208	0.0082	0.0072
	(0.0430)	*(0.0011)*	*(0.0050)*	*(0.0067)*	*(0.0112)*	*(0.0549)*	*(0.0058)*
25	-0.0815	-0.0014	0.0052	-0.0147	-0.0227	0.0004	0.0076
	(0.0453)	*(0.0011)*	*(0.0053)*	*(0.0072)*	*(0.0122)*	*(0.0564)*	*(0.0060)*
27	-0.0913	-0.0015	0.0051	-0.0155	-0.0242	-0.0082	0.0074
	(0.0478)	*(0.0011)*	*(0.0055)*	*(0.0077)*	*(0.0133)*	*(0.0579)*	*(0.0062)*
29	-0.0963	-0.0014	0.0046	-0.0166	-0.0252	-0.0129	0.0072
	(0.0504)	*(0.0012)*	*(0.0057)*	*(0.0084)*	*(0.0145)*	*(0.0596)*	*(0.0065)*
31	-0.1007	-0.0013	0.0039	-0.0175	-0.0260	-0.0115	0.0064
	(0.0531)	*(0.0012)*	*(0.0059)*	*(0.0091)*	*(0.0157)*	*(0.0618)*	*(0.0068)*
33	-0.1022	-0.0011	0.0029	-0.0176	-0.0264	-0.0080	0.0052
	(0.0558)	*(0.0012)*	*(0.0062)*	*(0.0099)*	*(0.0170)*	*(0.0646)*	*(0.0072)*
35	-0.1025	-0.0009	0.0017	-0.0174	-0.0262	-0.0027	0.0040
	(0.0584)	*(0.0013)*	*(0.0065)*	*(0.0106)*	*(0.0183)*	*(0.0679)*	*(0.0075)*
R^2	0.78	0.85	0.74	0.84	0.79	0.84	0.69

Notes: The p-values are displayed in parentheses.

Source: own calculations based on data from ECB Statistical Warehouse (2017).

Table 6. Impulse responses to MRO rate innovation — lower bound

Period	HICP	GDP	UNEMPL	BASE MONEY	CREDIT	EURIBOR	TP
1	0.0370	0.0001	-0.0002	-0.0038	-0.0012	0.0496	-0.0064
	(0.0144)	*(0.0001)*	*(0.0003)*	*(0.0020)*	*(0.0017)*	*(0.0070)*	*(0.0024)*
3	0.0922	0.0005	-0.0010	-0.0008	-0.0056	0.1077	-0.0038
	(0.0259)	*(0.0002)*	*(0.0007)*	*(0.0037)*	*(0.0033)*	*(0.0173)*	*(0.0044)*
5	0.1136	0.0009	-0.0022	0.0010	-0.0029	0.1417	-0.0051
	(0.0343)	*(0.0003)*	*(0.0012)*	*(0.0045)*	*(0.0046)*	*(0.0258)*	*(0.0051)*
7	0.1088	0.0009	-0.0020	0.0117	-0.0035	0.1259	0.0006
	(0.0397)	*(0.0004)*	*(0.0015)*	*(0.0051)*	*(0.0056)*	*(0.0327)*	*(0.0056)*
9	0.0934	0.0006	-0.0007	0.0091	-0.0043	0.0977	0.0067
	(0.0421)	*(0.0005)*	*(0.0019)*	*(0.0055)*	*(0.0064)*	*(0.0379)*	*(0.0057)*
11	0.0530	0.0001	0.0004	0.0061	-0.0053	0.0802	0.0090
	(0.0413)	*(0.0005)*	*(0.0023)*	*(0.0055)*	*(0.0068)*	*(0.0408)*	*(0.0058)*
13	0.0362	-0.0003	0.0014	0.0023	-0.0083	0.0578	0.0088
	(0.0395)	*(0.0006)*	*(0.0028)*	*(0.0057)*	*(0.0073)*	*(0.0429)*	*(0.0059)*
15	0.0149	-0.0006	0.0026	-0.0016	-0.0108	0.0423	0.0075
	(0.0377)	*(0.0007)*	*(0.0033)*	*(0.0057)*	*(0.0078)*	*(0.0451)*	*(0.0058)*
17	-0.0144	-0.0009	0.0034	-0.0065	-0.0138	0.0363	0.0077
	(0.0377)	*(0.0008)*	*(0.0038)*	*(0.0059)*	*(0.0085)*	*(0.0477)*	*(0.0058)*
19	-0.0324	-0.0010	0.0042	-0.0091	-0.0163	0.0297	0.0068
	(0.0389)	*(0.0009)*	*(0.0043)*	*(0.0062)*	*(0.0093)*	*(0.0504)*	*(0.0057)*
21	-0.0511	-0.0012	0.0048	-0.0109	-0.0187	0.0177	0.0060
	(0.0409)	*(0.0010)*	*(0.0047)*	*(0.0064)*	*(0.0102)*	*(0.0529)*	*(0.0057)*
23	-0.0656	-0.0014	0.0052	-0.0133	-0.0208	0.0082	0.0072
	(0.0430)	*(0.0011)*	*(0.0050)*	*(0.0067)*	*(0.0112)*	*(0.0549)*	*(0.0058)*
25	-0.0815	-0.0014	0.0052	-0.0147	-0.0227	0.0004	0.0076
	(0.0453)	*(0.0011)*	*(0.0053)*	*(0.0072)*	*(0.0122)*	*(0.0564)*	*(0.0060)*
27	-0.0913	-0.0015	0.0051	-0.0155	-0.0242	-0.0082	0.0074
	(0.0478)	*(0.0011)*	*(0.0055)*	*(0.0077)*	*(0.0133)*	*(0.0579)*	*(0.0062)*
29	-0.0963	-0.0014	0.0046	-0.0166	-0.0252	-0.0129	0.0072
	(0.0504)	*(0.0012)*	*(0.0057)*	*(0.0084)*	*(0.0145)*	*(0.0596)*	*(0.0065)*
31	-0.1007	-0.0013	0.0039	-0.0175	-0.0260	-0.0115	0.0064
	(0.0531)	*(0.0012)*	*(0.0059)*	*(0.0091)*	*(0.0157)*	*(0.0618)*	*(0.0068)*
33	-0.1022	-0.0011	0.0029	-0.0176	-0.0264	-0.0080	0.0052
	(0.0558)	*(0.0012)*	*(0.0062)*	*(0.0099)*	*(0.0170)*	*(0.0646)*	*(0.0072)*
35	-0.1025	-0.0009	0.0017	-0.0174	-0.0262	-0.0027	0.0040
	(0.0584)	*(0.0013)*	*(0.0065)*	*(0.0106)*	*(0.0183)*	*(0.0679)*	*(0.0075)*
R^2	0.78	0.85	0.74	0.84	0.79	0.84	0.69

Notes: The p-values are displayed in parentheses.

Source: own calculations based on data from ECB Statistical Warehouse (2017).

Table 7. Impulse responses to MRO rate innovation — upper bound

Period	HICP	GDP	UNEMPL	BASE MONEY	CREDIT	EURIBOR	TP
1	0.0658	0.0002	0.0004	0.0003	0.0022	0.0637	-0.0017
	(0.0143)	*(0.0001)*	*(0.0003)*	*(0.0020)*	*(0.0017)*	*(0.0069)*	*(0.0023)*
3	0.1441	0.0009	0.0005	0.0066	0.0011	0.1424	0.0049
	(0.0257)	*(0.0002)*	*(0.0007)*	*(0.0036)*	*(0.0033)*	*(0.0171)*	*(0.0043)*
5	0.1822	0.0015	0.0001	0.0100	0.0063	0.1934	0.0051
	(0.0339)	*(0.0003)*	*(0.0012)*	*(0.0045)*	*(0.0046)*	*(0.0256)*	*(0.0050)*
7	0.1882	0.0017	0.0011	0.0219	0.0078	0.1913	0.0118
	(0.0393)	*(0.0004)*	*(0.0015)*	*(0.0050)*	*(0.0056)*	*(0.0324)*	*(0.0055)*
9	0.1776	0.0015	0.0032	0.0200	0.0084	0.1734	0.0181
	(0.0417)	*(0.0005)*	*(0.0019)*	*(0.0054)*	*(0.0063)*	*(0.0375)*	*(0.0057)*
11	0.1357	0.0012	0.0051	0.0171	0.0083	0.1618	0.0206
	(0.0409)	*(0.0005)*	*(0.0023)*	*(0.0055)*	*(0.0068)*	*(0.0404)*	*(0.0057)*
13	0.1152	0.0010	0.0070	0.0136	0.0063	0.1435	0.0206
	(0.0391)	*(0.0006)*	*(0.0028)*	*(0.0056)*	*(0.0072)*	*(0.0424)*	*(0.0058)*
15	0.0904	0.0008	0.0092	0.0098	0.0048	0.1324	0.0191
	(0.0373)	*(0.0007)*	*(0.0033)*	*(0.0057)*	*(0.0077)*	*(0.0446)*	*(0.0057)*
17	0.0609	0.0008	0.0111	0.0053	0.0032	0.1317	0.0192
	(0.0373)	*(0.0008)*	*(0.0038)*	*(0.0059)*	*(0.0084)*	*(0.0472)*	*(0.0057)*
19	0.0455	0.0008	0.0127	0.0032	0.0022	0.1305	0.0182
	(0.0385)	*(0.0009)*	*(0.0042)*	*(0.0061)*	*(0.0092)*	*(0.0499)*	*(0.0057)*
21	0.0307	0.0008	0.0142	0.0019	0.0017	0.1235	0.0174
	(0.0405)	*(0.0010)*	*(0.0047)*	*(0.0063)*	*(0.0101)*	*(0.0524)*	*(0.0056)*
23	0.0204	0.0007	0.0153	0.0002	0.0015	0.1180	0.0187
	(0.0426)	*(0.0010)*	*(0.0050)*	*(0.0067)*	*(0.0111)*	*(0.0543)*	*(0.0057)*
25	0.0092	0.0008	0.0159	-0.0004	0.0018	0.1133	0.0195
	(0.0449)	*(0.0011)*	*(0.0053)*	*(0.0071)*	*(0.0121)*	*(0.0559)*	*(0.0059)*
27	0.0044	0.0008	0.0161	-0.0001	0.0025	0.1076	0.0198
	(0.0474)	*(0.0011)*	*(0.0055)*	*(0.0077)*	*(0.0132)*	*(0.0573)*	*(0.0062)*
29	0.0045	0.0009	0.0161	0.0001	0.0038	0.1063	0.0202
	(0.0499)	*(0.0011)*	*(0.0057)*	*(0.0083)*	*(0.0143)*	*(0.0590)*	*(0.0065)*
31	0.0054	0.0011	0.0157	0.0008	0.0054	0.1121	0.0200
	(0.0525)	*(0.0012)*	*(0.0059)*	*(0.0090)*	*(0.0155)*	*(0.0612)*	*(0.0068)*
33	0.0093	0.0014	0.0152	0.0022	0.0075	0.1211	0.0195
	(0.0552)	*(0.0012)*	*(0.0061)*	*(0.0098)*	*(0.0168)*	*(0.0639)*	*(0.0071)*
35	0.0143	0.0017	0.0147	0.0039	0.0103	0.1332	0.0190
	(0.0578)	*(0.0013)*	*(0.0064)*	*(0.0105)*	*(0.0181)*	*(0.0673)*	*(0.0074)*
R^2	0.78	0.85	0.74	0.84	0.79	0.84	0.69

Notes: The p-values are displayed in parentheses.

Source: own calculations based on data from ECB Statistical Warehouse (2017).

Table 8. Impulse responses to credit multiplier shock

Period	HICP	GDP	UNEMPL	BASE MONEY	CREDIT	EURIBOR	TP
1	-0.0225	0.0002	0.0005	-0.0068	0.0005	-0.0049	0.0004
	(0.0144)	*(0.0001)*	*(0.0003)*	*(0.0020)*	*(0.0017)*	*(0.0078)*	*(0.0024)*
3	0.0311	0.0006	-0.0006	-0.0004	0.0000	-0.0082	-0.0048
	(0.0270)	*(0.0002)*	*(0.0008)*	*(0.0040)*	*(0.0036)*	*(0.0199)*	*(0.0046)*
5	0.0644	0.0011	-0.0014	-0.0031	-0.0019	0.0000	-0.0063
	(0.0368)	*(0.0003)*	*(0.0012)*	*(0.0051)*	*(0.0050)*	*(0.0296)*	*(0.0055)*
7	0.0680	0.0014	-0.0020	-0.0044	-0.0062	0.0172	-0.0041
	(0.0429)	*(0.0005)*	*(0.0016)*	*(0.0061)*	*(0.0062)*	*(0.0358)*	*(0.0059)*
9	0.0732	0.0015	-0.0018	-0.0036	-0.0077	0.0225	-0.0020
	(0.0466)	*(0.0005)*	*(0.0021)*	*(0.0071)*	*(0.0072)*	*(0.0404)*	*(0.0063)*
11	0.0754	0.0015	-0.0012	-0.0046	-0.0078	0.0246	-0.0001
	(0.0482)	*(0.0006)*	*(0.0025)*	*(0.0077)*	*(0.0082)*	*(0.0437)*	*(0.0067)*
13	0.0735	0.0014	-0.0006	-0.0060	-0.0076	0.0287	0.0034
	(0.0478)	*(0.0007)*	*(0.0031)*	*(0.0078)*	*(0.0089)*	*(0.0463)*	*(0.0067)*
15	0.0612	0.0012	0.0000	-0.0054	-0.0082	0.0273	0.0054
	(0.0447)	*(0.0008)*	*(0.0036)*	*(0.0077)*	*(0.0094)*	*(0.0481)*	*(0.0064)*
17	0.0454	0.0011	0.0009	-0.0042	-0.0084	0.0164	0.0070
	(0.0404)	*(0.0009)*	*(0.0041)*	*(0.0074)*	*(0.0099)*	*(0.0494)*	*(0.0062)*
19	0.0317	0.0009	0.0018	-0.0038	-0.0089	0.0038	0.0079
	(0.0369)	*(0.0009)*	*(0.0046)*	*(0.0068)*	*(0.0103)*	*(0.0507)*	*(0.0059)*
21	0.0173	0.0007	0.0026	-0.0036	-0.0100	-0.0070	0.0074
	(0.0349)	*(0.0010)*	*(0.0050)*	*(0.0064)*	*(0.0109)*	*(0.0524)*	*(0.0055)*
23	0.0028	0.0005	0.0034	-0.0033	-0.0112	-0.0177	0.0065
	(0.0347)	*(0.0010)*	*(0.0054)*	*(0.0063)*	*(0.0116)*	*(0.0536)*	*(0.0052)*
25	-0.0110	0.0004	0.0041	-0.0033	-0.0121	-0.0270	0.0058
	(0.0359)	*(0.0011)*	*(0.0056)*	*(0.0064)*	*(0.0124)*	*(0.0539)*	*(0.0050)*
27	-0.0235	0.0003	0.0046	-0.0034	-0.0130	-0.0337	0.0051
	(0.0375)	*(0.0011)*	*(0.0057)*	*(0.0067)*	*(0.0133)*	*(0.0530)*	*(0.0048)*
29	-0.0324	0.0003	0.0049	-0.0038	-0.0137	-0.0381	0.0043
	(0.0390)	*(0.0010)*	*(0.0056)*	*(0.0072)*	*(0.0142)*	*(0.0512)*	*(0.0047)*
31	-0.0377	0.0003	0.0049	-0.0043	-0.0143	-0.0394	0.0036
	(0.0404)	*(0.0010)*	*(0.0055)*	*(0.0078)*	*(0.0150)*	*(0.0487)*	*(0.0047)*
33	-0.0405	0.0004	0.0047	-0.0050	-0.0148	-0.0373	0.0030
	(0.0418)	*(0.0010)*	*(0.0053)*	*(0.0084)*	*(0.0158)*	*(0.0461)*	*(0.0048)*
35	-0.0410	0.0005	0.0042	-0.0056	-0.0151	-0.0323	0.0024
	(0.0432)	*(0.0010)*	*(0.0051)*	*(0.0090)*	*(0.0165)*	*(0.0444)*	*(0.0049)*
R^2	0.80	0.79	0.76	0.82	0.80	0.79	0.73

Notes: The p-values are displayed in parentheses.

Source: own calculations based on data from ECB Statistical Warehouse (2017).

Table 9. Impulse responses to credit multiplier shock — lower bound

Period	HICP	GDP	UNEMPL	BASE MONEY	CREDIT	EURIBOR	TP
1	-0.0513	0.0000	-0.0001	-0.0109	-0.0030	-0.0206	-0.0044
	(0.0143)	*(0.0001)*	*(0.0003)*	*(0.0020)*	*(0.0017)*	*(0.0078)*	*(0.0024)*
3	-0.0229	0.0002	-0.0021	-0.0083	-0.0071	-0.0481	-0.0140
	(0.0267)	*(0.0002)*	*(0.0008)*	*(0.0039)*	*(0.0035)*	*(0.0197)*	*(0.0046)*
5	-0.0092	0.0004	-0.0038	-0.0134	-0.0120	-0.0593	-0.0173
	(0.0364)	*(0.0003)*	*(0.0012)*	*(0.0051)*	*(0.0050)*	*(0.0293)*	*(0.0055)*
7	-0.0178	0.0005	-0.0053	-0.0166	-0.0185	-0.0544	-0.0159
	(0.0425)	*(0.0004)*	*(0.0016)*	*(0.0060)*	*(0.0061)*	*(0.0354)*	*(0.0058)*
9	-0.0199	0.0005	-0.0059	-0.0179	-0.0221	-0.0582	-0.0146
	(0.0461)	*(0.0005)*	*(0.0020)*	*(0.0071)*	*(0.0072)*	*(0.0400)*	*(0.0062)*
11	-0.0209	0.0002	-0.0062	-0.0200	-0.0241	-0.0628	-0.0134
	(0.0477)	*(0.0006)*	*(0.0025)*	*(0.0076)*	*(0.0081)*	*(0.0433)*	*(0.0066)*
13	-0.0221	-0.0001	-0.0067	-0.0216	-0.0254	-0.0640	-0.0099
	(0.0473)	*(0.0007)*	*(0.0030)*	*(0.0077)*	*(0.0088)*	*(0.0459)*	*(0.0066)*
15	-0.0281	-0.0004	-0.0071	-0.0207	-0.0271	-0.0689	-0.0074
	(0.0442)	*(0.0008)*	*(0.0035)*	*(0.0076)*	*(0.0093)*	*(0.0476)*	*(0.0064)*
17	-0.0353	-0.0007	-0.0073	-0.0189	-0.0282	-0.0824	-0.0054
	(0.0400)	*(0.0009)*	*(0.0041)*	*(0.0073)*	*(0.0098)*	*(0.0489)*	*(0.0061)*
19	-0.0421	-0.0010	-0.0074	-0.0175	-0.0296	-0.0976	-0.0038
	(0.0365)	*(0.0009)*	*(0.0046)*	*(0.0068)*	*(0.0102)*	*(0.0502)*	*(0.0058)*
21	-0.0524	-0.0013	-0.0074	-0.0164	-0.0318	-0.1118	-0.0035
	(0.0345)	*(0.0010)*	*(0.0050)*	*(0.0063)*	*(0.0108)*	*(0.0519)*	*(0.0054)*
23	-0.0666	-0.0016	-0.0073	-0.0158	-0.0344	-0.1249	-0.0039
	(0.0344)	*(0.0010)*	*(0.0053)*	*(0.0062)*	*(0.0115)*	*(0.0531)*	*(0.0051)*
25	-0.0828	-0.0017	-0.0071	-0.0160	-0.0370	-0.1347	-0.0041
	(0.0356)	*(0.0010)*	*(0.0055)*	*(0.0063)*	*(0.0123)*	*(0.0533)*	*(0.0049)*
27	-0.0986	-0.0018	-0.0067	-0.0168	-0.0396	-0.1398	-0.0045
	(0.0371)	*(0.0010)*	*(0.0056)*	*(0.0066)*	*(0.0132)*	*(0.0525)*	*(0.0047)*
29	-0.1104	-0.0018	-0.0063	-0.0182	-0.0420	-0.1405	-0.0051
	(0.0386)	*(0.0010)*	*(0.0056)*	*(0.0071)*	*(0.0140)*	*(0.0507)*	*(0.0047)*
31	-0.1185	-0.0017	-0.0060	-0.0199	-0.0443	-0.1367	-0.0058
	(0.0400)	*(0.0010)*	*(0.0054)*	*(0.0077)*	*(0.0148)*	*(0.0482)*	*(0.0047)*
33	-0.1241	-0.0016	-0.0059	-0.0218	-0.0463	-0.1296	-0.0066
	(0.0414)	*(0.0010)*	*(0.0052)*	*(0.0083)*	*(0.0156)*	*(0.0457)*	*(0.0048)*
35	-0.1275	-0.0014	-0.0061	-0.0235	-0.0480	-0.1211	-0.0075
	(0.0428)	*(0.0009)*	*(0.0051)*	*(0.0089)*	*(0.0163)*	*(0.0439)*	*(0.0049)*
R^2	0.80	0.79	0.76	0.82	0.80	0.79	0.73

Notes: The p-values are displayed in parentheses.

Source: own calculations based on data from ECB Statistical Warehouse (2017).

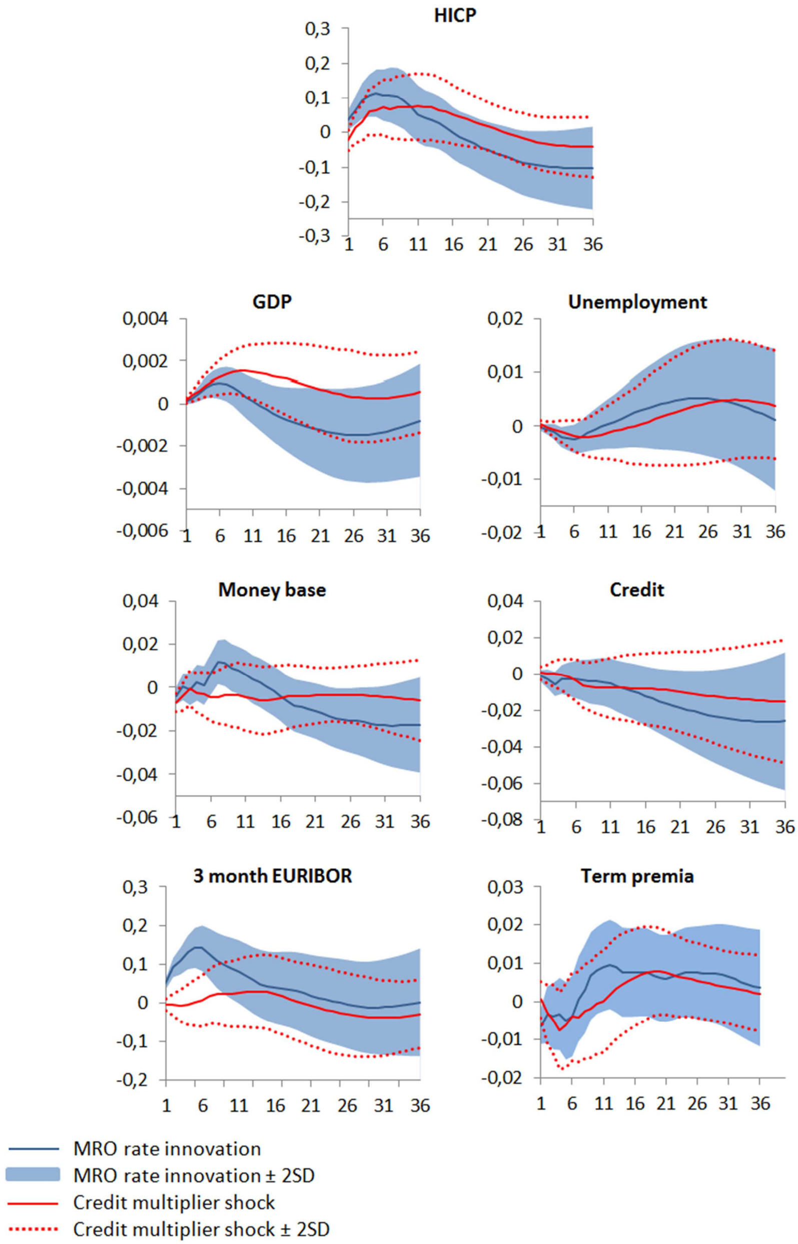
Table 20. Impulse responses to credit multiplier shock — upper bound

Period	HICP	GDP	UNEMPL	BASE MONEY	CREDIT	EURIBOR	TP
1	0.0064	0.0003	0.0011	-0.0028	0.0040	0.0108	0.0052
	(0.0143)	*(0.0001)*	*(0.0003)*	*(0.0020)*	*(0.0017)*	*(0.0078)*	*(0.0024)*
3	0.0852	0.0010	0.0009	0.0075	0.0071	0.0317	0.0044
	(0.0267)	*(0.0002)*	*(0.0008)*	*(0.0039)*	*(0.0035)*	*(0.0197)*	*(0.0046)*
5	0.1379	0.0018	0.0011	0.0072	0.0081	0.0593	0.0048
	(0.0364)	*(0.0003)*	*(0.0012)*	*(0.0051)*	*(0.0050)*	*(0.0293)*	*(0.0055)*
7	0.1538	0.0023	0.0012	0.0079	0.0061	0.0887	0.0077
	(0.0425)	*(0.0004)*	*(0.0016)*	*(0.0060)*	*(0.0061)*	*(0.0354)*	*(0.0058)*
9	0.1664	0.0026	0.0023	0.0107	0.0068	0.1033	0.0106
	(0.0461)	*(0.0005)*	*(0.0020)*	*(0.0071)*	*(0.0072)*	*(0.0400)*	*(0.0062)*
11	0.1717	0.0028	0.0039	0.0108	0.0085	0.1120	0.0133
	(0.0477)	*(0.0006)*	*(0.0025)*	*(0.0076)*	*(0.0081)*	*(0.0433)*	*(0.0066)*
13	0.1691	0.0028	0.0055	0.0096	0.0102	0.1213	0.0167
	(0.0473)	*(0.0007)*	*(0.0030)*	*(0.0077)*	*(0.0088)*	*(0.0459)*	*(0.0066)*
15	0.1505	0.0028	0.0072	0.0100	0.0107	0.1235	0.0183
	(0.0442)	*(0.0008)*	*(0.0035)*	*(0.0076)*	*(0.0093)*	*(0.0476)*	*(0.0064)*
17	0.1262	0.0028	0.0091	0.0106	0.0114	0.1153	0.0194
	(0.0400)	*(0.0009)*	*(0.0041)*	*(0.0073)*	*(0.0098)*	*(0.0489)*	*(0.0061)*
19	0.1054	0.0028	0.0110	0.0099	0.0117	0.1053	0.0196
	(0.0365)	*(0.0009)*	*(0.0046)*	*(0.0068)*	*(0.0102)*	*(0.0502)*	*(0.0058)*
21	0.0871	0.0027	0.0127	0.0092	0.0118	0.0978	0.0184
	(0.0345)	*(0.0010)*	*(0.0050)*	*(0.0063)*	*(0.0108)*	*(0.0519)*	*(0.0054)*
23	0.0723	0.0026	0.0141	0.0092	0.0120	0.0895	0.0169
	(0.0344)	*(0.0010)*	*(0.0053)*	*(0.0062)*	*(0.0115)*	*(0.0531)*	*(0.0051)*
25	0.0609	0.0025	0.0152	0.0094	0.0127	0.0807	0.0157
	(0.0356)	*(0.0010)*	*(0.0055)*	*(0.0063)*	*(0.0123)*	*(0.0533)*	*(0.0049)*
27	0.0515	0.0024	0.0159	0.0099	0.0136	0.0724	0.0147
	(0.0371)	*(0.0010)*	*(0.0056)*	*(0.0066)*	*(0.0132)*	*(0.0525)*	*(0.0047)*
29	0.0457	0.0023	0.0161	0.0106	0.0146	0.0644	0.0138
	(0.0386)	*(0.0010)*	*(0.0056)*	*(0.0071)*	*(0.0140)*	*(0.0507)*	*(0.0047)*
31	0.0432	0.0023	0.0159	0.0112	0.0157	0.0579	0.0131
	(0.0400)	*(0.0010)*	*(0.0054)*	*(0.0077)*	*(0.0148)*	*(0.0482)*	*(0.0047)*
33	0.0432	0.0023	0.0153	0.0118	0.0167	0.0550	0.0126
	(0.0414)	*(0.0010)*	*(0.0052)*	*(0.0083)*	*(0.0156)*	*(0.0457)*	*(0.0048)*
35	0.0454	0.0024	0.0144	0.0123	0.0178	0.0564	0.0122
	(0.0428)	*(0.0009)*	*(0.0051)*	*(0.0089)*	*(0.0163)*	*(0.0439)*	*(0.0049)*
R^2	0.80	0.79	0.76	0.82	0.80	0.79	0.73

Notes: The p-values are displayed in parentheses.

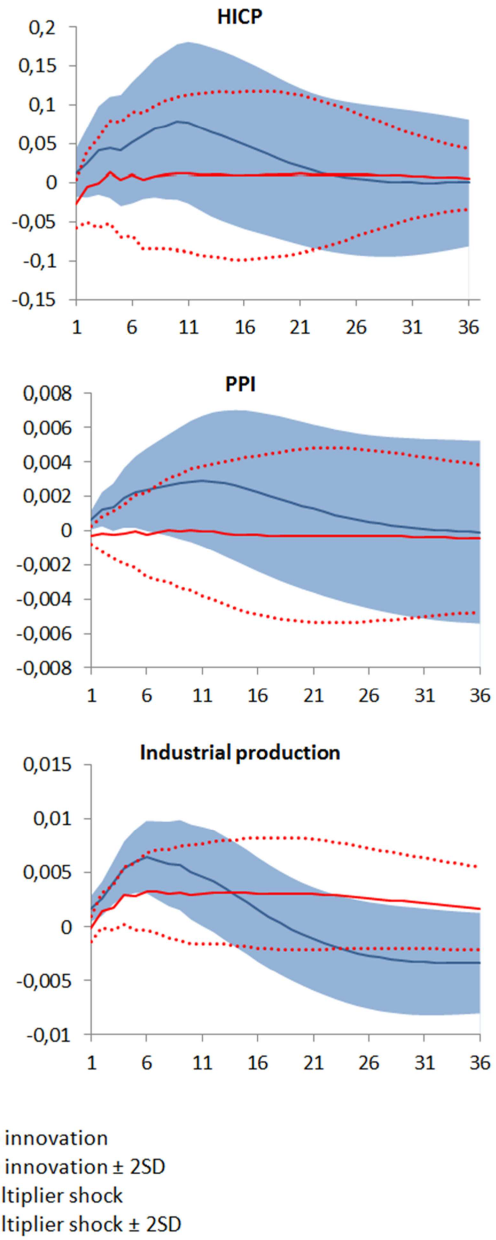
Source: own calculations based on data from ECB Statistical Warehouse (2017).

Figure 1. Impulse responses to interest rate and credit multiplier shocks (in log)



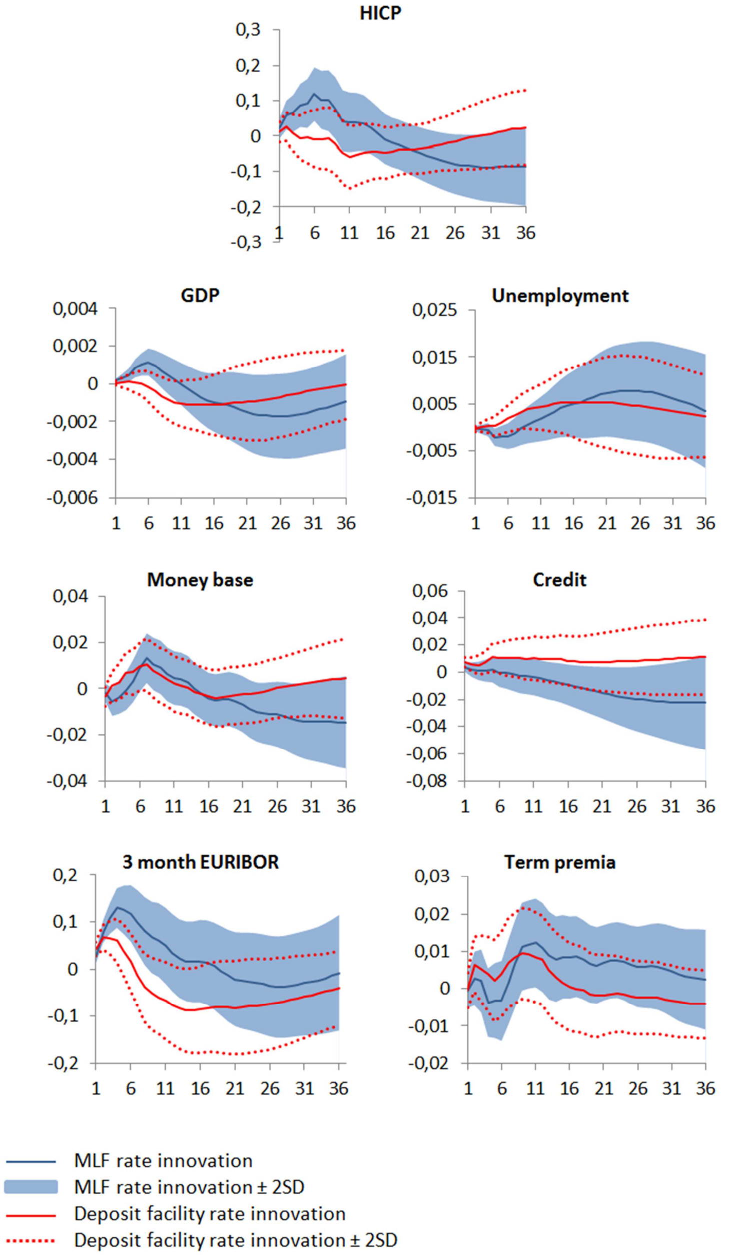
Source: own calculations based on data from ECB Statistical Warehouse (2017).

Figure 2. Impulse responses of inflation to different types of credit supply shocks (in log)



Source: own calculations based on data from ECB Statistical Warehouse (2017).

Figure 3. Impulse responses to different types of credit supply shocks (in log)



Source: own calculations based on data from ECB Statistical Warehouse (2017).