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Monetary Policy and Bank Lending in Euro Area since the Outset of the Global Financial Crisis

Summary: In this article, we present the impact of the monetary policy stance of the European Central Bank (ECB) since 2007 on bank lending in the euro area and compare the effects of the main measures: interest rate changes, liquidity provision, and asset purchase programmes. We also analyse the channels through which monetary policy might influence the banking system and narrow our focus to the individual countries. The main results indicate stimulating impact of ECB's policy stance on bank lending that extends its influence mainly through interest rate cuts further supported by the liquidity provision and asset purchase programmes. However, we also find considerable differences across the member states, often depending on the state of the banking system and loan demand in the member state. The results support the variety of monetary policy measures introduced by the ECB, as each played its own role in supporting the banking system and encouraging bank lending in the euro area.

Keywords: Unconventional monetary policy, Bank lending, Monetary transmission, EMU, Synthetic indicator.

JEL: E50, E52, E58, G21.

Given the importance of the banks in the euro area as the foremost source of funds, banking system strains because of the global financial crisis, and the European debt crisis hinder the transmission of the monetary policy to the real economy. From the outset of the crisis, the European Central Bank (ECB) concentrated its actions largely on providing liquidity and easing the strain on banks to support their credit creation; later on, the ECB began facilitating bank lending to support a weak economy and fight deflationary pressures. Thus, it is of paramount importance to assess the effectiveness of the ECB policy steps in supporting the banking sector.

This article uses a shadow rate as a measure of monetary policy stance and vector autoregression (VAR) model to study the impact of ECB monetary policy on the credit supply since the outset of global financial crisis. It is also one of few studies that compare the effects of all the three main monetary policy measures implemented by the ECB: interest rate changes, liquidity provision, and asset purchase programmes. Our analysis extends further into the channels through which bank lending is affected and also compares the effects of ECB policies across individual euro area countries.

The study is structured as follows. Section 1 provides literature review on the topic. Section 2 describes policy measures taken by the ECB and derivation of the synthetic monetary policy measure. Section 3 presents the methodology and data. Sections 4 and 5 comment on the empirical results, whereas Section 6 concludes.

1. Literature Review

Numerous studies have explored the policy measures implemented by the ECB since the outbreak of the financial crisis. Many concentrate on the impacts of nonstandard monetary policies on financial variables. Studies on the effects of either announcements or implementation of the ECB's unconventional policies variously examine the impacts on sovereign spreads (Matteo Falagiarda and Stefan Reitz 2015), interbank rates (Puriya Abbassi and Tobias Linzert 2011), covered bond markets (John Beirne et al. 2011), money market rates (Paolo Angelini, Andrea Nobili, and Cristina Picillo 2011), and a number of monetary and credit variables (Domenico Giannone et al. 2011). Other studies are directly concerned with the macroeconomic variables (e.g., Michele Lenza, Huw Pill, and Lucrezia Reichlin 2010; Gert Peersman 2011; Carlo Altavilla, Giannone, and Lenza 2014; Leonardo Gambacorta, Boris Hofmann, and Peersman 2014).

Relatively few scholars, however, have focussed on how the ECB's monetary policies since the global financial crisis happened have influenced bank lending. Of those that have carried out the analysis, many concentrate on the effects of the ECB liquidity provision. Matthieu Darracq-Paries and Roberto de Santis (2015) show in a panel analysis for the 11 largest euro area countries that the two 3-year longer-term refinancing operations (LTROs) of December 2011 and February 2012 have had positive impact on the euro area economy, including loans to nonfinancial corporations (NFCs). Jef Boeckx, Maarten Dossche, and Peersman (2017), using the data available up to the end of 2014, that is, before the start of the large-scale asset purchase programmes, find that expansionary ECB balance sheet shock had a positive impact on euro area output and inflation and stimulated bank lending. Christophe Cahn, Julien Matheron, and Jean-Guillaume Sahuc (2017) use the dynamic stochastic general equilibrium (DSGE) model to show that ECB liquidity provision was a crucial factor in averting a credit crunch.

On the other hand, Luca Gambetti and Alberto Musso (2017) identify the shock connected to the introduction of asset purchase programmes and show its positive effect on GDP and inflation, one of the transmission channels being policy-induced increase in bank lending. Marco Pagano, Altavilla, and Saverio Simonelli (2016) identify unconventional monetary policy shocks with event study based on daily data and implement the shocks to the VAR model to analyse the impact of LTROs as well as asset purchase programmes and targeted longer-term refinancing operations (TLTROs) on bank lending in the euro area. They show that LTROs do not affect lending in the euro area, in both stressed and nonstressed countries; in the stressed countries, the additional liquidity being used instead for purchase of sovereign debt. Simultaneously, stimulating impact of asset purchases and TLTROs is observed in both country groups.

2. ECB Policy Measures and Liquidity Conditions in Euro Area

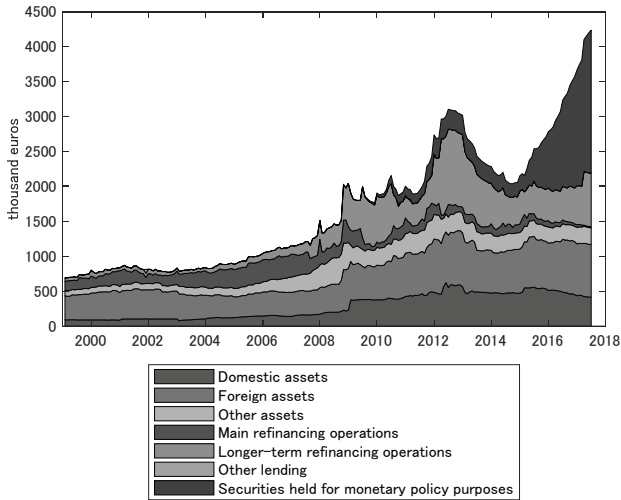
This section presents first the monetary policy steps undertaken by the ECB from 2007 and the resulting balance sheet structure. Subsequently, it describes the derivation of the measure of the ECB monetary policy stance at the time.

2.1 Monetary Policy of the ECB

The European Central Bank's first responses to the Lehman Brothers collapse concentrated largely on interest rate cuts from autumn 2008, with the policy rate reaching the historically low 1% level in May 2009. Later on, even at the low levels, the central bank did not give up entirely its operating target. After a short period of interest rate hikes in 2011, from October 2011 a new series of cuts took place, bringing the main refinancing rate to 0% in March 2016. Moreover, the ECB introduced the negative deposit rate in June 2014, which brought further downward pressure on the interbank overnight interest rate (Eonia), which notes negative values from November 2014.

Simultaneously, the ECB's policy decisions implemented since 2007 sought to ease tensions in the financial markets to facilitate bank funding and lending. Such decisions included supplementary LTROs, granting unlimited access to the central bank's liquidity, extension of maximum maturity of liquidity provision, extension of the list of eligible collateral as well as the first and the second covered bond purchase programmes (CBPP, CBPP2) from June 2009 and November 2011, respectively. In response to the sovereign crisis, ECB committed to Securities Markets Programme (SMP) from May 2010, further extended liquidity provision schemes, and announced the technical details of Outright Monetary Transactions (OMT) programme in September 2012. From 2014, concerns over the deflationary environment prompted the central bank to take further actions to also support the weak economy and increase the inflation rate, *via* the above-mentioned interest rate cuts and introduction of negative deposit rate as well as TLTROs. Finally, the bank undertook the third covered bond purchase programme (CBPP3) and asset-based securities (ABS) purchase programme in October and November 2014, respectively, and the public securities purchase programme (PSPP) in March 2015; the quantitative easing programmes more similar to the ones undertaken in the US and UK (Klaus-Jurgen Gern et al. 2015).

Figure 1 presents the assets held by the ECB. The balance sheet of the ECB shows a progression from slow growth in the first half of the 2000s to a rapid expansion from 2009, with an especially sharp increase taking place from mid-2011 to mid-2012. At the time, the expansion in assets was mainly attributable to an increase in LTROs. The main refinancing operations prevailed as the basic monetary policy instrument up to 2007, and thereafter significantly decreased in favour of longer-term operations. Finally, "Securities held for monetary policy purposes" on the balance sheet represents asset purchase programmes that up to 2015 lacked significance compared with the size of the whole balance sheet or the scale of refinancing operations.



Source: ECB (2018); data on balance sheet items have been summed up to the main categories by the author.

Figure 1 Assets of European Central Bank

2.2 Synthetic Measure of the Monetary Policy Stance

Given the variety of monetary policy steps introduced by the ECB since 2007, any study of the policy effects encounters a difficulty in terms of measuring the monetary policy. Here, we base the measurement on the literature concerning the computation of the so-called shadow rate – a synthetic measure of the monetary policy stance that basically moves similar to the interest rates but also captures noninterest-rate policy actions and is not constrained by a zero lower bound. Specifically, we follow the logic of Marco J. Lombardi and Feng Zhu (2014) and Oxana B. Kucharcukova, Peter Claeys, and Borek Vasicek (2016), who calculate the monetary conditions index (MCI) for the US and euro area, respectively. The MCI summarizes the information included in the range of monetary variables, including interest rates, monetary aggregates, central bank balance sheet items, and exchange rate. The variables used in this article closely follow the set applied by Kucharcukova, Claeys, and Vasicek (2016), although we also add the data on Eonia and deposit facility interest rates.

Specifically, the list of variables is as follows:

I. Interest rates: (1) deposit facility interest rate; (2) main refinancing operations rate; (3) overnight interbank interest rate (Eonia); (4) 3-month Euro interbank offered rate (Euribor); (5) 12-month Euribor; (6) average euro area 10-year government bond yield; (7) overnight interest swap (OIS) rate;

II. Monetary aggregates: (8) M1; (9) M2; (10) M3;

III. Selected items of ECB balance sheet: (11) total assets; (12) LTROs; (13) securities held for monetary policy purposes; (14) currency in circulation; (15) liabilities to euro area credit institutions related to MPOs;

IV. Exchange rate: (16) nominal exchange rate of US dollar to euro.

All data come monthly and cover the time period from January 2000 to June 2017. In case of variables in blocks II and III, we use year-on-year growth rates with the sign reversed so that increase means monetary policy tightening (as in case of interest rates). The exchange rate data is also in the form of year-on-year rate of change.

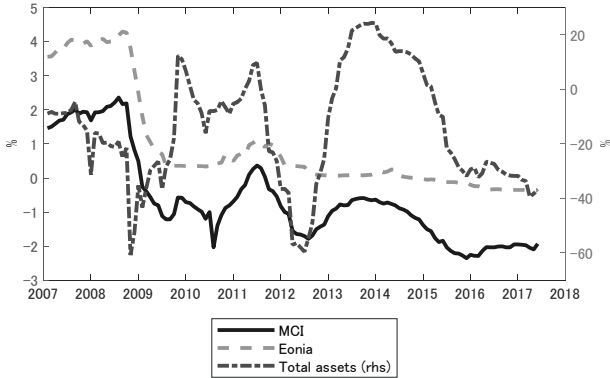
We employ the principal components analysis to transform the information from the correlated variables listed above into the set of uncorrelated variables, called principal components (PCs). The first PC accounts for the highest proportion of variability in the dataset, and the succeeding components account for the decreasing proportions of the variability. Then, we choose the components with the highest eigenvalue to use for estimation of MCI and in further analysis.

Table 1 Component Loadings for Five PCs from Principal Component Analysis.

| | PC1 | PC2 | PC3 | PC4 | PC5 |
|-----------------------------|--------|--------|--------|--------|--------|
| 1) Deposit facility rate | 0.351 | 0.004 | 0.107 | -0.075 | 0.003 |
| 2) MRO rate | 0.354 | 0.008 | 0.088 | -0.046 | -0.038 |
| 3) Eonia rate | 0.356 | -0.012 | 0.033 | -0.067 | -0.029 |
| 4) Euribor 3M | 0.356 | 0.018 | 0.067 | -0.030 | -0.058 |
| 5) Euribor 12M | 0.351 | 0.023 | 0.122 | -0.016 | -0.075 |
| 6) 10-year bond yield | 0.285 | -0.112 | 0.218 | 0.102 | -0.157 |
| 7) OIS | 0.355 | -0.24 | 0.031 | -0.076 | -0.033 |
| 8) M1 | 0.046 | -0.021 | 0.524 | 0.489 | -0.014 |
| 9) M2 | -0.248 | -0.188 | 0.390 | 0.098 | -0.055 |
| 10) M3 | -0.269 | -0.190 | 0.333 | 0.104 | -0.158 |
| 11) Total assets | 0.028 | -0.580 | -0.069 | -0.015 | 0.111 |
| 12) LTRO | -0.035 | -0.493 | -0.085 | -0.309 | -0.055 |
| 13) Securities | 0.102 | -0.010 | -0.211 | 0.362 | 0.782 |
| 14) Currency in circulation | 0.007 | -0.086 | 0.493 | -0.276 | 0.524 |
| 15) Liabilities of MPO | 0.091 | -0.531 | -0.141 | -0.031 | 0.010 |
| 16) USD/EUR rate | 0.101 | -0.216 | -0.239 | 0.637 | -0.183 |
| Component proportion | 0.4825 | 0.1699 | 0.1131 | 0.0719 | 0.0584 |

Source: Author's calculations.

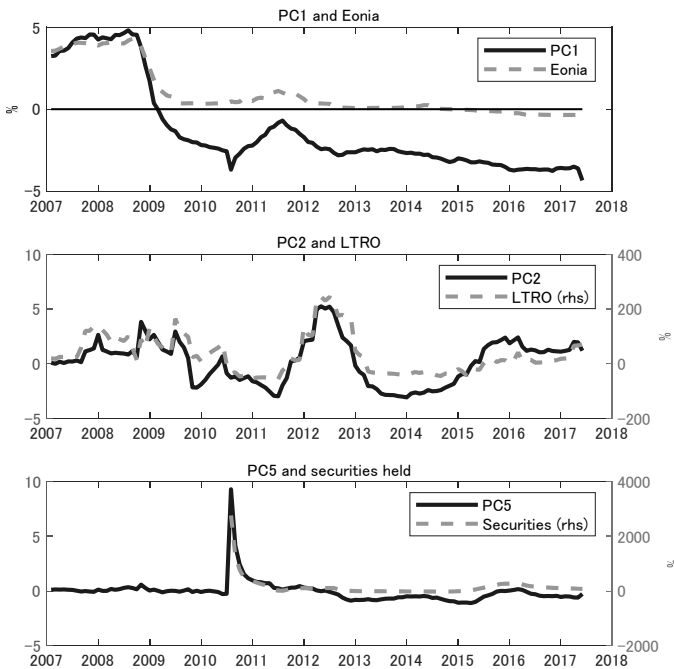
Table 1 presents the component loadings of the four identified components with eigenvalue greater than one, which together explain approximately 84% of the data variability, plus the fifth PC with eigenvalue slightly below one and explaining additional 5.8% of the data variability. PC1 can be interpreted to mainly represent changes in the interest rates – the conventional monetary policy stance. PC2 corresponds mainly to changes in the size of the ECB's balance sheet as triggered by the LTROs. PC3 not only summarizes changes in monetary aggregates, but also government bond yield and exchange rate to some extent. PC4 seems to illustrate changes in the exchange rate connected with the changes in LTROs, securities purchases by the ECB, and M1. PC5 is most closely related with the changes in the security holdings for monetary policy purposes.



Notes: Year-on-year growth rate in total assets multiplied by -1 to match interest rate and MCI movements where increase means policy tightening.

Source: ECB (2018)¹; growth rate in ECB assets estimated by the author based on raw data.

Figure 2 MCI, Eonia Rate, and Growth Rate in Total ECB Total Assets



Notes: PC2 and PC5 multiplied by -1 to match observed series; LTRO and securities held: year-on-year growth rate.

Source: ECB (2018); growth rates estimated by the author based on raw data.

Figure 3 Principal Components and Observed Variables

¹ **European Central Bank.** 2018. Statistical Data Warehouse. <https://sdw.ecb.europa.eu/> (accessed January 10, 2018).

We use the five components to calculate the summary measure of the ECB's monetary policy – the monetary conditions index (MCI). The MCI is calculated as a weighted average of the components (weights being proportions of the variability they explain). Figure 2 plots the MCI over time with the Eonia rate and the growth rate of total ECB assets for comparison. The peaks and troughs of the estimated MCI are similar to the MCI estimated by Kucharcukova, Claeys, and Vasicek (2016). Until 2009, the MCI moves largely in tandem with the Eonia rate. From 2009 onward, the MCI is still affected by the interest rate, but the changes seem to be in large part associated also with changes in the size of the ECB's balance sheet.

Thus, for the following analysis, we use the MCI as a measure of the overall monetary policy stance of ECB. Simultaneously, we also employ PC1, PC2, and PC5 as measures of the separate policy measures implemented by ECB – interest rate changes, liquidity provision (LTROs), and asset purchase programmes, respectively. Figure 3 depicts the three factors together with the policy measures they represent.

3. Empirical Methodology and Data

This section describes the model implemented for our empirical analysis of the effects of ECB policies from the start of the crisis on bank lending as well as the data used for the analysis.

3.1 Model

The empirical analysis is based on a simple VAR model. First, we construct the following structural VAR model for the euro area as a whole:

$$B(L)X_t = \varepsilon_t, \quad (1)$$

where X_t is a vector of endogenous euro area variables, $B(L) = B_0 - B_1L - \dots - B_pL^p$ is a p^{th} order lag polynomial of a coefficient matrix B_m ($m = 0, \dots, p$) (the diagonal elements of the matrix of contemporaneous coefficients B_0 are equal to 1), and ε_t is a vector of serially uncorrelated structural disturbances with a mean zero and a covariance matrix $\Sigma_\varepsilon = I$.

This structural model can be described by the following reduced-form VAR:

$$A(L)X_t = u_t, \quad (2)$$

where $A(L) = I - A_1L - \dots - A_pL^p$ is a p^{th} order lag polynomial of a coefficient matrix A_m ($m = 1, \dots, p$), and $u_t = R\varepsilon_t$ is a vector of serially uncorrelated reduced-form innovations with a mean of zero and a covariance matrix Σ_u . We use Cholesky decomposition of the reduced-form covariance matrix Σ_u ($\Sigma_u = R^{-1}R^{-1'}$) to identify structural shocks ε_t .

In the basic specification, we follow Yuzo Honda, Yoshihiro Kuroki, and Minoru Tachibana (2007) and construct a simple VAR model with variables representing euro area output, inflation, monetary policy measure, and the variable describing the amount of bank lending in the euro area.

The variable describing monetary policy stance is the MCI derived in Section 1.2. Further, to disentangle the effects of separate monetary policy steps undertaken

by the ECB, we use also the principal components 1, 2, and 5 as measures of interest rate changes, liquidity provision, and asset purchases, respectively. We put all three components in the VAR model simultaneously.

In the next steps, we first add to the model, one at time, the channel variables. We also carry out the analysis for individual euro area countries (excluding Estonia, Latvia, and Lithuania because of their short periods as euro area members) in which we add each country output and inflation to control for their macroeconomic conditions as well as the bank lending variable.

The use of economic activity and consumer prices measures is a standard practice in VAR literature; the variables being regarded important macro variables that represent aggregate activities, extend impact on monetary policy variables, and thus are necessary to correctly identify the monetary policy shocks (e.g., Lawrence J. Christiano, Martin Eichenbaum, and Charles L. Evans 1998). Similarly, each country output and inflation is included to represent a country's macroeconomic situation that might affect demand for banking loans.

The VAR models with MCI as policy measure are estimated with four lags, and models containing PC1, PC2, and PC5 use two lags of each variable, as indicated by Akaike information criterion (AIC).

3.2 Data

All data are expressed at a monthly frequency and in logarithms (except for interest rate). The sample period starts in January 2007 and ends in June 2017. We choose this period to include also the first signals of strains in the world and in the European banking system, as well as the first ECB reactions in the spring and summer of 2007. The data are taken from Eurostat and the ECB Statistical Data Warehouse as well as the ECB website.

Industrial production and the all-items Harmonised Index of Consumer Prices (HICP) index serve as proxies for euro area economic activity and inflation, respectively. To analyse the effects of monetary policy steps on the banking system, we use a variable that describes bank lending in the euro area and its individual countries; this is calculated as the sum of the amount of monetary financial institutions (MFI) loans to nonfinancial corporations and the household sector.

The use of industrial production as a measure of economic activity stems from the will to use data of monthly frequency and therefore being able to ensure bigger data samples. Given a large share of services in GDP of the economies under consideration, industrial production is not the ideal proxy for economic activity. However, considerations based solely on a pure contribution of the industrial sector to GDP might be misleading because they do not reflect linkages between industrial and service sectors, e.g., industrial sector consuming high share of output of the service sector. Gabor Fulop and Gyorgy Gyomai (2012) shows that industrial production represents well the cyclicity of GDP, although admits that it is only a suboptimal proxy of most countries' GDP. VAR studies using monthly data usually employ industrial production as a measure of economic activity (e.g., Peersman 2011; Soyoung Kim and Doo Yong Yang 2012) or use industrial production as reference series for interpolation of quarterly GDP values to a monthly measure (e.g., Gambacorta, Hofmann, and Peersman

2014; Boeckx, Dossche, and Peersman 2017). Here, we follow the former strand of the literature.

4. Effects of ECB Monetary Policy on Bank Lending

This section presents the empirical results of our analysis for euro area as a whole. First, we present the effects of ECB monetary policy steps on bank lending. Then we analyse the channels through which monetary policy might affect credit supply.

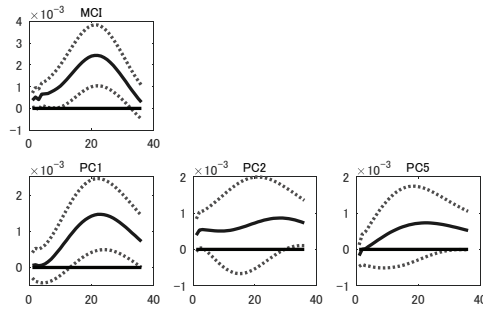
4.1 Bank Lending in the Euro Area

Figure 4 presents the 36-month impulse response functions (IRFs) of the total bank lending in the euro area to the shock in overall monetary policy stance as well as three separate monetary policy measures: interest rate, LTROs, and asset purchase programmes. All IRFs present the effects of monetary easing, i.e., fall in interest rate, increase in liquidity provision or increase in asset purchases.

The results imply that the overall monetary policy stance of the ECB as well as all the main measures have a positive impact on the amount of bank loans in the euro area. The stimulating effect of expansionary change in the monetary policy stance is statistically significant for most of the analysed period, appears rather rapidly, and reaches the peak approximately two years after the shock.

The shape of the IRF curve after interest rate cuts is similar to the overall monetary policy, although the effect takes more time to appear and becomes significant approximately one year after the shock. The positive effect of the fall in interest rate on bank lending might seem confusing, given low levels of interest rates, and thus also, a small magnitude of interest rate shocks during this period. The result is, however, consistent with the concept of risk-taking channel (Claudio Borio and Haibin Zhu 2008; Tobias Adrian and Hyun S. Shin 2009) and its empirical evidence (e.g., Gabriel Jimenez et al. 2014). Low interest rates levels, especially the negative interest rate, extend negative impact on bank profits because of the narrowing spread between loan and deposit rates. Thus, facing the low/negative interest rates, banks might increase investment in riskier but more profitable assets, including loans. Our results imply that such an effect might take place in case of the euro area too, although it takes at least a few months until banks react to lower interest rates and begin increasing lending and even more time for the effect to be statistically significant.

Positive impact of LTRO programmes seems to appear faster, that is, already at the time of the shock, and is slightly significant in the first few months as well as in a long-run of almost three years. The direction of response matches, *inter alia*, Darracq-Parries and de Santis (2015) who show that two 3-year LTROs implemented in December 2011 and February 2012 have positive impact on loans to NFCs. They interpret the liquidity provision programmes as credit supply shocks, which lower credit standards. The other possibility might be that liquidity provision eases bank funding constraints allowing for higher lending by the banks, which, however, would be unable to do so because of balance sheet problems. Further, in contrast to interest rates, the impact on bank lending is immediate. As soon as banks receive additional liquidity, they are able to change in into new loans.



Notes: Solid lines - impulse response functions; dotted lines - bootstrapped 90% confidence interval. **Source:** Author's calculations.

Figure 4 Effects of ECB Monetary Policy Easing on Bank Lending in Euro Area

Finally, asset purchase programmes also extend its positive impact on bank lending, although the influence increases rather slowly and becomes statistically significant but almost three years after the shock. The stimulating effect of asset purchases is consistent with evidence given, *inter alia*, by Pagano, Altavilla, Simonelli (2016) and Gambetti and Musso (2017). In our case, however, the impact is smaller and not so statistically significant. Asset purchases can increase loan supply *via* portfolio rebalancing channel, which compresses the yields on securities, and thus makes lending more attractive as a source of income for banks. The impact might also come *via* a direct pass-through channel, that is, an increase in a price of the targeted assets (e.g., covered bonds or ABSs), which encourages banks to increase supply of loans that can be securitised (ECB 2015).

Table 2 presents variance-covariance decomposition of the bank lending. Monetary policy stance presents a slight impact on the volatility in lending within the first months after the shock. The impact increases with time, rising most prominently in the period between one and two years after the shock, and at its peak, approximately three years after the shock, explains close to 40% of bank lending variance. The contribution of the separate monetary policy steps varies considerably. Initially, the impact of interest rate changes and asset purchases is subdued but rises steadily, reaching approximately 12% and 4%, respectively. The contribution of liquidity provision is evident from the moment of the shock, falls considerably after few months, and recovers again approximately 18 months after the shock.

Table 2 Variance-Covariance Decomposition of Bank Lending Due to Monetary Policy

| Period | MCI | PC1 | PC2 | PC5 |
|--------|-------|-------|------|------|
| 1 | 2.52 | 0.06 | 2.59 | 0.51 |
| 6 | 6.47 | 0.14 | 4.46 | 0.26 |
| 12 | 9.53 | 1.62 | 3.10 | 1.02 |
| 18 | 19.89 | 5.03 | 2.93 | 1.88 |
| 24 | 31.36 | 8.74 | 3.60 | 2.67 |
| 36 | 36.97 | 12.24 | 5.62 | 3.75 |

Notes: Percentage of bank lending variance explained by each monetary policy variable. **Source:** Author's calculations.

4.2 Channels of Transmission

The results of the analysis in Section 4.1 show how various monetary policy steps influence bank lending in the euro area. They say nothing, however, about the transmission mechanism, making interpretation only circumstantial. In this subsection we study the effects of monetary policy steps on various economic and financial variables to better explain the ways in which the central bank policy affects the banking sector in the euro area.

The literature proposes a few channels through which monetary policy might affect bank lending. First, traditional interest rate channel assumes that monetary policy easing (interest rate cuts) has an impact on short-term and long-term nominal interest rates that in turn depresses long-term interest rates and finally lower cost of capital for economic entities (Frederic S. Mishkin 1995). For our analysis of the interest rate channel, we introduce short-term interest rates of various maturities as well as retail bank lending rate.

Ben S. Bernanke and Mark Gertler (1995) point at the gaps in the understanding on interest rate effects and provide a further explanation in the form of so-called credit channel. According to this view, monetary policy effects on interest rate are supported by policy-induced changes in external finance premium – the difference in costs between external and internal funding. Within the credit channel theory, one can point at two possible linkages. Balance sheet channel (broad credit channel) emphasises the impact of monetary policy on borrowers' balance sheet and risk characteristics. Higher interest rate means higher interest payments for a borrower, lowers the value of collateral, and thus leads to lower quantity of loans supplied. The bank lending channel (narrow credit channel) links external finance premium with loan supply and implies that higher interest rates lead to higher marginal cost for obtaining external finance for banks and thus lower quantity of loans supplied.

Risk-taking channel (Borio and Zhu 2008; Adrian and Shin 2009) is based on the impact of monetary policy on banks' incentive to bear risk. Low interest rates, on the one hand, boost asset and collateral values making borrowers and banks accept higher risk. Simultaneously, they also make riskier assets more attractive leading banks to lower credit standards.

Further, Robert E. Krainer (2014) describes the stock market channel for bank lending in which monetary policy can extend influence on bank lending in two ways. Loan supply depends, first, on the overall market value of a stock, which serves as a potentially useful proxy for changes in the loan demand of nonfinancial companies by reflecting changes in the current forecasts of their prospects. Second, the market valuations of bank stocks affect bank's cost of capital. Here, therefore, we use growth rates of both the MSCI European Union general stock price index and stock price index of euro area banks to analyse the importance of the stock market channel for bank lending.

Nonstandard monetary policy can complement the usual channels of monetary transmission. The impact of nonstandard policy steps on general stock prices might also illustrate portfolio rebalancing channel (Gambetti and Musso 2017). Nonstandard policies can also affect yield on public debt and other securities that in turn might lead to lower lending rates (e.g., Pagano, Altavilla, and Simonelli 2016). Similarly, liquidity

provision by a central bank might lead to lower public debt yields and thus lower loan rates and higher lending through portfolio substitution – banks using additional liquidity to buy public debt or hoard cash or directly increase lending through refinancing channel – banks simply using additional liquidity to lend more (Pagano, Altavilla, and Simonelli 2016).

Further, according to the so-called bank liquidity risk channel (Seth Carpenter, Selva Demiralp, and Jens Eisenschmidt 2013), nonstandard policy steps can affect bank lending by reducing the liquidity risk that banks face because of financial market strains. The policy statements from the ECB have often espoused a similar opinion by quoting the need to ease “funding conditions for credit institutions and enterprises” (ECB 2011, p. 70). We thus use Euribor-OIS spread as a measure of risk premium.

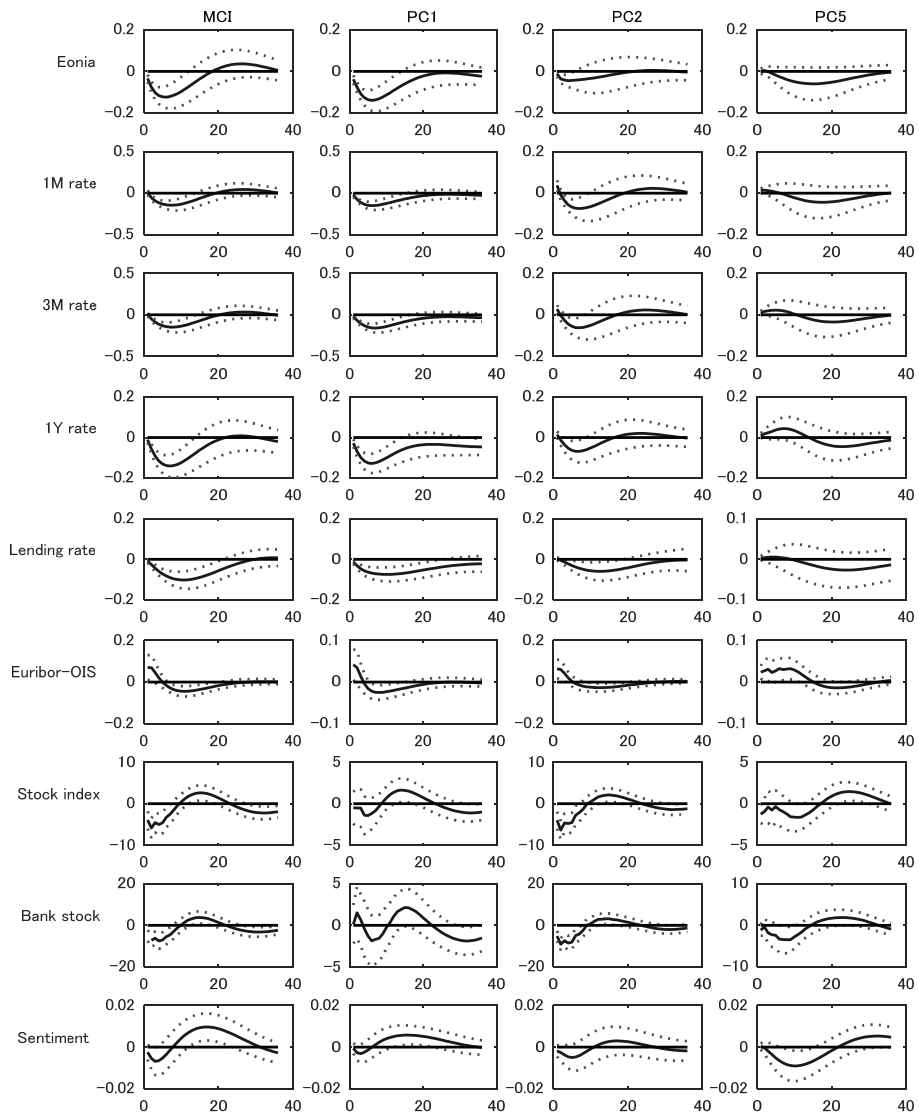
Finally, bank lending might be influenced not only by bank liquidity and cost of funding conditions (loan supply side), but also by the demand for loans from the economic entities. Monetary policy can also partly shape demand by influencing market economic sentiments and expectations toward the future state of economy. Here, therefore, we look at the effects of the policy measures on economic sentiment in the euro area to check whether the ECB’s monetary policy steps have some impact on bank lending *via* influences on loan demand.

Figure 5 shows the results of the analysis: The responses of the various financial and economic variables to monetary policy shocks. First, the results imply that monetary policy stance of the ECB, as described by MCI, indeed extends the impact on interest rates. We therefore find again that, even with interest rate close to or even below zero, the traditional interest rate channel in the euro area is still active. The interest rates of different maturities, from overnight (Eonia) to one-year, fall immediately after monetary policy easing because of fall in overnight interest rate and increase in the ECB liquidity provision to credit institutions; the effect lasts for at least few months. The additional easing through nonstandard policy measures, on the other hand, depresses the interest rates of short maturities with longer lag and to a significantly smaller extent only.

The fall in short-term interest rates because of monetary easing also brings a fall in retail bank lending rates. The impact is fastest after interest rate cut and increase in liquidity provision. The asset purchase programmes influence lending rates with a lag of approximately one year, but even after this time, the response is rather small and not statistically significant. It thus seems that ECB asset purchases have very limited impact on cost of borrowing in the euro area and it is not their primary path to influence loan supply.

Next, we find that monetary policy easing has a positive effect on lowering financial market stress. The spread between the 3-month Euribor and OIS falls significantly a few months after the shock and all the analysed monetary policy steps contribute to that decline in risk premium. The interest rate and LTROs impact seems to be the quickest, although it still takes a few months for the positive effect to materialize. Increase in asset purchases lower the tensions with longer lag and immediately after the shock, the stress seems to increase. This temporary effect, observable on impact in case of liquidity provisions also, might be attributed to markets interpreting the introduction of nonstandard steps at first as confirmation for existing problems (Gern

et al. 2015). Simultaneously, responses to all monetary policy steps show that the ECB seems to be incapable of immediately easing the market stress and lowering the risk premium. Monetary easing in different forms play an important role, but the financial markets need time to change their outlook. A few months later, the markets begin feeling the positive impacts of policy and settle down.



Notes: Solid lines - impulse response functions; dotted lines - bootstrapped 90% confidence interval.

Source: Author's calculations.

Figure 5 Effects of ECB Monetary Policy Easing on Financial and Economic Variables

On the other hand, we find only very limited evidence on the stock market channel to bank lending. The overall monetary policy easing seems to slightly push up the growth rate of the general stock price index as well as the bank stock price index approximately one year after the shock. We simultaneously notice that the response of the stock price index of the euro area banks changes synchronously with and to a much larger extent than the general stock price index. This raises another possibility that the monetary policy easing in the studied period extends positive effects mainly on the stock prices of the benefiting banks, whereas the change in the general stock index merely reflects the change in bank stock valuation and not the positive effect on non-bank entities. Increase in bank stock prices because of monetary easing might also demonstrate the additional effect of monetary policy – increase in bank capital fuelled by higher stock valuations. Lower capital constraints, in turn, might lead banks to higher lending.

Responses to the separate monetary policy steps bring more insight to these results. Interest rate cuts and liquidity provision seem to bring positive effect on growth in stock prices approximately one year after the shock, whereas, in case of asset purchases, approximately two years are needed. Further, liquidity provision and asset purchases tend to increase growth rate of bank stock index more than the general stock prices. It thus seems that although interest rate cuts extend positive effects on the wider spectrum of economic entities, the impact of the two other policies is largely concentrated in the banking sector.

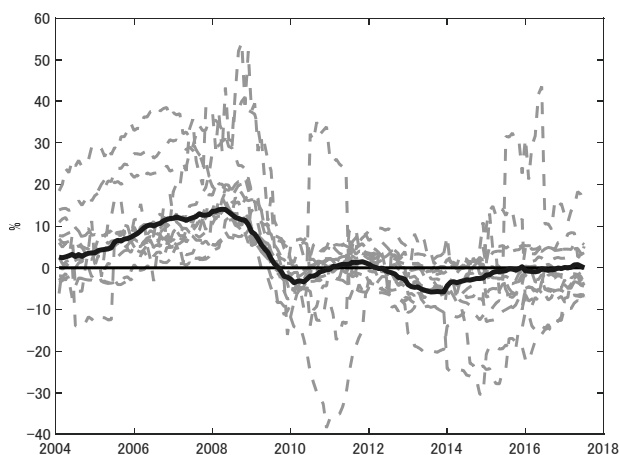
The observations on the monetary policy effects on general and bank stock prices as well as risk premium are also corroborated by the responses of economic sentiment. Interest rate cuts extend the fastest and largest positive impact on sentiment in real economy. Liquidity provisions do not seem to affect real economy considerably at all, although a small fall in sentiment in a few months after the shock is consistent with fall in growth rate of stock index; further recovery in the variables also take place almost simultaneously. Finally, asset purchases lead first to a rather deep fall and an improvement in economic sentiment takes place only over two years after the shock. Thus, it seems it is still mainly the role of interest rate to give economic entities a more optimistic outlook on the future prospects of the economy and thus increase their willingness to take new loans.

5. Effects of ECB Monetary Policy in Individual Countries

The previous section studied the effectiveness of ECB monetary policy steps on bank lending in the euro area as a whole. Study at the euro area level is important to the ECB, as the bank must consider the situation of the euro area holistically when making policy decisions. However, the economic situations and credit conditions of individual euro area countries vary rather widely. As Figure 6 shows, the growth rates of bank lending in individual countries often vary greatly from each other and from the euro area average. In this section, therefore, we first compare the effects of ECB policy steps on bank lending in individual euro area countries, check how changes in bank lending in each country relate to the policy effects and finally study the potential explanations for the observed differences.

5.1 Bank Lending in Individual Euro Area Countries

Figure 7 shows the impulse response functions of bank loans to monetary policy shocks in each country. The shape of the IRF curve for MCI shock rather resembles that of the aggregate euro area for many countries, although visible differences in the magnitude and the timing of the response often appear. In many countries, however, the change in bank lending after the monetary policy impulse diverges drastically from the average euro area response. Especially, Cyprus, Ireland, Portugal, and Spain do not show any positive impact of monetary policy easing on bank lending.

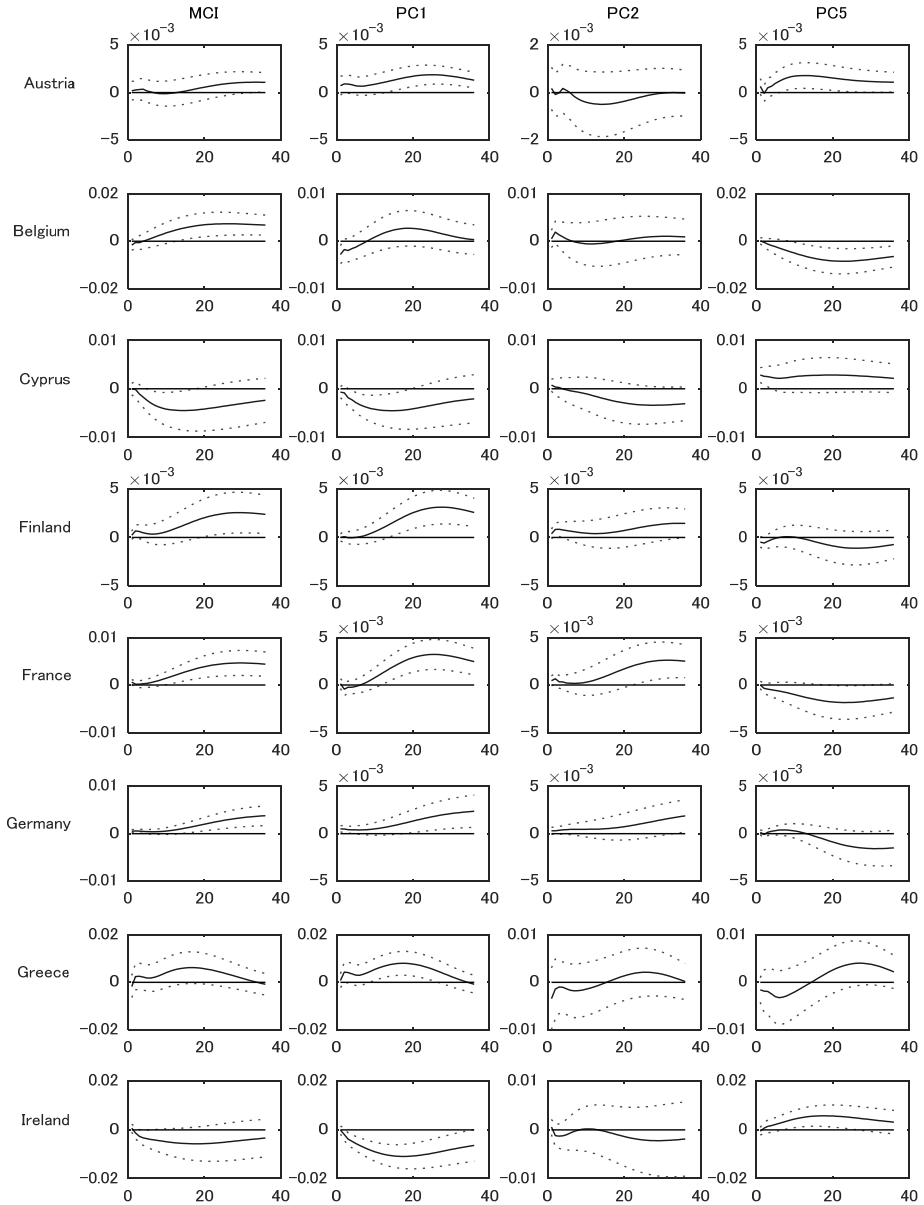


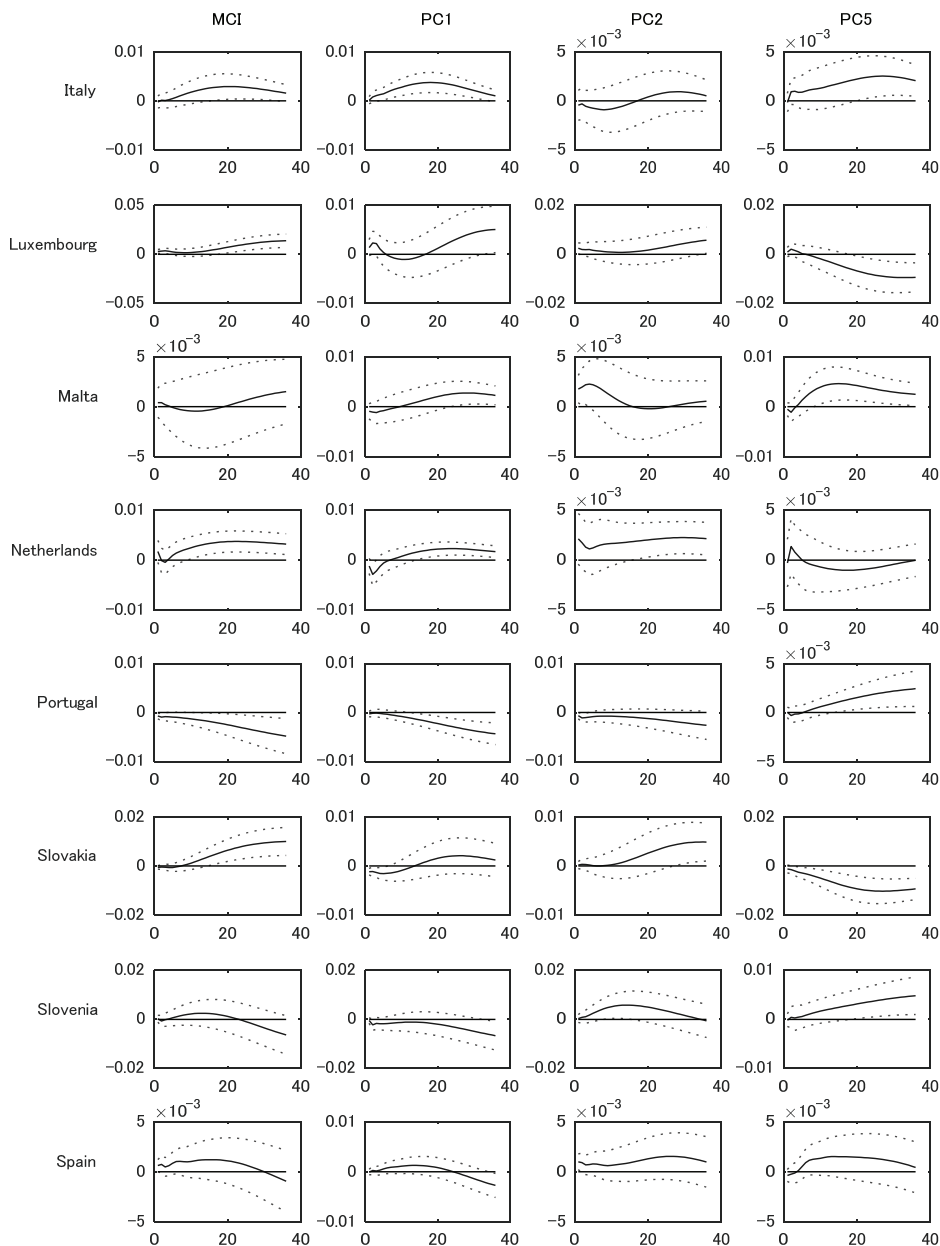
Notes: Euro area - solid black line; each country - dashed grey line.

Source: ECB (2018); growth rates estimated by the author based on raw data.

Figure 6 Growth in Bank Lending in Euro Area and Individual Countries

Divergent effects of particular ECB monetary policy steps bring further insight to the matter. The inability of monetary policy to stimulate bank loans seems to be associated in most of cases with lack of positive impact of interest rate cuts. In Cyprus, Ireland, Portugal, and in Slovenia, the interest rate cut does not bring positive impact on loan supply, on the contrary, we observe fall in bank lending. It thus seems that interest rate changes bring about positive effects mostly in the sound countries, i.e., the countries not affected directly by the European debt or banking sector crisis. Admittedly, crisis-hit Greece as well as Spain experience positive effects of lower interest rates, but the common point of the above-mentioned countries, where we observe the puzzling effect of interest rate cuts, is the experience of the banking sector or related crisis. It seems that in the stressed environment, banks might not be willing to take higher risks in the form of higher credit supply even if the low interest rates undermine their profits.





Notes: Solid lines - impulse response functions; dotted lines - bootstrapped 90% confidence interval.

Source: Author's calculations.

Figure 7 Effects of ECB Monetary Policy Easing on Bank Lending in Individual Euro Area Countries

Additionally, liquidity provision also seems to extend positive effects mostly in the sound countries and only in a few of the strained countries. Especially, there is also no stimulating effect of liquidity provision in Cyprus, Ireland, and Portugal; these three countries experience positive effects on bank lending only, thanks to asset purchase programmes. The asset purchases, on the other hand, show positive effects in only a few sound countries and their impact is concentrated in the strained countries. Specifically, we observe increase in bank lending because of easing shock in Cyprus, Greece, Ireland, Italy, Portugal, Slovenia, Spain, as well as Austria and Malta.

Summing up, our comparison of the ECB monetary policy effects in individual euro area countries shows that we can lose very important country-specific information when analysing only the aggregate effects of the common monetary policy. The first type of information we lose is the variation in the magnitude of the impact and the time lag before the effects appear. The second and probably more important type concerns the rather distinct effects observed in many countries affected most by the banking and/or sovereign debt crisis. The results clearly demonstrate that the crisis can have a significant impact on the monetary transmission to the banking sector of the country of concern.

The results also imply that, depending on a country's situation, different monetary policy steps might prove most effective in stimulating bank lending. Thus, the results not only support the simultaneous implementation of various monetary policy measures but might also imply some flexibility for the ECB in choosing measures to affect the situation in a chosen group of countries within the euro area.

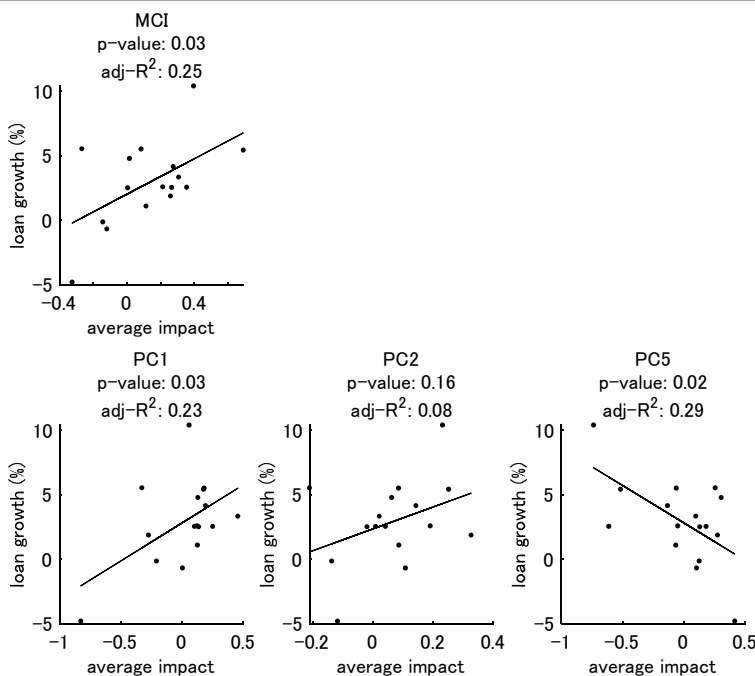
5.2 Determinants of Divergent Monetary Policy Effects

Now that we have ascertained the effects of ECB monetary policy steps on bank lending in individual euro area countries, two questions arise. First, how well is loan growth in each country explained by the effects of monetary policy on bank lending? We wonder whether the countries that experience higher stimulating effects of monetary policy steps are also the countries with higher growth in bank lending. The second question is, what are the more specific reasons for high variability of the monetary policy effects across the countries.

First, Figure 8 displays the relationships between the average growth rates of bank loans in the period January 2007-June 2017 and the average responses of the bank lending in each country to each monetary policy shock (results being qualitatively identical also if we use the change in loans between the beginning and the end of the analysed period). The solid lines depict the regression line of the relationship. The p -value of the slope coefficient and adjusted R^2 coefficient are provided in the title of each subplot.

The scatterplots show that growth in bank lending in euro area countries is strongly positively associated with effects of the overall monetary policy stance on loans. Higher growth rate of bank lending can be explained largely by the positive impact of monetary policy easing. When it comes to particular policy measures, the relation is the strongest and statistically significant for interest rate changes and is also positive, although not statistically significant for LTROs. In case of the asset purchase programmes, we observe the opposite relationship: lower growth in bank loans is

associated with higher effectiveness of the monetary policy measure. These results corroborate the observations of impulse response functions in the previous subsection where we observe interest rate changes and liquidity provisions extending positive effects mostly in the sound countries and asset purchases working more in the strained countries.



Notes: Relationships between growth rates of bank lending and average responses of bank lending to ECB monetary policy shocks; solid lines depict regression lines with the *p*-values of the slope coefficient and adjusted *R*² statistics provided in the title of each subplot; estimations with Ordinary Least Squares (OLS) regressions with Halbert White's (1980) heteroscedasticity-consistent standard errors, number of cross-country data points: 16.

Source: Author's calculations.

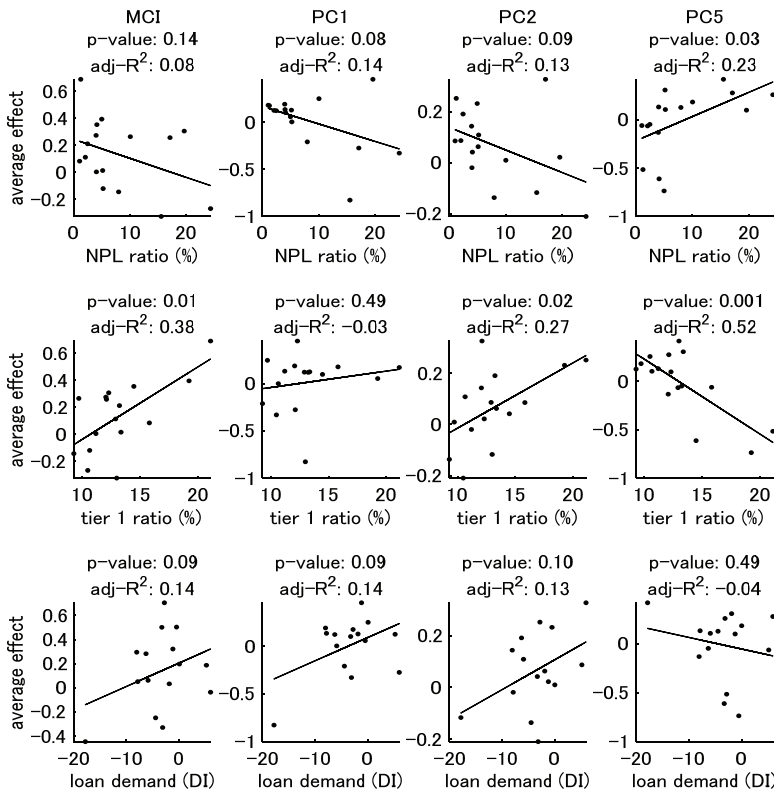
Figure 8 Growth in Bank Lending and Effects of ECB Monetary Policy Easing on Bank Lending in Individual Euro Area Countries

Next, we provide more specific country characteristics behind the observed differences in the effectiveness of monetary policy steps. We look for the possible determinants of the monetary policy transmission mechanism in the variables describing each country banking sector and economic conditions. We measure the soundness of each country banking system by the average of tier 1 capital ratio as well as ratio of nonperforming loans to total loans. The state of the real economy is described by demand for bank loans, taken from Bank Lending Survey of ECB and showing backward-looking (i.e., actual) demand for loans by enterprises.

Generally, we might expect the monetary policy steps to extend more positive effects on bank loans in countries where banks are better capitalised (e.g., Giovanni

Dell’Ariccia, Luc Laeven, and Gustavo A. Suarez 2017 on the evidence for US banks) and where demand for the bank loans is higher. Simultaneously, the anti-crisis nature of the LTROs and asset purchase programmes might imply that these policies might be more effective in countries with higher need for such help, i.e., the ones where the above-mentioned measures point at worse conditions.

Figure 9 displays the relationships between the average responses of the bank lending in each country to each monetary policy shock and countries’ characteristics. As in Figure 8, the solid line depicts the regression line of the relationship, and the p -value of the slope coefficient and adjusted R^2 coefficient are provided in the title of each subplot.



Notes: Relationships between banking sector characteristics as well as loan demand and average responses of loans to ECB monetary policy shocks; grey solid lines depict regression lines with the p -values of the slope coefficient and adjusted R^2 statistics provided in the title of each subplot; estimations with Ordinary Least Squares (OLS) regressions with White’s (1980) heteroscedasticity-consistent standard errors; number of cross-country data points: 16 (15 in case of loan demand: scatter plot including loan demand excludes Finland where the Bank Lending Survey is not carried out); DI = diffusion index (weighted difference between the share of banks reporting an increase in loan demand and the share of banks reporting a decline).

Source: Author’s calculations.

Figure 9 Banking Sector Characteristics, Loan Demand, and Effects of ECB Monetary Policy Easing on Bank Lending in Individual Euro Area Countries

The results suggest that monetary policy easing is indeed extending more positive results in the countries with sound banking system: high tier 1 capital ratio and low non-performing loan (NPL) ratios; the first relationship being strongly statistically significant. The sounder banks with stronger balance sheets are more capable of responding to monetary policy easing and increasing lending. At the same time, their ability to increase bank lending is also dependent on the loan demand: the effects of policy easing are the higher, the higher is demand for loans, with the relationship being statistically significant.

The negative and statistically significant relationship of NPL ratio and monetary policy effects is also observable for interest rate cuts and liquidity provisions. Sound balance sheet seems to be an important condition to take on any further risk connected to higher credit supply when policy interest rate is lower and higher cheap liquidity is available. Additionally, it seems that banks with higher capital ratio are also able to respond to monetary policy stimulus, especially in form of LTROs for which the relationship is statistically significant and interest rates which show not significant positive relationship.

The impact of asset purchases on bank lending, on the other hand, shows statistically significant relationships with NPL ratio and tier 1 capital ratio of the opposite signs. Countries where banks have more strained balance sheets due to high ratio of non-performing loans as well as are low-capitalised are the ones where higher positive effects of asset purchase programmes can be felt. This observation is consistent with results of Altavilla, Fabio Canova, and Matteo Ciccarelli (2016) who show that banks with high NPL level and low capital ratio are more responsive to ECB non-standard policy measures. It also again corroborates the previous observations that asset purchase programmes extend higher positive effects in the more strained countries that have experienced banking sector or related crisis.

Finally, the effectiveness of interest rate and liquidity measures depends positively on loan demand, for asset purchase programmes the relationship is slightly negative but close to non-existent. No matter what the condition of the banks in a country is, higher stimulating impact on loan supply is observable where there is higher demand for bank loans. Thus, this result points at the importance of the condition of real economy for stimulation of loan supply by monetary policy steps.

It might be also important to control for banking sector characteristics and loan demand simultaneously to lower the risk of omitted variables and spurious regressions. Due to the small number of countries studied, in each regression we include only two variables at time: demand for loans and one variable describing banking system.

The results of pairwise regressions (Table 3) largely support our previous observations. Monetary policy extends more positive effects on loans in countries with better capitalised banks, low ratio of non-performing loans and higher loan demand. All coefficients are statistically significant even in the pairwise regression. Lower ratio of non-performing loans also shows statistically significant influence on the effectiveness of interest rate changes and liquidity provision. If paired together with NPL ratio and tier 1 ratio, loan demand also becomes statistically significant determinant of the LTRO impact. In case of effectiveness of asset purchases, the signs and statistical significance stay as described above.

Table 3 Banking Sector Characteristics and the Effects of ECB Monetary Policy on Bank Lending in Individual Euro Area Countries - Pairwise Regressions

| MCI | | |
|----------------|----------------------|---------------------|
| | (1) | (2) |
| Constant | -0.506** (0.208) | 0.346*** (0.104) |
| Tier 1 ratio | 0.054*** (0.015) | |
| NPL ratio | | -0.016* (0.009) |
| Loan demand | 0.019** (0.009) | 0.022* (0.011) |
| Adjusted R^2 | 0.551 | 0.27 |
| PC1 | | |
| | (1) | (2) |
| Constant | -0.062 (0.332) | 0.249* (0.115) |
| Tier 1 ratio | 0.012 (0.024) | |
| NPL ratio | | -0.018* (0.01) |
| Loan demand | 0.024 (0.014) | 0.025* (0.012) |
| Adjusted R^2 | 0.088 | 0.285 |
| PC2 | | |
| | (1) | (2) |
| Constant | -0.223 (0.132) | 0.186*** (0.057) |
| Tier 1 ratio | 0.025** (0.01) | |
| NPL ratio | | -0.009* (0.005) |
| Loan demand | 0.010* (0.006) | 0.012* (0.006) |
| Adjusted R^2 | 0.393 | 0.287 |
| PC5 | | |
| | (1) | (2) |
| Constant | 0.990*** (0.275) | -0.281* (0.135) |
| Tier 1 ratio | -0.079*** (0.020) | |
| NPL ratio | | 0.026* (0.011) |
| Loan demand | -0.008 (0.011) | -0.012 (0.014) |
| Adjusted R^2 | 0.511 | 0.223 |

Notes: Estimations with Ordinary Least Squares (OLS) regressions with White's (1980) heteroscedasticity-consistent standard errors; number of cross-country data points: 15; standard errors are reported in parentheses; ***, **, and * indicate statistical significance at the 99%, 95%, and 90% levels, respectively.

Source: Author's calculations.

6. Concluding Remarks

This paper studies the effects of monetary policy steps taken by the ECB from the onset of the financial market strains in 2007. The main results indicate stimulating impact of the monetary policy stance on bank lending, mainly due to interest rate cuts further supported by the liquidity provision and asset purchase programmes. Comparison of the effects in individual countries shows considerable cross-country divergence. The interest rate cuts and liquidity provision, to some extent, seem to be in effect mostly in the countries with sound banking system while asset purchases seem to be act as support for countries facing banking sector problems.

The results show thus that a range of policy steps is necessary to ease tensions in the banking sector across the whole euro area. By no means should the ECB limit its policy actions to interest rate, liquidity provision, or asset purchase programmes alone. The results also imply that, by correctly choosing policies of the correct types and scale, the ECB might even be able to target and influence the situations in selected countries of focus within the euro area.

Our analysis is not free from potential caveats. VAR model shows the effects of implemented monetary policy steps, not taking the effects of policy announcements into consideration. Further, as Lombardi and Zhu (2014) point out, use of MCI which summarizes rates of change of monetary aggregates and central bank balance sheet items might mean loss of important information contained in the levels of the variables.

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Appendix

Robustness Check

The paper employs principal components as measures of particular monetary policy steps: interest rate changes, liquidity provisions, and asset purchase programmes. Figure 3 in the main text shows that the estimated components PC1, PC2, and PC5 capture well the stochastic properties of the Eonia interest rate, the LTROs, and securities held for monetary policy purposes, making them good measures of the respective policies. It can be argued, however, that the Eonia interest rate, the LTROs, and securities held for monetary policy purposes can be used instead, as a direct measure of the policies under consideration.

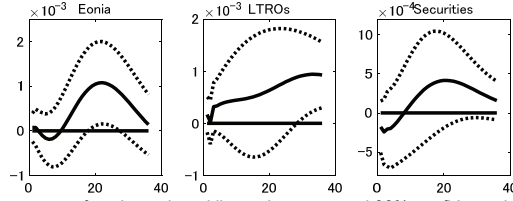
Thus, here we present estimates of the VAR models including the raw variables of Eonia rate, growth rate in the LTROs as well as growth rate in the securities held, and discuss their impact on bank lending in the euro area as well as the individual countries.

The impact of Eonia interest rate on the overall lending in the euro area as well as on the range of financial and economic variables as well as individual country lending is most similar to the impact of the estimated principal component (PC1) presented in the main text of the paper. The impulse response functions follow the same patterns, are very similar in magnitude and shape. The scatter plots of the average responses with NPL ratio, tier 1 ratio, and loan demand also show the same relations as in case of the PC1.

In case of securities held for monetary policy purposes, the influence on the overall lending and financial and economic variables is also rather similar to the impact of the respective principal components, but here the similarity lies much more in the direction and strength of response than in the exact shape. In case of the individual country effects, however, we observe a few differences in the impact on the country bank lending. In some cases, the responses fail to rise or decline and stay at very low, close to zero levels. Still, the scatter plots of the average responses show the same relations as in case of the PC5: the monetary easing is more effective in countries with lower loan demand and banking sector characterised with higher NPL ratio and lower tier 1 ratio; the relations are however not statistically significant.

The largest differences in the policy impact are for liquidity provision. The impact on overall lending is much lower than in case of PC2. The effect on financial and economic variables is largely similar to the benchmark results. The largest differences are in case of individual country effect – the impact is usually very small and in some countries the response of bank lending even takes the opposite direction as compared to PC2. Still, the scatter plots confirm that liquidity provision is on average more effective in the countries with higher tier 1 capital ratio and higher loan demand. Only in case of NPL ratio we fail to observe the negative relationship from the main text – here the relation is slightly positive, though like all other not statistically significant.

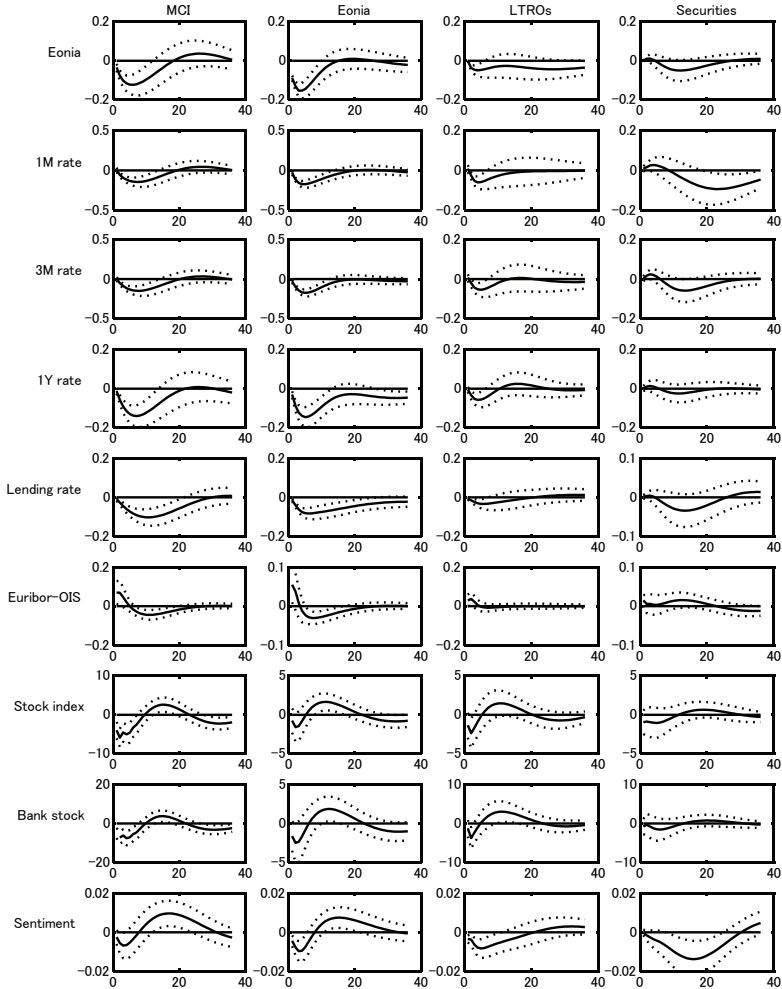
These differences in the response of the considered variables to the LTROs and securities held as compared to their representatives in a form of PC2 and PC5 might stem from stronger relationships across the original variables in comparison with the estimated principal components. It cannot be negated that the decisions on implementation of various monetary policy are taken with regard to each other. This interdependence in the raw policy variables, as compared to the by definition uncorrelated principal components representing the variables, might result in higher uncertainty of some responses and lower impact in case of the others. Thus, we still opt rather for the estimations employing principle components as preferable method of analysis.



Notes: Solid lines - impulse response functions; dotted lines - bootstrapped 90% confidence interval.

Source: Author's calculations.

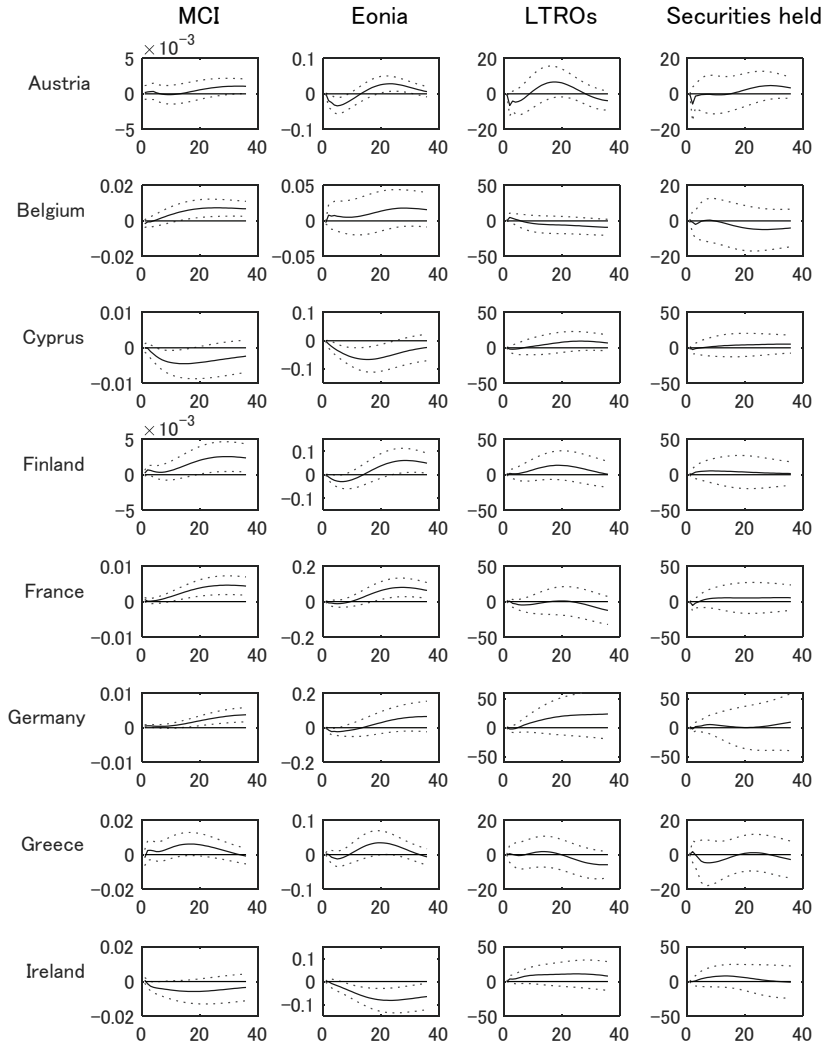
Figure A1 Effects of ECB Monetary Policy Easing on Bank Lending in Euro Area

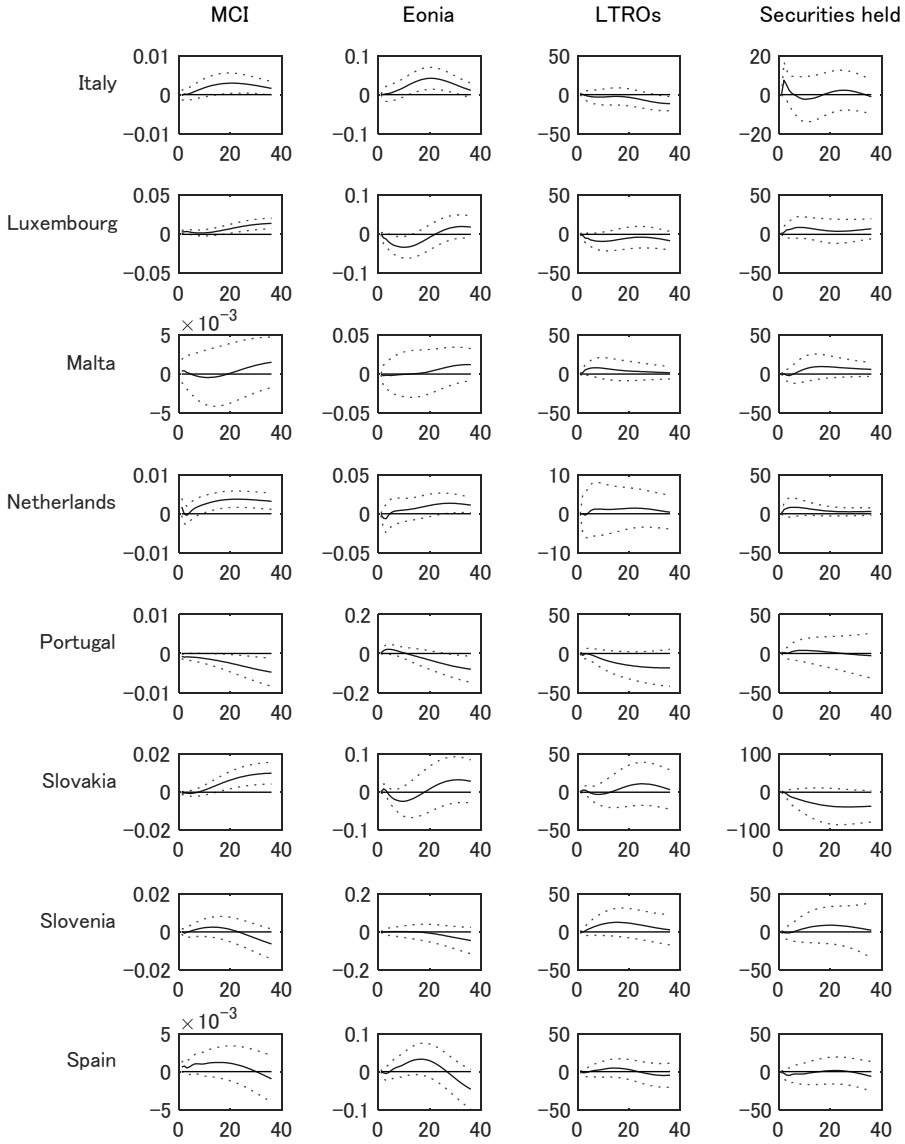


Notes: Solid lines - impulse response functions; dotted lines - bootstrapped 90% confidence interval.

Source: Author's calculations.

Figure A2 Effects of ECB Monetary Policy Easing on Financial and Economic Variables

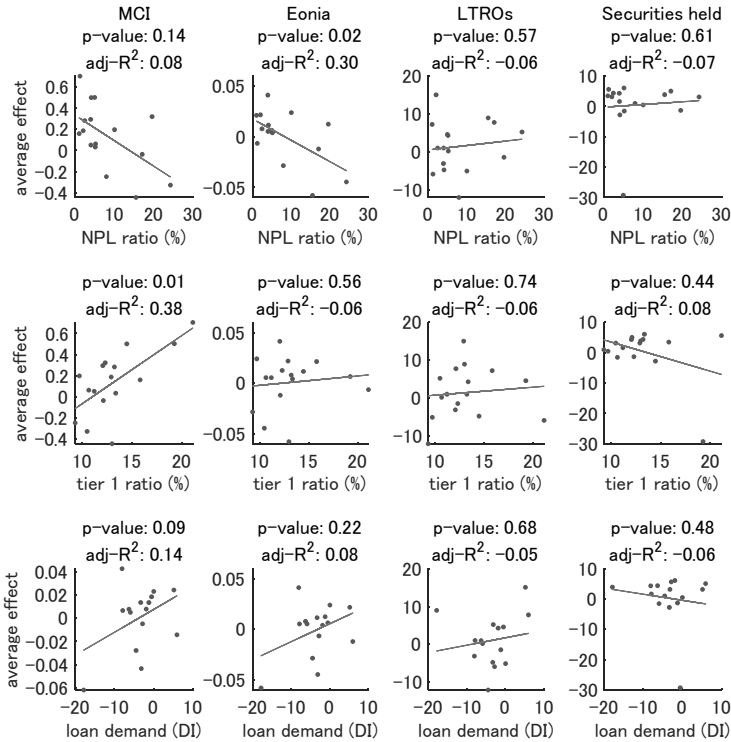




Notes: Solid lines - impulse response functions; dotted lines - bootstrapped 90% confidence interval.

Source: Author's calculations.

Figure A3 Effects of ECB Monetary Policy Easing on Bank Lending in Individual Euro Area Countries



Notes: Relationships between banking sector characteristics as well as loan demand and average responses of loans to ECB monetary policy shocks; grey solid lines depict regression lines with the p -values of the slope coefficient and adjusted R^2 statistics provided in the title of each subplot; estimations with Ordinary Least Squares (OLS) regressions with White's (1980) heteroskedasticity-consistent standard errors; number of cross-country data points: 16 (15 in case of loan demand: scatter plot including loan demand excludes Finland where the Bank Lending Survey is not carried out); DI = diffusion index (weighted difference between the share of banks reporting an increase in loan demand and the share of banks reporting a decline).

Source: Author's calculations.

Figure A4 Banking Sector Characteristics, Loan Demand, and Effects of ECB Monetary Policy Easing on Bank Lending in Individual Euro Area Countries

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