ECB unconventional policies and bank lending

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Abstract

The purpose of this study is to look into, whether European central bank's unconventional policies positively and significantly affected lending through its operations. The study uses lender-level data of 57 Euro zone lenders in the period from 2008 to 2016. The relationship between liquidity provision by the European Central Bank (ECB) and lending is tested. Findings provide evidence to significant and positive impact of ECB unconventional policies on lending. Additionally, findings show weaker transmission of unconventional policies in the periphery. A possible reason for weaker transmission is undercapitalized lenders in the peripheral countries.

Keywords: ECB, unconventional policies, lending, effectiveness, bank-level

Table of contents

1. Introduction 1

2. ECB operations after the financial crisis 3

3. Literature review 5

4. Methodology 8

5. Data 11

7. Robustness checks 19

8. Additional insights 20

9. Conclusion 25

Appendix 28

Reference list 33

1. Introduction

In the period before the financial crisis interest rates have already been falling. Since the financial crisis, many central banks have introduced policies to stimulate the economy and support the financial system. Monetary stimulus is normally executed through lowering of short-term interest rates. Rogers, Scotti, and Wright (2014) see interest rates used by central banks reaching zero lower bound, which has forced central banks to use unconventional tools. Unconventional monetary policies have not been used widely before. Bowman, Cai, Davies, and Kamin (2015) study the rare example of unconventional monetary policy, in the case of Japan. The big question is, if these policies worked. Based on the previous question, the research question of this study is: Did the unconventional monetary policies of the ECB positively and significantly affect lending during the observed period?

The research question is important for policy makers all over the world and especially to the ones who are already using unconventional policies and the ones who will be using them. An answer is also of interest to the economic forecasters who try to forecast the economic performance. Unconventional policies have been an unknown variable in their models and therefore forecasts have been less precise. Studies so far have mainly based their conclusions on past relationships which they applied on the immediate reactions of markets and people. I have observed the relationships during the period when the policies were executed. The answer will also provide supporting or a contrary view on the past research observations.

To answer the above question, I use micro-level information. I observe financial statement information of 57 lenders incorporated the Euro zone. First, I test if liquidity was an important determinant of loan creation, in the period of unconventional policies. Following the liquidity test I examine whether ECB was the main source of liquidity during my sample period. The tests conclusions are based on coefficients estimated using fixed effects estimation. By combining the findings of previous tests, I can reason on whether ECB unconventional policies have been positively affecting lending in the Euro zone.

When testing the effect of liquidity on lending growth, I find it positive and significant in magnitude. Test of liquidity sources during the period show ECB as an important source. The above mentioned findings led me to conclude to answer the research question affirmatively. ECB unconventional policies have significantly and positively affected lending in the Euro zone. Liquidity effect provides evidence that ECB operations, by providing liquidity, have targeted a relevant factor. Remaining tests say the ECB operations have been indeed an important source of liquidity to lenders. After answering the

main question, I have looked for additional insights that could be gained from the data. Comparing the effects of the ECB operations in the peripheral and core countries, I have found surprising results. Usually, weaker lenders are expected to benefit more from the help than the stronger ones, such relationship is observed by Bowman, Cai, Davies, and Kamin (2015). Through the channel of liquidity, lending was not stimulated in peripheral countries while it was in the core countries. ECB policies were the most effective at lenders who were well capitalized, having a high tier 1 ratio. Lender capitalization was a crucial determinant of whether ECB operations will have a significant impact on lending through liquidity. Loan growth was positively affected by lenders decreasing their size. This relationship is significant in magnitude probably due to stronger regulatory requirements for bigger banks and refocus of bigger banks back to their core business. Lastly, I find banks which have high liquidity positions to be less negatively affected by increases in loan loss reserves.

This paper contributes to the existing research by providing up to date observations of lender determinants of lending and based on these observations the study gives an answer on whether unconventional policies of the ECB have been effective. The paper also adds a view gained with an approach using lender level data, which is not commonly used. I have managed to find only one study Creel, Hubert, and Viennot (2016), which had a contemporary sample. Other previous literature like Darracq-Paries and De Santis (2015), Ciccarelli, Maddaloni and Peydro (2015), Peersman (2011) and Lenza, Pill and Reichlin (2010) have used past relationships to estimate the effects of unconventional policies. A study using lender level data and also addressing the question of the effectiveness of unconventional policies but with not so up to date data sample was written by Gambacorta and Marques-Ibanez (2011). The findings of my research confirm those of the previous research, which used the past and the contemporary data. I present evidence which opposes the conventional view on who yields most benefit from supportive policies and give a possible reason why transmission of policies was not as successful at some lenders.

The implications of findings in practice are the following. The study provides evidence to the policymakers that their policies have been effective at supporting liquidity and lending. There is also evidence that policies are effective only if lenders are sufficiently capitalized. Liquidity benefits are bigger for lenders who are larger or have high loan loss reserves. To address periphery problems with transmission of monetary policies through liquidity channel, policymakers should improve capital positions of lenders. For economic forecaster, important observations are that unconventional policies have a significant impact in general but differ depending on the characteristics of lenders. Capitalization characteristic plays the main role.

The paper is organized as follows. The next section briefly describes the ECB's unconventional policies after the financial crisis. In the third section, the literature relevant to the research question and methodology is described. The fourth section is about methodology, which presents the reasoning and the empirical approach. It also includes hypotheses, which need to be answered in order to reach a conclusion on the research question. The fifth section describes the sample selection and variable construction. The sixth section contains the empirical results and data characteristics. The next are robustness checks. The eighth section brings forward some additional insights on lending during the sample period. The last section concludes the thesis.

2. ECB operations after the financial crisis

Since the financial crisis in 2007, central banks have been providing additional liquidity to the banking system. To do so, many have adopted unconventional policies including the ECB. From the start, ECB was determining the amounts of liquidity offered at its auctions. The liquidity was provided to the lenders depending on their bidding rate. As financial constraints became bigger ECB moved to providing all the liquidity demanded by lenders, full allotment. With full allotment, bidding was abandoned and the rate was set at a fixed level by the ECB. In 2009-2015 period, main new activities of the ECB, were LTROs and two asset purchase programs, described also by Fratzscher, Lo Duca, and Straub (2016) in the IMF paper. Main refinancing operations were in place before the financial crisis, in a form of sorter durations of up to three months. Both asset purchase programs were introduced to support monetary transmission in distressed countries. The purpose of Long-term refinancing operations (LTROs) was to provide longer-term liquidity to the banks. From March 9th 2015, ECB (2016) also started another asset purchase program. The program is called Public sector purchase program and is bigger than the two previous ones. It aims to purchase 80 billion EUR of securities per month.

First of the two asset purchase programs was Securities market program, which started in May 2010. ECB was purchasing government bonds of countries in distress, Greece Portugal, Ireland, Spain and Italy, to stabilize the value of eligible collateral, which banks held and used as collateral to get liquidity from the ECB in repurchasing agreements. The second purchase program started in September 2012, after SMP ended. It included all countries in European stability mechanism and had the same purpose as the SMP. Both asset purchase programs were small compared to LTROs. To receive the liquidity through LTROs, banks had to provide eligible collateral as mentioned before. LTROs are loan like operations, where ECB lends to the banks and securities are used as collateral. Lender sells the collateral to the ECB and commits to buying it at a predetermined date for a predetermined amount. The duration of LTROs was up to 3 years. LTROs with maturity of 1 year began in May 2009. The first 3-year LTRO was

announced in December 2011. LTROs were distributed to banks in preannounced auctions. At the start of the crisis, theses auctions had a limited amount of liquidity available and it was allocated to banks through a bidding process. After October 2008, auctions provided unlimited liquidity.

From Figure 1 it can be seen how cash positions of lenders and ECB assets move in the same direction. Through increased liquidity provision, ECB's assets increased. Lenders can acquire liquidity not only through ECB operations but also through markets. Especially during this period of market turmoil, because market funding was unavailable or it was more expensive, lenders relied on the ECB for liquidity. Figure 2 shows a relationship between ECB assets and the Composite indicator of systemic stress or CISS index. These two series experience similar moves as well. ECB's provision of liquidity increased in the periods of stress. Knowing how liquidity provision amounts were determined, through full allotment, most of the increase in ECB assets was due to increased demand for liquidity from lenders. This strong relationship was enabled through ECB unconventional move to give away its ability to determine the amount of money created.

Figure 1
ECB assets and bank cash holdings

This figure shows the movement of total ECB assets and bank cash and other assets positions from 2008 to 2016. Both series are retrieved from the ECB statistical warehouse. Cash and other assets are from the aggregated balance sheet of the monetary financial institutions in the Euro zone.

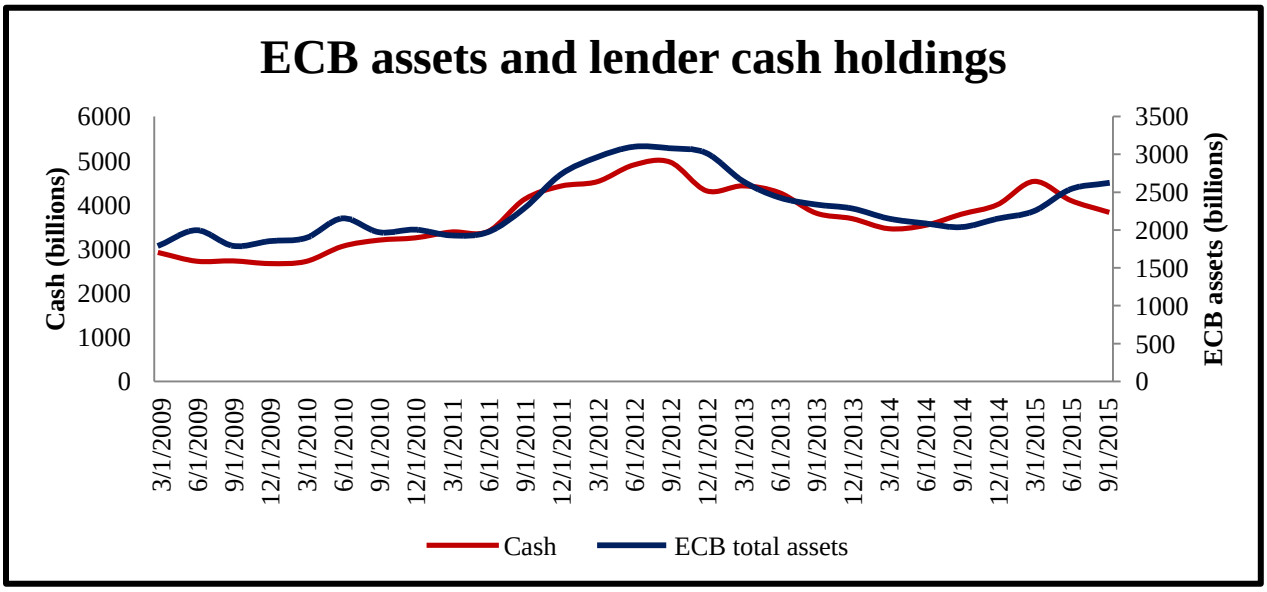
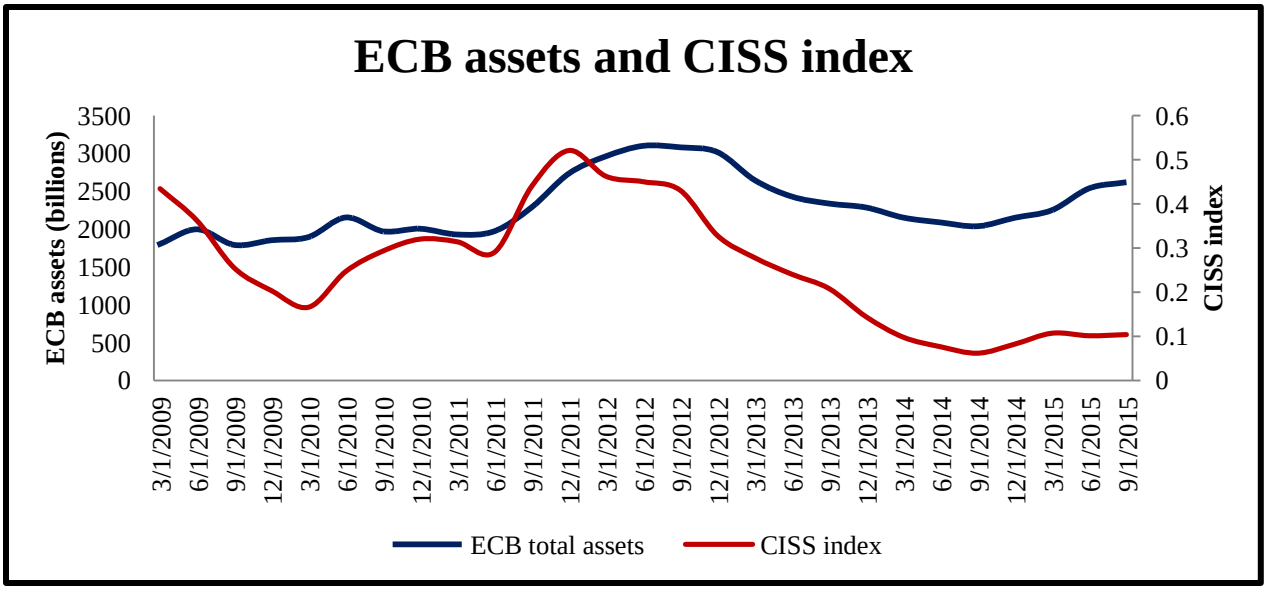


Figure 2
ECB assets and CISS index

This figure shows the movement of total ECB assets and the CISS index – Composite indicator of systemic stress. The data were retrieved from the ECB statistical warehouse. CISS index measures systemic stress in the financial system.



3. Literature review

To provide evidence on the significance of the unconventional monetary policies for lending volumes, the relationship between monetary policy and lending must be evaluated. Unconventional policies of the ECB have been implemented through purchases of assets and liquidity provision. Such actions can be observed through the balance sheets changes of lenders and central banks and through the money market impact. Through different proxies of unconventional policies, monetary policy relationship with lending can be evaluated.

Literature has covered different consequences of unconventional monetary policies. Policies have touched all the aspects of the economy, from risk taking, borrowing costs, portfolio allocations, asset prices and capital flows. Rogers, Scotti, and Wright (2014) evaluate effects of the monetary action of four most important central banks. They focus on effects on asset prices. Using high-frequency data, they observe relaxation of conditions and appreciation of assets. Unconventional policies at zero lower bound worked mostly through reducing term premium. These major central banks do not only play an important role for their domestic economy, their policies also have spillovers to other economies. A paper by Fratzscher, Lo Duca, and Straub (2013) expands the analyses of domestic markets, in the U.S. by observing foreign markets as well. First quantitative easing program by the Federal Reserve System (FED) in 2008, caused capital flows to the U.S. from markets abroad, especially emerging markets. The second quantitative program has seen a reverse situation. Fratzscher, Lo Duca, and Straub (2016) have also

looked at the effects of ECB's policies. Evidence found points to similar results as in the case of the FED. ECB's policies did not see a big impact on capital flows and international yields. Study finds evidence of a decrease in bank credit risk. Looking at bank and government borrowing costs, Szczerbowicz (2015) finds a significant decrease. Costs fell the most in the most distressed banks and governments. LTROs had a strong impact on money markets but a weak effect on government yields.

Unconventional policies are expected to have an effect on macroeconomic measures such as GDP growth, inflation and loan volumes. Historical evidence on loan volumes during unconventional policies has focused on Japan, due to data availability. Bowman, Cai, Davies, and Kamin (2015) have studied the lending behaviour of Japanese banks, during Bank of Japan's quantitative easing policy in the 2000s. They concentrate on the liquidity in the banking sector, which was created by Bank of Japan's unconventional policies. Results showed liquidity on the banks' balance sheets lead to improved lending. In their regressions, they controlled for bank characteristics and aggregate effects. The analysis was performed using panel data regression using ordinary least squares with time fixed effects.

For the more recent unconventional policies, studies have used historical relationships of policy shocks and applied them to the recent shocks. Most studies used aggregate monthly data and found a positive and significant impact on macroeconomic indicators, including lending volumes. Darracq-Paries and De Santis (2015) and Ciccarelli, Maddaloni, and Peydro (2015) conducted simulations of possible effects of ECB's unconventional policies. They found the LTROs improved bank liquidity positions and lead to an increase in lending volumes. The authors control for demand and supply impacts using bank lending surveys, to make sure the supply shock it exogenous. A study by Carpenter, Demiralp, and Eisenschmidt (2013) looks at policies of the Federal Reserve and European central bank. Estimating policy effect on loans takes in two steps. Authors evaluated the effect of policies on banks liquidity risks and a relationship of liquidity risk with loans by modelling loan supply and demand in simultaneous equation framework. Combining these two steps resulted in simulations showing how unconventional policies in the short-term reduced amount of lending, but increased it in the longer-term. The net outcome of the simulations shows increased amount of lending. Gambacorta, Hofmann, and Peersman (2014) observe major part of the central bank balance sheets expansion was not due to exogenous factors, but instead due to endogenous factors like market turmoil. Their sample is from the crisis period, from 2009 until 2011. Creel, Hubert, and Viennot (2016) use most recent data sample which spans from June 2007 until October 2014 and includes Germany, France, Spain and Italy. From their sample period, they find the effect of unconventional policies on loan volumes has been weak and uneven across different countries. Peersman (2011) performed an in-depth research of banking sector transmission of unconventional monetary policies to the real economy. To get a clear unbiased picture of different monetary developments, he

divided credit supply changes into three groups. Credit supply changes could be due to multiplier changes by lenders themselves, changes in policy rate or due to unconventional policies. Such analysis addresses the so-called lack of unconventional policies in the pre-crisis period. The author argues ECB had been using unconventional policies before the financial crisis. These policies were identified by ECB balance sheet innovations. The study's results point to successful stimulation of credit, output and prices by unconventional monetary measures of the ECB. Lenza, Pill, and Reichlin (2010) look at the effects of unconventional monetary measures on monetary and real economy variables. They use two scenarios to measure the difference between conventional and unconventional measures. Differences are captured by short-term changes in interest rates, changes in spreads and yield curve slope. They also point to the consequences of ECB measures, to previously treated policy rate benchmark. With full allotment and 1-year LTRO, main refinancing operations rate lost its policy stance measurement power as its relationship to EONIA reversed. A country-specific approach was adopted by Casiraghi, Gaiotti, Rodano, and Secchi (2013). Authors address the case of Italy during the sovereign debt crisis. All improvements achieved through unconventional measures were statistically and economically very significant. The impact was of a bigger magnitude due to crisis environment, which made monetary policy more effective compared to non-crisis conditions.

Gambacorta and Marques-Ibanez (2011) discusses bank lending channel through the lenses of bank-specific characteristics using quarterly bank level data. Their sample covers 1000 banks from U.S. and Europe. The changes in banks business models have lead to changes in significance of characteristics measures and the responsiveness of the bank transmission channel. In general bank specific characteristics were found significant determinants of loans supply. They find a significant impact of unconventional policies on lending volumes.

The research differs on how they identify monetary shocks. Studies used money markets, Carpenter, Demiralp and Eisenschmidt (2013), Lenza, Pill and Reichlin (2010), Casiraghi, Gaiotti, Rodano, and Secchi (2013), to identify shocks. Easing monetary policies decreased spreads and volatility in money markets. This lead to better funding conditions for the banks. Some research by Darracq-Paries and De Santis (2015), Casiraghi, Gaiotti, Rodano, and Secchi (2013), Ciccarelli, Maddaloni, and Peydro (2015) used banker surveys, in Europe bank lending surveys, to identify the shock. Surveys offer demand and supply measures, but only in relative measures to the previous period. Most common proxy for unconventional monetary policy used is central bank assets or monetary base. Studies using this identifier are Gambacorta, Hofmann and Peersman (2014), Peersman (2011), Gambacorta and Marques-Ibanez (2011) Creel, Hubert and Viennot (2016). In the previously mentioned study, Bowman, Cai, Davies and

Kamin (2015), authors use lender liquidity as a measure of central bank policy. This is due to Bank of Japan's specific targeting of lenders liquidity positions.

Overall, recent literature on unconventional policies describes policies to be successful at increasing lending, gross domestic product and prices. ECB unconventional policies decreased money markets spreads and government bond yields. The majority of the literature described above draws their conclusions from historical relationships between monetary policy and economic activity, mainly from the 2000s. Only Creel, Hubert, and Viennot (2016) have a more contemporary sample, who find weaker results than literature using pre-crisis and historical samples.

4. Methodology

I assess the effects of unconventional monetary policies of the ECB on loan volumes. I use semi-annual bank-level data from their financial reports. Data was collected from Bloomberg, Bankscope and bank's financial reports. Data spans from 2008 to 2016. Empirically, the paper leans on Bowman, Cai, Davies and Kamin (2015) and Gambacorta and Marques-Ibanez (2011).

I expect ECB policies to be reflected in lenders balance sheets through liquidity positions. This assumption is similar to Bowman, Cai, Davies, and Kamin (2015) in their study of Japanese banks. A central bank buys lender assets, in the case of ECB with a repurchasing agreement, and gives them liquid cash. Banks with bigger liquidity positions are expected to lend more, increasing lending volumes. Banks should be motivated to lend the extra liquidity, as liquid assets earn less than loans. Bowman, Cai, Davies and Kamin (2015), Gambacorta and Marques-Ibanez (2011) have similar expectations from liquidity position effect on lending.

For the ECB to provide this liquidity it needs to expand its assets. Gambacorta, Hofmann and Peersman (2014) and Peersman (2011) say changes in balance sheet size are defined unconventional as central banks usually only change the decomposition of the balance sheet and use short-term interest rates. To observe for policy effect on lending, I take liquidity positions of lenders as a proxy for ECB unconventional policy similar to Bowman, Cai, Davies, and Kamin (2015). Although increases in lenders liquidity could have occurred due to other reasons, I think lenders without ECB's operations would not be able to increase or maintain their liquidity positions to such extent and at such cost. Some of the increases in liquidity positions could come from a higher desire for liquidity due to market uncertainty and be financed on money markets. Liquidity increase could be smaller than the increase of the ECB balance sheet because lenders used ECB's liquidity to replace liquidity from other parties. I also follow Gambacorta and Marques-Ibanez (2011) who apply a more direct measure of unconventional monetary

policy. They apply lender's central bank assets relative to the lender's country nominal GDP. When the ratio increases, central bank is providing extra liquidity to lenders, increasing and supporting their liquidity positions.

I will test the following hypothesis.

Hypothesis 1: Liquidity positions of lenders play a significant role in determining lending volumes and higher liquidity positions lead to increased lending.

Hypothesis 2: ECB through its operations was a significant source of liquidity for the lenders.

To test the hypotheses, I employ unbalanced panel data analysis with multiple banks observed through semi-annual time periods. For the first hypothesis, I employ the following regression:

$$\Delta(\ln)\text{loan}_{i,t} = \alpha_i + \beta_1 \text{liquidity}_{i,t-1} + \beta_2 X_{i,t-1} + \varepsilon_{i,t} \qquad (1)$$

My dependent variable is bank lending growth. Independent variable of interest is bank liquidity position, which will confirm the first hypothesis if significant and positive and deny it if otherwise. Other independent variables of capital adequacy, deposit growth, credit risk of borrowers, lagged loan growth, size and profitability are controlling for other influences that might impact lending growth. These control variables and lagged dependent variable are presented in the equation by vector X. All variables in vector X are lagged once. Demand side it addressed by including time dummies, which capture aggregate influences. α stands for a vector of fixed effects and ε presents the error term.

Expected signs for other independent variables are the following. The relationship between loan growth and size should be positive. Loan growth is measured in absolute terms, which means if the bank grows in total assets the loans should grow with it, assuming the business model stays the same. Tier 1 ratio is used as a measure of the capital adequacy of a bank. Gambacorta and Marques-Ibanez (2011) find standard capital to assets measure not to be the best in recent time. Capital to assets measure lost its value due to accounting complexities. They see tier 1 capital ratio to be a better measure. Better capitalized banks, have the ability to lend more and are expected to lend more than inadequately capitalized banks. The coefficient of tier 1 ratio is expected to be positive. Deposits as the main source of funding for loans are expected to have a positive coefficient. The more deposits a bank has the more it can lend. Credit risk of borrowers represented by loan loss reserves reflects the expected losses associated with outstanding loans. Higher reserves reflect riskier borrowers. Assuming risk-averse banks, lending growth is expected to have a negative relationship with reserves. Lenders who are more profitable are more motivated to lend

and those who are making a loss are discouraged from lending. Therefore I expect the sign of profitability measure to be positive.

To address the endogeneity problem in my regression I also estimate my regression with generalized method of moments. In methodology, I follow the studies of Bowman, Cai, Davies and Kamin (2015), Gambacorta and Marques-Ibanez (2011). Both studies used generalized method of moments (GMM) method to address endogeneity between loan growth and liquidity position. Lenders who want to lend more can acquire more liquidity before the actual lending occurs. I estimate the model using difference GMM. In my sample using system GMM would cause the number instruments to surpass the number of groups, which is not desired.

If moment conditions and parameter count equal, the method of moments is applied. An example of MM is OLS estimation. In MM moment conditions are expected to be zero for actual parameter values. In the GMM moment conditions cannot be solved for zero because the instruments overcome the number of parameters. Therefore GMM tries to get as close as possible to zero. The distance to zero is measured by a matrix of weights, which is crucial to the GMM estimator. This matrix which defines the weights is based on the positive semi-definite quadratic form. To get the instruments for GMM, original variables are transformed in first differences or forward orthogonal deviations. I use first differences as my sample does not have many missing data points and number of observations is not adversely affected by the transformation. Endogenous variables are instrumented by their lags. To ensure consistency, sample cross sections must be as big as possible to proxy infinity. Consistency is a prerequisite for efficient estimators. To achieve efficient estimators two conditions must be met, no serial correlation of second order for GMM performed in differences and instruments used must be relevant. Instruments relevance can be tested with Hansen test, whose null hypothesis states that valid instruments are used. Second order serial correlation can be tested by the Arellano-Bond test for autocorrelation.

To run this complex method I use xtabond2 command in Stata developed by Roodman (2009). This estimation is applicable to samples with little time periods and many groups or cross-sectional observations, matching my sample. When estimating GMM, I define lagged loan growth and liquidity ratio to be endogenous variables and the rest to be exogenous. Endogenous variables are instrumented with one or more lags of their original variables. As I am doing differenced GMM, my variables can be left in levels. Differenced GMM is run in two-step and robust setting. For determining the validity of the model, I check Hansen statistic and Arellano-Bond test for autocorrelation.

For the second hypothesis, this regression is employed:

$$\text{Liquidity}_{i,t} = \alpha_i + \beta_1 \text{ ECB assets}_{i,t} + \beta_2 X_{i,t-1} + \varepsilon_{i,t} \qquad (2)$$

The dependent variable in this model is liquidity ratio. The main focus is on the ECB assets independent variable. To confirm the second hypothesis its coefficient needs to be significant and positive. Control variables are in vector X and are lagged once. I control for capital injections, deposit growth, loan loss reserves, loan growth, borrowing, and profitability. The model does not include semi-annual time dummies when looking at the second hypothesis. α stands for a vector of fixed effects and ε presents the error term.

In the case of the second hypothesis, I expect the following signs. For the borrowing variable of total liabilities decreased for customer deposits, I expect the relationship with liquidity to be positive. If a lender takes on additional debt on the liability side, this is expected to increase liquidity position on the assets side. For capital injections or tier 1 ratio measure, I expect additional capital should be seen as a boost to liquidity position. During the period banks retained most of their earnings which should also improve their liquidity position. Higher profitability is expected to support liquidity positions. An increase in deposits should provide additional liquidity to the lender. For loan loss reserves I expect an increase would lead to a decrease in liquidity, as resources need to be put aside. If a lender experienced increased loan creation for which it consumed liquidity, I expect the relationship between loan growth and liquidity to be negative.

5. Data

The sample period is from 2008 to 2016 and it does not take into account the beginning of the financial crisis with high market uncertainty and starts right before the launch of the first 1-year LTRO. Including the height of the crisis could bias my liquidity coefficient towards negative, as lenders increased liquidity positions and restrained lending substantially, due to market uncertainty. The time period overall covers also longer LTROs, of whose the main effect is through additional liquidity to lenders. I think this time period at the moment best enables me to test the hypotheses and answer the research question.

To get the loan growth variable, I sum up the loans from lender's balance sheets including consumer, commercial and other loans. To get loan growth in natural logarithm, total outstanding loans need to be transformed by natural logarithm. Lastly, growth rates are calculated from transformed total loan values. The measure of size is total assets reported in millions of Euros at the time of observation. Tier 1 capital ratio is presenting capital adequacy measure and is calculated by dividing the defined total tier 1 capital with risk-weighted assets. Deposits, as the main source of funding, are a sum of all customer

deposits at a lender excluding deposits from banks or amounts due to other banks. Credit risk of the borrower's variable is measured by loan loss reserves divided by outstanding loans. Loan loss reserves amounts are decided by management to cover for losses in lenders loan portfolio. Liquidity is defined as cash or near cash items assets on balance sheet. This item includes cash in vaults, non-interest earning deposits in banks, receivables from the central bank, postal accounts, items of cash in the process of collection and statutory deposits with the central bank. The measure of liquidity is constructed as liquid assets over total assets of a lender at a given moment. The measure of profitability is defined as the return from operations and is calculated by dividing profit from operations with total assets. The borrowing measure is constructed by subtracting deposits from total liabilities. Lastly, ECB assets is a measure of ECB operations and is constructed by gathering information on member central banks assets and their respective countries' nominal GDPs. Then assets of the member central bank are divided by their respective nominal GDP. This ratio is assigned to the lenders depending on where they are headquartered.

The sample includes publicly listed and some bigger non-listed banks. Lenders collect deposits and lend to individuals and businesses. Banks excluded were the ones whose purpose is to finance larger projects of public interest got relatively little or none of their funding from deposits or their main activity was specialized services like investment banking, advisory or wealth management. Banks are incorporated in Euro zone countries and most or all of their data is available on Bloomberg and Bankscope. Banks with reasonable amounts of missing data points were gathered from individual bank financial statements. Banks, which were acquired and consolidated into a group, during the period, are not included. If a bank is a part of a banking group, whose parent is already included, their results are reflected in parent's consolidated reports and therefore are not included as well. Banks incorporated in Greece and Ireland were excluded, as their economies and banking sectors during the period were under severe contraction and could bias my results. Lastly, when the data is collected I exclude outlying periods with loan growth above 20% and contraction below 20%. The final number of lenders is 57 and the list can be found in the appendix table A1**.**

6. Empirical results

In this section, I present results of regressions put forward in the methodology section. Before I continue to the results, I will present data statistics and correlation matrix. Summary statistics present variables used in the regressions. Correlation matrix offers a useful insight into multicollinearity between the variables.

Table 1 presents summary statistics of variables used in the regression. Loan growth reported here is transformed following the steps described in the data section. Mean loan growth is slightly negative in

the sample. Mean liquidity position is 2.24% of total assets. The smallest bank size at the time is 2.2 billion and the biggest is 2241 billion. Tier 1 ratio sample mean is 11.49. In the sample mean growth of deposits was 2.49%. Lenders mean loan loss reserves were at 3.59% of their outstanding loans. Mean profitability of operations is close to zero for the sample. ECB member banks assets as the percentage of nominal GDP varied from around 6% to up to 24%. Number of observations varies from 748 to 746, which is 50 observations less than the sample would have if there would be no missing values in the panel data.

Table 2 shows a correlation matrix, from which it can be seen that the strongest correlation is around 34%. Correlations between variables are weak. Even the highest correlation between deposit growth and loan growth is considered low. This means that multicollinearity will not be a problem in my regressions. In the case of total assets and liabilities minus deposits, variables are not used in the same estimation.

Table 1
Summary statistics

This table presents the number of observations (N), mean, standard deviation, minimum and maximum for variables used in semi-annual the regressions. Loan growth is logarithmically transformed.

Variable	N	mean	St. Dev.	min.	max.
Loan growth	748	-0.00014	0.00394	-0.01754	0.01565
Liquidity ratio	748	0.02243	0.02350	0.00028	0.14190
Total assets	748	330632	466575	2210	2241174
Tier 1 ratio	748	11.49	2.66	5.00	22.80
Deposit growth	748	0.02485	0.10761	-0.53061	1.18163
Loan loss reserve ratio	748	0.03594	0.02841	-0.00440	0.20479
Return from operations	746	0.00104	0.00512	-0.06353	0.01285
ECB assets	748	0.11848	0.03646	0.06523	0.24043
Liabilities-deposits	748	193872	304954	505	1579402

Table 2
Correlation matrix

This table presents correlation coefficients of the variables used in the semi-annual regressions. Liab-depos. stands for Liabilities-deposits variable. Loan growth is logarithmically transformed.

	Loan growth	Total Assets	Liquidity ratio	Tier 1 ratio	Deposit growth	Loan loss	Profitability	ECB assets	Liabi.-depos.
Loan growth	1								
Total Assets	0.03	1							
Liquidity ratio	-0.05	0.13	1						
Tier 1 ratio	-0.13	0.13	0.29	1					
Deposits	0.34	-0.03	0.10	0.01	1				
Loan loss	-0.17	-0.07	0.01	-0.15	-0.06	1			
Profitability	0.22	0.08	0.15	0.22	0.10	-0.30	1		
ECB assets	-0.14	0.02	0.04	0.09	-0.02	0.21	-0.23	1	
Liab.-depos.	0.02	0.98	0.09	0.11	-0.03	-0.07	0.05	0.00	1

Table 3 presents estimated coefficients of the fixed effects estimation and the difference GMM estimation. First two columns are estimated using fixed effects but with a different number of lags of liquidity ratio and loan growth. In the case of difference GMM, I use two lags of liquidity ratio and loan growth because of potential endogeneity. When GMM estimation is performed using one lag for endogenous variables, there is an autocorrelation problem. Therefore, I report the one with two lags. Two lags in the case of fixed effect estimation are made available for better comparability of methods. Semi-annual time dummies are included in all models but are not reported in the results.

For the fixed effects regression with one lag of liquidity and loan growth, I find liquidity ratio to have a positive and significant effect on loan growth while controlling for other factors. Total assets have a negative and significant impact on loan growth. Higher tier 1 ratio increased lending at significant levels. Deposit growth coefficient has a positive sign but is not significant. The increase in loan loss reserve ratio leads to a significant decrease in loan growth. Profitability coefficient is insignificant with a positive sign. Difference GMM estimation gives a positive but insignificant effect of liquidity on loan growth. Total assets have again strong and negative impact on loan growth. Tier 1 ratio has strong and positive effect on loan growth with GMM estimation. I find deposit growth positive but statistically insignificant. Loan loss coefficient is negative and significant, signalling negative effect higher loan loss reserves on lending. Profitability measure of return from operations has a significant and negative impact. GMM instruments are valid and there is no second order autocorrelation problem, shown by Hansen test and Arellano-Bond test for autocorrelation. Both tests do not reject their null hypotheses of valid over-identifying restrictions and no autocorrelation.

Comparing fixed effects with one lag and difference GMM estimations, I see them provide different statistical significance. GMM liquidity coefficient is weaker than that of the fixed effects estimation but still positive. Coefficients and significance of other control variables are very similar between the different estimations, except in the case of profitability. Profitability is insignificant and positive in the fixed effects estimation while it is significant and negative in GMM approach. A possible reason for such a drastic change in the profitability coefficient could be the affected by twice lagged loan growth. Loan growth lagged twice in the fixed effects estimation gives a positive and significant sign, which is contrary to the result of the GMM estimation. Lagged dependent variable or loan growth is also the primary driver of autocorrelation when GMM is estimated using one lag. Otherwise, it is hard to see a less profitable lender to be lending out more. The significance and sign remain the same when GMM estimation is done without the loan loss reserve control variable, which profitability has the highest correlation with.

Looking at the difference between the two lags fixed effect estimation and the difference GMM, it can be seen there is little difference. The variable which coefficient varies depending on the estimation is the lagged loan growth. The variable of interest, liquidity ratio, shows the same coefficient significance and sign. The results and conclusions do not differ between the models, liquidity ratio coefficient is not biased by endogeneity. Therefore, from here on I will only report the fixed effects estimations.

The results, with significant liquidity ratio effect on lending with one lag of half a year, support my hypothesis of higher liquidity positions leading to higher lending growth. The results with two lags and the GMM estimation provide evidence where liquidity has a statistically insignificant effect. Two lags represent a year long period. In this case, to interpret the results two views can be taken. GMM and two lag results are weaker because of the longer periods and the effect of increased liquidity was already utilized, therefore single lag fixed effect estimation is correctly showing significance. On the other hand, it can be said that single lag result could be biased through endogeneity. Liquidity coefficient could be biased upwards by lenders who intend to lend and acquire additional liquidity before lending. Depending on the view taken, the first hypothesis can be rejected or confirmed. I choose to confirm the hypothesis and take the first view of weaker liquidity coefficient due to time difference which caused the liquidity effect to fade away. In my opinion, lenders are unlikely to acquire additional liquidity half a year before the actual lending. There is an opportunity cost for holding more liquidity than needed in the form of unearned returns or paid interest. Gambacorta and Marques-Ibanez (2011) prefer to observe the effect on a quarterly basis with one lag, which is even shorter than my half a year lag.

Table 3
Hypothesis 1- fixed effects and GMM estimation

This table presents coefficient estimated with fixed effects estimation, in the second and third column, and coefficients estimated with difference GMM in the fourth column. Third column regression is performed with two lags of liquidity ratio and loan growth. Other independent variables are always lagged once. The dependent variable in all regressions is logarithmically transformed loan growth. The model estimated is presented in methodology section (1). Semi-annual time dummies are included in all models, but not reported. In difference GMM estimation endogenous variables are liquidity ratio and loan growth. GMM estimation is performed using two lags as instruments for endogenous variables and in robust two-step estimation. Hansen test is the reported p-value of J-statistic where the null hypothesis is over-identifying restrictions are valid. Statistical significance is measured by t-test for fixed effects and by z-test in the case of GMM, they are reported under the coefficients. ***, **, * represent significance at 1, 5, and 10 percent significance levels respectively. Second order serial correlation is tested using Arellano-Bond test for autocorrelation. Reported value is z-value for rejecting the null hypothesis of no autocorrelation or serial correlation.

Dependant variable: Loan growth	Fixed effects(t-1)	Fixed effects(t-2)	GMM
Liquidity ratio(t-1)/(t-2)	0.02050**	0.01233	0.03181
	(1.97)	(1.15)	(0.9)
Total assets(t-1)	-0.00001**	-0.00001***	-0.00001***
	(-2.5)	(-2.71)	(-3.19)
Tier 1 ratio(t-1)	0.00022**	0.00028***	0.00031**
	(2.39)	(2.85)	(2.38)
Deposit growth(t-1)	0.00188	-0.00003	0.00036
	(1.31)	(-0.02)	(0.3)
Loan loss reserve ratio(t-1)	-0.03360***	-0.03218***	-0.04161**
	(-3.3)	(-2.88)	(2.07)
Loan growth(t-1)/(t-2)	-0.13069***	0.09530**	-0.21256***
	(-3.23)	(2.35)	(-2.67)
Profitability(t-1)	0.02685	0.01078	-0.05337**
	(0.84)	(0.33)	(-2.08)
Time dummies	YES	YES	YES
Observations	677	644	613
R-squared	0.19	0.18	
Number of instruments			41
Hansen test			0.43
2nd order serial correlation			0.25

Other control variables all have significant coefficient magnitude and signs as expected, except in the case of total assets sign and deposits significance. For total assets, I was expecting a positive sign, but got a negative, which is statistically significant. This coefficient could be reflecting the fact regulation for bigger lenders got stricter relative to the smaller lenders, which are deemed systemically irrelevant. Bigger lenders also refocused their business models back to their core business of lending, away from fee based revenues and investment banking. Insignificant deposits could be a consequence of uncertainty as

deposits increased but there was no increase in lending. Profitability is also insignificant but becomes significant when loan loss reserves are not included in fixed effects estimation. Loan loss reserves and profitability have relatively high correlation and profitability partly reflects loan loss reserve through expenses for reserves.

To connect the first hypothesis to the effectiveness of unconventional monetary policies of the ECB, I see that confirming the hypothesis gives support to ECB policies, which aimed at supporting liquidity in the banking system. When addressing the effectiveness of ECB policies, the possible endogeneity problem in my estimation does not play a determining role. This is because of the nature of the execution of policies, where lenders themselves determined the liquidity provided. If the ECB operations were a significant source of liquidity during the period, it does not matter which happened first, did liquidity increase lead to lending, or did the lending desire increase liquidity needed. In both cases, the ECB was there providing unlimited liquidity on demand, supporting lenders funding ability.

For the second hypothesis, the results of estimations are presented in Table 4**.** Estimations are done with fixed effects approach. The dependent variable is liquidity measured by liquidity ratio. When evaluating the second hypothesis, control variables are the same as in the first hypothesis with the exception of total assets which is replaced by liabilities subtracted for customer deposits, presenting borrowing of the lender. The variable of interest is ECB assets. Second hypothesis estimation does not include semi-annual time dummies. In estimation, control variables are lagged once while ECB assets are not. In the additional estimation, I add the time dummies to control also for aggregate factors. This allows me to look into forces which influenced the movement of liquidity positions.

Results for the second hypothesis are the following. The variable of interest, ECB assets, is positive and significant at one percent level. Liabilities reduced for deposits show significance with a negative sign, which was not expected. It is possible that lenders who acquired liquidity through other sources than debt used it to decrease debt. Tier 1 ratio is significant and positive as expected. Deposits had a significant and positive effect on liquidity matching expectations. Loan loss reserve and loan growth coefficients are insignificant. Loan loss sign is positive and not as expected. The effect of banks preparing to absorb the losses is stronger than the one decreasing assets through resource reservation. Loan growth has a negative sign which is as expected. Profitability coefficient is found significant and positive which is in line with expectations. When time dummies are added, ECB assets, borrowing and tier 1 ratio become insignificant. The majority of liquidity movement is captured by time dummies.

The results of the second column estimation confirm the second hypothesis, which states ECB's operations were a significant source of liquidity. A measure of ECB assets, which is a proxy for ECB

operations, is found positive and significant. Third column results show aggregate factors, retained earnings and deposits significantly influence liquidity positions of lenders. ECB operations proxy, ECB assets, does not show a significant influence.

Applying these findings to the effectiveness of ECB's unconventional policies, I observe that ECB through its operations was an important provider of liquidity to the lenders. Through the view of where the lenders sourced the liquidity from, the concept of full allotment at fixed rate proven to be very attractive. ECB assets were by far the most significant variable determining the liquidity source. Additional observation provides evidence ECB was not significantly influencing liquidity positions. A possible reason is the way liquidity amounts were determined.

Table 4
Hypotheses 2 - ECB influence on liquidity positions

This table presents coefficient estimated with fixed effects estimation. The second column presents estimation for the second hypothesis. The third column shows estimation the same as the second hypothesis and including time dummies. Variables are always lagged once except for the ECB assets. In the estimations below liquidity ratio is the dependent variable. The model was presented under the second hypothesis (2). Semi-annual time dummies are not reported when included. Statistical significance is measured with t-test, which is reported under the coefficients. ***, **, * represent significance at 1, 5, and 10 percent significance levels respectively.

Dependent variable: Liquidity ratio	hypothesis 2	with time dummies
ECB assets(t)	0.08357***	0.00931
	(4.6)	(0.31)
Liabilities-deposits(t-1)	-0.00001*	-0.00000
	(-1.71)	(-0.93)
Tier 1 ratio(t-1)	0.00052*	-0.00048
	(1.69)	(-1.26)
Deposit growth(t-1)	0.01143**	0.01132**
	(1.92)	(1.91)
Loan loss reserve ratio(t-1)	0.05132	0.02090
	(1.27)	(0.48)
Loan growth(t-1)	-0.16462	-0.18704
	(-1.01)	(-1.12)
Profitability(t-1)	0.23844*	0.21878*
	(1.86)	(1.65)
Time dummies	NO	YES
Observations	677	677
R-squared	0.08	0.13

Overall, the results from the two hypotheses give evidence, which supports the notion of ECB effectively supporting lending through the provision of liquidity. ECB was the main source of liquidity during the period enabling lenders to increase liquidity if desired. Without the unconventional policies,

which enabled ECB to expand its liquidity provision above levels observed historically, lenders would not be able to maintain the liquidity positions that they did. Liquidity would be more expensive or even unavailable to some lenders, which would, in turn, lead to lower liquidity positions. Although ECB was the main liquidity provider, it did not influence lender liquidity positions upwards. Lower liquidity positions from the first hypothesis lead to decreased lending. If lenders are rational and ECB is providing liquidity if demanded, lenders will only utilize ECB as a source of liquidity if ECB's liquidity is cheaper or the only source available. Assuming rational lenders, ECB would not have been the main source of liquidity, if there were an alternative source. Summing up the above mentioned evidence, the ECB's unconventional policies had effectively supported the lending activity during the observed period. ECB's policies mainly acted as preventing contraction rather than encouraging expansion of lending. My finings match the findings of previous literature to some extent. I do not find such strong stimulation of lending as it is found in the literature using pre-crisis data. To say ECB stimulated lending above what lenders wanted to lend is not the case. For ECB to stimulate lending above the desired by lenders, it would have to exogenously increase liquidity positions of lenders. From this perspective, my results align quite well with the findings of Creel, Hubert, and Viennot (2016). They also find weaker effects of ECB's unconventional policies on lending volumes.

7. Robustness checks

For robustness checks, I replace liquidity ratio in levels with the liquidity ratio squared. I estimate the model using quarterly data, where the number of banks decreases to 32. I also account for higher and lower outlier limitation for loan growth of 10% and 30%. Results are presented in tables A4 and A5. To check the robustness of the second hypothesis I do the following. ECB assets are put in as growth rates and not in levels and liquidity ratio, the dependent variable, is squared. ECB total assets are also replaced by a sum of ECB's lending to credit institutions and securities held. Results of these checks are reported in table A6.

From table A4 results in the appendix, it can be seen that the significance of liquidity variable across different robustness checks does not differ from my main estimations from the previous section, except in the case of lowered outlier limitation. In estimation where liquidity ratio is transformed by squares, coefficients do not differ in significance or sign from the baseline estimation. When increasing the outlier limitation to 10% the number of observations falls by 43. Coefficients are again similar; the difference is in significance of tier 1 ratio and lagged loan growth. With softening the outlier limitation to 30%, the observations increase by 19. In this estimation, the liquidity ratio is reported insignificant, which is not in line with my baseline model. By allowing such high outliers, the results can be biased by those

outliers. The highest liquidity ratio in the period is 15% and for a bank to increase the loans by more than 15% by normal means is unlikely. To support the bias argument, the change in the deposit growth coefficient sign while remaining significant is a big change, which is hard to explain. I see the results where outliers are limited to 30% to be biased. Overall, the results from table A4 support the confirmation of the first hypothesis.

Table A5 in the appendix shows the results of estimations using quarterly data of 32 lenders. The list of lenders, summary statistics, and correlation matrix for quarterly estimation can be found in the appendix tables A1, A2, and A3. The number of observations stays fairly the same, the number of lenders decreases and time periods double. R-squared metric sees a slight increase relative to the baseline model. The sample was constructed based on the availability of quarterly data for lenders. Coefficients of variables present similar significance and signs. The significance of size on quarterly basis diminishes. This can be due to higher volatility of total assets on a quarterly basis. Liquidity ratio significance differs depending on the number of lags. For estimation with 1 lag of liquidity ratio, it is found positive but insignificant. For additional lags of two and three liquidity becomes significant and positive. One lag is a quarter long period. The results again support finding from the previous section. These results given by quarterly estimation provide support for the argument which argues liquidity ratio is not affected by endogeneity bias. Endogeneity would bias one lag liquidity ratio upwards the most and then fade away with additional lags. This is not the case as results go against this trend.

When checking for robustness of estimations for the second hypothesis, I express ECB policy variable as the growth of ECB assets and ECB's lending to credit institutions and securities, I also square liquidity ratio. When ECB assets are replaced by the sum of ECB's lending to credit institutions and securities held, the variable is matched to the lender according to its member central bank. The results are reported in table A6. Looking at the results for the second hypothesis, signs remain the same as in the baseline but the significance of some variables changes. Most importantly sign and significance of ECB unconventional policy proxy does not change depending on the specification. ECB assets, growth of ECB assets and ECB lending and securities coefficients are not impacted by different specifications to such extent to give different conclusions. The results support the findings of previous estimations. The second hypothesis is confirmed. In summary, robustness checks back the results provided in the previous section.

8. Additional insights

In this section, I perform some comparison between different groups of lenders depending on their characteristics. Comparisons are made using the model from the first hypothesis. I compare lenders depending on their capital adequacy, country of incorporation, liquidity position, loan loss reserve ratio,

size, and their dependency on customer deposit funding. Groups are determined by using sample means from variables. Means are the separating points between for example bigger and smaller lenders.

Table 5
Different country of incorporation and capital adequacy

This table presents coefficient estimated with fixed effects estimation. Estimations are based on the model presented in methodology section for the first hypothesis (1). The second and third column show where lenders are differentiated weather they are incorporated in periphery or core country. The second column shows results of lenders from peripheral countries. The third column presents results of lenders from core countries. The fourth and fifth column report results of lenders with strong and weak capital adequacy, divided into the two groups by the tier 1 ratio mean. All variables are always lagged once. The dependent variable in all regressions is logarithmically transformed loan growth. Semi-annual time dummies are included in all models, but not reported. Statistical significance is measured with t-test, which is reported under the coefficients. ***, **, * represent significance at 1, 5, and 10 percent significance levels respectively. Below the estimation results means of variables are reported for the estimated sample.

Dependent variable: Loan growth	country of incorporation		capitalization	
	periphery	core	weak	strong
Liquidity ratio(t-1)	0.00134	0.02238**	-0.00792	0.03403***
	(0.04)	(2.02)	(-0.46)	(2.35)
Total assets(t-1)	-0.00000	-0.00001***	-0.00001	-0.00001**
	(-0.56)	(-2.43)	(-1.24)	(-2.17)
Tier 1 ratio(t-1)	0.00029**	0.00012	0.00027**	0.00015
	(1.91)	(0.96)	(2.22)	(0.96)
Deposit growth(t-1)	-0.00207	0.00344**	0.00148	0.00189
	(-0.7)	(2.1)	(0.74)	(0.88)
Loan loss reserve ratio(t-1)	-0.04119***	-0.06112*	-0.03699***	-0.04035
	(-2.82)	(-1.74)	(-3.39)	(-0.98)
Loan growth(t-1)	-0.15455**	-0.07822	-0.09540**	-0.14209**
	(-2.29)	(-1.47)	(-1.72)	(-2.3)
Profitability(t-1)	0.01958	0.15337**	0.03396	0.06420
	(0.5)	(1.96)	(1.03)	(0.68)
Time dummies	YES	YES	YES	YES
Observations	291	386	378	299
R-squared	0.23	0.22	0.26	0.18
Variable means				
Liquidity ratio	0.01651	0.02687	0.01989	0.02567
Total assets	228871	407919	313067	354535
Tier 1 ratio	10.21	12.44	10.27	13.03
Deposit growth	0.02341	0.02611	0.02246	0.02811
Loan loss reserve ratio	0.05192	0.02403	0.04807	0.02060
Profitability	0.00034	0.00157	0.00060	0.00160

To look at the differences between core and peripheral lenders table 5 shows the results in the second and third column. Lenders in the periphery are less capitalized than their counterparts in the core countries. Core lenders held more liquidity than lenders from peripheral countries. The two groups have

quite some differences in the coefficients. First, liquidity ratio is significant at core lenders but insignificant at lenders from the periphery. Profitability, deposit growth and total assets variables are significant for lenders incorporated in the core countries and insignificant in the periphery. Tier 1 ratio is significant only in the periphery. Loan loss reserves play a significant role in both groups. Columns four and five, in table 5 report results for lenders with higher and lower tier 1 ratio. The picture is similar to that of the core and periphery. Lenders with strong capitalization held more liquidity than the weakly capitalized ones.

From these differences, it can be seen that lenders from peripheral countries had only two significant determinants of lending volumes. Tier 1 ratio presenting capital adequacy and loan loss reserves presenting the risk of borrowers. Liquidity ratio was insignificant, giving evidence to a weak impact of ECB unconventional policies on the peripheral lenders. In core countries, a different picture is observed. Liquidity ratio, deposit growth and even profitability are found to have a significant impact on lending. Tier 1 ratio, on the other hand, is not found significant. Overall, lenders who are better capitalized are operating normally and provide more loans if their deposits, profitability and liquidity increase, lenders with lower capitalization provide loans depending on their capital adequacy. Such relationship could be explained by saying that lenders who are not well capitalized are capital constrained and therefore even with additional liquidity do not lend more. This is also supported by the results from the core lenders, who are better capitalized, and do not see capital adequacy to be determining their lending. Gambacorta and Marques-Ibanez (2011) find similar restrictions imposed by capital adequacy to loan supply.

In table 6, the results for lenders with high and low liquidity positions are reported in columns two and three. Columns four and five present results for high and low loan loss reserve ratios. Liquidity rich lenders and lenders with low loan loss reserves are more capitalized than their opposite groups. The main difference between lenders with high and low liquidity is the difference in loan loss reserve ratio effect. For lenders with a high liquidity, loan loss reserve ratio is insignificant, the opposite is the case for low liquidity. It can be interpreted that highly liquid banks react less to increases in loan loss reserves. Tier 1 ratio and liquidity significance follow the pattern of capitalization. The difference in means of loan loss reserve ratio between the liquidity groups is minor. The differences between groups with low and high loan loss reserve ratio are at liquidity ratio, deposit growth and loan loss reserves ratio. Deposit growth and loan loss reserves are significant and liquidity ratio is insignificant for the group with high loan reserve ratio, the opposite is for the group with low loan loss reserves. Higher levels of loan loss reserves can significantly affect lending while lower levels are not damaging to lending. For banks with high loan loss reserves, deposit growth is significant, possibly because it is harder for them to fund them through

other sources, as they are perceived riskier. Deposit growth at lenders with higher loan loss reserves is slower than at the average lender.

Table 6
Different liquidity positions and loan loss reserves

This table presents coefficient estimated with fixed effects estimation. Estimations are based on the model presented in methodology section for the first hypothesis (1). The second and third column show results where lenders are differentiated whether their average liquidity position was below or above sample mean. The second column shows results for lenders which had weak liquidity position. The third column presents results of lenders with strong liquidity position. Fourth and fifth column report results of lenders with low and high loan loss reserves ratio, divided into the two groups by the loan loss reserve ratio of the sample mean. All variables are always lagged once. The dependent variable in all regressions is logarithmically transformed loan growth. Semi-annual time dummies are included in all models, but not reported. Statistical significance is measured with t-test, which is reported under the coefficients. ***, **, * represent significance at 1, 5, and 10 percent significance levels respectively. Below the estimation results means of variables are reported for the estimated sample.

Dependent variable: Loan growth	liquidity		loan loss reserve	
	low	high	low	high
Liquidity ratio(t-1)	0.00247	0.02321*	0.03315**	-0.01017
	(0.1)	(1.66)	(2.53)	(-0.54)
Total assets(t-1)	-0.00001***	0.00000	-0.00001**	-0.00001
	(-2.78)	(-0.8)	(-2.17)	(-1.48)
Tier 1 ratio(t-1)	0.00036***	0.00006	0.00022*	0.00030**
	(2.92)	(0.37)	(1.66)	(2.11)
Deposit growth(t-1)	0.00046	0.00302	0.00086	0.00527*
	(0.26)	(1.16)	(0.52)	(1.65)
Loan loss reserve ratio(t-1)	-0.02989**	-0.03022	-0.01417	-0.04249***
	(-2.52)	(-1.42)	(-0.39)	(-3.22)
Loan growth(t-1)	-0.11939**	-0.14170**	-0.13216**	-0.09072
	(-2.27)	(-2.1)	(-2.47)	(-1.39)
Profitability(t-1)	0.01873	0.06376	0.13259	0.01636
	(0.54)	(0.77)	(1.49)	(0.44)
Time dummies	YES	YES	YES	YES
Observations	421	256	402	275
R-squared	0.22	0.19	0.19	0.26
Variable means				
Liquidity ratio	0.00964	0.04325	0.02444	0.01950
Total assets	258538	449813	332935	329033
Tier 1 ratio	10.87	12.48	12.24	10.37
Deposit growth	0.02105	0.03131	0.03026	0.01715
Loan loss reserve ratio	0.03714	0.03402	0.02112	0.05777
Profitability	0.00043	0.00204	0.00192	-0.00026

Table 7
Different sizes and reliance on deposit funding

This table presents coefficient estimated from fixed effects estimation. Estimations are based on the model presented in methodology section (1). The second and third column show results where lenders are differentiated based on their size measured by total assets, lenders are put into two groups depending on whether their average total assets were above or below sample mean. The second column shows results for smaller lenders and third for bigger. The fourth and fifth column report results of lenders with low and high funding dependency on customer deposits, measured by customer deposits divided by total liabilities. The two groups are constructed from banks whose deposit dependency is lower or higher than the sample mean. All variables are always lagged once. The dependent variable in all regressions is logarithmically transformed loan growth. Semi-annual time dummies are included in all models, but not reported. Statistical significance is measured with t-test, which is reported under the coefficients. ***, **, * represent significance at 1, 5, and 10 percent significance levels respectively. Below the estimation results means of variables are reported for the estimated sample.

Dependent variable: Loan growth	size		deposit funding	
	small	big	low	high
Liquidity ratio(t-1)	0.01938	0.02365	0.03897**	-0.00440
	(1.4)	(1.39)	(2.4)	(-0.31)
Total assets(t-1)	0.00001	-0.00001**	-0.00001***	0.00000
	(0.67)	(-2.45)	(-2.77)	(-0.22)
Tier 1 ratio(t-1)	0.00024**	0.00043**	-0.00008	0.00052***
	(2.01)	(2.53)	(-0.64)	(3.9)
Deposit growth(t-1)	0.00245	0.00158	0.00300**	-0.00085
	(1.21)	(0.78)	(1.92)	(-0.27)
Loan loss reserve ratio(t-1)	-0.03242**	-0.03849**	-0.04612***	-0.03701**
	(-2.34)	(-2.36)	(-2.96)	(-2.53)
Loan growth(t-1)	-0.11422**	-0.21995***	-0.09328	-0.15761***
	(-2.13)	(-3.28)	(-1.6)	(-2.63)
Profitability(t-1)	0.00370	0.02757	0.02473	0.01386
	(0.07)	(0.72)	(0.45)	(0.33)
Time dummies	YES	YES	YES	YES
Observations	408	269	329	348
R-squared	0.16	0.33	0.27	0.21
Variable means				
Liquidity ratio	0.02154	0.02244	0.01836	0.02630
Total assets	72533	331355	445140	223513
Tier 1 ratio	11.11	11.48	11.76	11.22
Deposit growth	0.02743	0.02495	0.02984	0.02032
Loan loss reserve ratio	0.03611	0.03596	0.03315	0.03861
Profitability	0.00097	0.00104	0.00074	0.00133

Comparison of lenders across size and reliance on deposit funding is found in table 7. Here capital adequacy is fairly similar across subgroups. Comparison of the size groups gives little differences, only in the sign and significance of size measure. Surprisingly both estimations have insignificant liquidity ratio. I believe this is a coincidence with sample choice; liquidity ratios for both groups are fairly strong and close

to significance. In estimations comparing lenders depending on reliance on deposit funding, there are more differences. Lenders who rely more on deposit funding, experience insignificant deposit growth and liquidity ratio and significant tier 1 ratio, the opposite is observed in the case of lenders who rely less on deposits funding. From the regulatory side, bigger banks are facing more restrictions, which is reflected in total assets coefficients sign and significance. Lender characteristics do not differ across different sizes. Bigger lenders tend to rely less on depositors. On the other hand, lenders who do rely on depositor have seen higher profitability and have maintained higher liquidity positions. In the example of deposit funding the trade-off between capitalization constrain and liquidity significance is seen again. ECB's unconventional policies seem to be more effective when lenders are less dependent on deposit funding. Such findings regarding deposit funding reliance and capital adequacy are also observed in the study by Gambacorta and Marques-Ibanez (2011). Creel, Hubert, and Viennot (2016) also find bigger lenders and more consolidated lender markets, which rely more on market funding, to benefit more from unconventional monetary policies.

In summary, this section finds a weaker relation between liquidity and lending in the peripheral countries. For better capitalized lenders, tier 1 capital ratio becomes an insignificant determinant of lending. This can be seen as capital requirements are no longer restricting lending. In the case of better capitalized lenders, transmission of unconventional policies is stronger. If lenders are having higher liquidity positions on average, they are less responsive to increases in loan loss reserves or as described before, to increases in borrower risk. Bigger lenders are shrinking their assets to increase lending, probably a consequence of regulation and refocus in business models.

9. Conclusion

After the financial crisis, central banks around the world have adopted unconventional policies. To understand the effectiveness of the unconventional policies in the Euro zone, this study answers the question of whether ECB's unconventional policies were successful at stimulating lending. The question is answered by testing the significance of liquidity for lending and the impact of the ECB operations on liquidity. The results are acquired using data from the period during which the policies were in place. After the main tests, there are additional insights on the relationship between lending and different lender characteristics.

In the search for an answer to the research question, I found the following results. Effect of liquidity on lending growth is positive and significant in magnitude. Liquidity effect provides evidence that ECB operations, by providing liquidity, have targeted a relevant factor. If ECB increased the liquidity positions, it would be effectively encouraging lending above desired by lenders. When looking at the

sources of liquidity during the period, ECB was an important source. I conclude to answer the research question affirmative. ECB unconventional policies have significantly and positively affected lending in the Euro zone. Overall, ECB's policies mainly acted as preventing contraction rather than encouraging expansion of lending. After answering the main question additional insight could be gained from the data. Comparing the effects of the ECB operations in the peripheral and core countries, I find surprising results. Usually, weaker lenders are expected to benefit more from the help than the stronger ones observed by Bowman, Cai, Davies, and Kamin (2015). Through the channel of liquidity, lending was not stimulated in peripheral countries while it was in the core countries. ECB policies were more effective at lenders who were well capitalized, having a high tier 1 ratio. Lender capitalization was a crucial determinant of the effectiveness of ECB operations on lending through liquidity. Loan growth was negatively affected as lenders grew, probably because of stronger regulatory requirements for bigger banks and refocus of bigger banks back to their core business. Lastly, well liquid banks were not as negatively affected by increases in loan loss reserves.

With my research, I contribute to the existing body knowledge firstly, by providing relationships between different lender factors and lending during the period of unconventional monetary policy over a longer period of time and secondly, I provide an answer to whether unconventional policies, based on historical data from the period of the policies, have been effective. I have managed to find one studyby Creel, Hubert, and Viennot (2016) which based their findings on similar data sample period. I also use a technique, which uses lender level data, which have not been used a lot and gives more information on the way the policies have been effective. Previous literature known to me had been utilizing the past relationships to provide insight into the effects of unconventional policies. Others have been using relatively short periods right after or even during the financial crisis. The findings of my research confirm those of the previous research, which used past data. I present evidence, which opposes the conventional view on who yields most benefit from supportive policies and give a possible reason why transmission of policies was not as successful at some lenders.

These findings give policymakers and forecasters new insight into work they do. For policymakers, study provides evidence, which confirms that policies were successful at supporting liquidity and lending. It also tells that policy works only if lenders are well capitalized and that liquidity is beneficial more to lenders who are less dependent on deposits and the ones with higher loan loss reserves. To address core and periphery divergence policymakers should capitalize peripheral lenders to improve transmission of unconventional monetary policies. When taking the perspective of economic forecasters they can see the policies have a significant effect and the effectiveness differs depending on the characteristics of lenders, mainly their capitalization.

There could be an alternative explanation for the relationship between ECB assets and liquidity positions of lenders. ECB assets could have been increasing because lenders have been acquiring more liquidity on the markets and they have deposited this liquidity at the ECB. This alternative would give an impression of effective ECB policies while they actually would not be. Looking at the significance of liquidity, it could be significant because ECB policies did not work and lenders had been liquidity constrained. Evaluating core and periphery differences, an alternative observation could be that ECB operations have eliminated liquidity constraints in the periphery and therefore their liquidity is found insignificant. Of course, this is highly unlikely. The main limitation of my research is sample size and the selection of the sample. Because I do not have access and time to collect data for a very big and detailed sample, my sample's representation of population is weaker than in other comparable studies. The sample poorly represents the lending market in Germany. The German market for lending is more fragmented and has many smaller lenders, which are not captured by the sample. In other countries the problem of representation is not as big, their markets are more consolidated meaning my sample captures them well. Overall, the sample is biased towards bigger lenders because data for smaller ones are not as easily available. There could potentially be errors and noise in my data as it was collected manually from the financial statements and from different sources. Most of the data has come from Bloomberg, around 80%.

Possible further research can enrich the sample used by including more lenders and include additional countries of the Euro zone. I have mainly relied on the semi-annual data, but it is possible to get quarterly data which is used in the study of Gambacorta and Marques-Ibanez (2011). In this paper, I have used lender fixed effect to address the differences between lenders. A possible further research with enlarged sample could look at country specific characteristics. Finally, I find evidence that less capitalized lenders are limiting transmission I think this should be researched further to determine with certainty.

Appendix

Table A1
List of lenders

In this table, a list of lenders for semi-annual and quarterly estimations is presented. In the next column on the right, they are grouped depending on the country of incorporation.

Semi-annual	
Nova Ljubljanska banka	Periphery
SNS bank	Core
WGZ bank	Core
Ibercaja banco	Periphery
La Banque postale	Core
Crédit Mutuel	Core
Landesbank Hessen-thueringen girozentrale	Core
LBBW bank	Core
NORD/LB	Core
Bankia	Periphery
HSH Nordbank	Core
ABN AMRO	Core
Credit Agricole	Core
Aktia bank	Core
Aareal bank	Core
BBVA	Periphery
Banco Comercial Portugues	Periphery
Banco di Desio e della Brianza	Periphery
Banco Espírito Santo	Periphery
Bankinter	Periphery
BKS bank	Core
Bayerische Landesbank	Core
Banca Monte dei Paschi di Siena	Periphery
BNP Paribas	Core
Banco Popolare	Periphery
Banca Popolare dell'Emilia Romagna	Periphery
Banco BPI	Periphery
Banca Popolare di Sondrio	Periphery
CaixaBank	Periphery
Commerzbank	Core
Banca Carige	Periphery
Credito Valtellinese	Periphery
Deutsche Bank	Core
Deutsche Postbank	Core
DZ bank	Core
Erste Group bank	Core
Societe Generale	Core
IKB Deutsche Industriebank	Core
ING group	Core
Intesa Sanpaolo	Periphery
KBC group	Core
Natixis	Core
Van Lanschot	Core
Landesbank Berlin	Core
Mediobanca	Periphery
NIBC bank	Core
Oberbank	Core
Banca Popolare di Milano	Periphery
OP Corporate Bank	Core
Banco Popular Espanol	Periphery
Rabobank	Core
Raiffeisen bank international	Core
Banco de Sabadell	Periphery
Banco Santander	Periphery
Unione di Banche Italiane	Periphery
UniCredit	Periphery
Volksbank Vorarlberg	Core
Quarterly	
NORD/LB	Core
HSH Nordbank	Core
Credit Agricole	Core
Aareal bank	Core
BBVA	Periphery
Banco Comercial Portugues	Periphery
Bankinter	Core
Bayerische Landesbank	Core
BNP Paribas	Core
Banco Popolare	Periphery
Banca Popolare dell'Emilia Romagna	Periphery
Banco BPI	Periphery
Banca Popolare di Sondrio	Periphery
CaixaBank	Periphery
Commerzbank	Core
Banca Carige	Periphery
Deutsche Bank	Core
Deutsche Postbank	Core
Erste Group bank	Core
Societe Generale	Core
ING group	Core
Intesa Sanpaolo	Periphery
KBC group	Core
Mediobanca	Periphery
Oberbank	Core
Banca Popolare di Milano	Periphery
Banco Popular Espanol	Periphery
Raiffeisen bank international	Core
Banco de Sabadell	Periphery
Banco Santander	Periphery
Unione di Banche Italiane	Periphery
UniCredit	Periphery

Table A2
Summary statistics - quarterly

This table presents the number of observations (N), mean, standard deviation, minimum and maximum for variables used in the quarterly regressions. Loan growth is logarithmically transformed.

Variable	N	mean	St. Dev.	min.	max.
Liquidity ratio	833	0.01970	0.01935	0.00028	0.11546
Total assets	833	444449	557343	15866	2392177
Tier 1 ratio	831	11.11	2.29	5.70	18.92
Deposit growth	833	0.01861	0.18394	-0.57575	1.36352
Loan loss reserve ratio	833	0.03860	0.02255	0.00627	0.12497
Loan growth	833	-0.00016	0.00230	-0.00941	0.00750
Return from operations	833	0.00068	0.00210	-0.01964	0.00549

Table A3
Correlation matrix – quarterly

This table presents correlation coefficients of the variables used in the quarterly regressions. Loan growth is logarithmically transformed.

	Liquidity ratio	Total assets	Tier 1 ratio	Deposit growth	Loan loss	Loan growth	Profitability
Liquidity ratio	1						
Total assets	0.28	1					
Tier 1 ratio	0.24	0.24	1				
Deposit growth	-0.04	-0.01	-0.04	1			
Loan loss	0.03	-0.16	-0.05	0.05	1		
Loan growth	-0.07	0.01	-0.13	0.07	-0.08	1	
Profitability	0.15	0.06	0.07	0.10	-0.15	0.19	1

Table A4
Robustness checks – liquidity squared and outliers

This table presents coefficient estimated from fixed effects estimation. The second column presents estimation with squared liquidity ratio. The fourth and fifth columns present results, which exclude periods where loan growth increased more than 30% or contracted more than 30% and an increase or decrease of more than 10%, respectively. All variables are always lagged once. The dependent variable in all regressions is logarithmically transformed loan growth. Estimations are based on the model presented in methodology section (1). Semi-annual time dummies are included in all models, but not reported. Statistical significance is measured with t-test, which is reported under the coefficients. ***, **, * represent significance at 1, 5, and 10 percent significance levels respectively.

Dependent variable: Loan growth	liquidity ratio^2	Dependent variable: Loan growth	outliers 30%	outliers 10%
Liquidity ratio^2(t-1)	0.22459**	Liquidity ratio(t-1)	0.00488	0.01913**
	(2.33)		(0.4)	(2.18)
Total assets(t-1)	-0.00001**	Total assets(t-1)	-0.00001*	-0.00001***
	(-2.5)		(-1.71)	(-2.76)
Tier 1 ratio(t-1)	0.00022**	Tier 1 ratio(t-1)	0.00027**	0.00012
	(2.36)		(2.45)	(1.42)
Deposit growth(t-1)	0.00180	Deposit growth(t-1)	-0.00341**	0.00189
	(1.25)		(-2.27)	(1.56)
Loan loss reserve(t-1)	-0.03484***	Loan loss reserve(t-1)	-0.05045***	-0.02197**
	(-3.42)		(-4.11)	(-2.55)
Loan growth(t-1)	-0.13050***	Loan growth(t-1)	-0.31435***	-0.03499
	(-3.23)		(-7.8)	(-0.87)
Profitability(t-1)	0.02475	Profitability(t-1)	0.04809*	0.03805
	(0.77)		(1.63)	(1.16)
Time dummies	YES	Time dummies	YES	YES
Observations	677	Observations	696	634
R-squared	0.19	R-squared	0.22	0.23

Table A5
Robustness check – quarterly estimation

This table presents coefficients estimated with fixed effects estimation. The second column presents estimation where liquidity is lagged once. The third column shows results of an estimation where liquidity is lagged twice. In the fourth column, there are 3 lags of liquidity ratio. All other independent variables are always lagged once. The dependent variable in all regressions is logarithmically transformed loan growth. Estimations are based on the model presented in methodology section (1). Quarterly time dummies are included in all models, but not reported. Statistical significance is measured with t-test, which is reported under the coefficients. ***, **, * represent significance at 1, 5, and 10 percent significance levels respectively.

Dependent variable: Loan growth	Liquidity(t-1)	Liquidity(t-2)	Liquidity(t-3)
Liquidity ratio(t-1)/(t-2)/(t-3)	0.01114	0.01547**	0.01592**
	(1.47)	(1.96)	(2.01)
Total assets(t-1)	-0.00000	-0.00000	-0.00000
	(-0.88)	(-0.98)	(-1.17)
Tier 1 ratio(t-1)	0.00022***	0.00019***	0.00018***
	(3.53)	(2.9)	(2.78)
Deposit growth(t-1)	0.00007	0.00007	-0.00008
	(0.17)	(0.16)	(-0.2)
Loan loss reserve ratio(t-1)	-0.03245***	-0.03136***	-0.03020***
	(-4.78)	(-4.42)	(-4.24)
Loan growth(t-1)	-0.20235***	-0.24227***	-0.22821***
	(-5.66)	(-6.55)	(-6.1)
Profitability(t-1)	0.00486	-0.00014	0.00035
	(0.12)	(0.0)	(0.01)
Time dummies	YES	YES	YES
Observations	784	743	717
R-squared	0.21	0.23	0.22

Table A6
Robustness check – hypothesis 2

This table presents coefficients estimated with fixed effects estimation. The second column presents estimations where ECB assets are defined in growth. The third column shows results of estimations where liquidity ratio is squared. In the case of fourth column variable of interest is defined as the sum of ECB's lending to credit institutions and securities held. The dependent variable in all regressions is liquidity ratio or liquidity ratio squared. Estimations are based on the model presented in methodology section for second hypothesis (2). Time dummies are not included in the second hypothesis estimation. Statistical significance is measured with t-test, which is reported under the coefficients. ***, **, * represent significance at 1, 5, and 10 percent significance levels respectively.

Dependant variable:	ratio	*ratio^2*	**ratio**
ECB asset growth(t)			
ECB assets(t)	0.00004*	*0.00947***	**0.08657*** **
ECB lending and securities(t)	(1.85)	*(4.62)*	**(4.15)**
Liabilities-deposits(t-1)	-0.00000	*-0.00000*	**-0.00001***
	(-1.11)	*(-0.81)*	**(-1.69)**
Tier 1 ratio(t-1)	0.00074**	*0.00003*	**0.00053***
	(2.37)	*(0.97)*	**(1.71)**
Deposit growth(t-1)	0.01107*	*0.00091*	**0.01263** **
	(1.84)	*(1.36)*	**(2.12)**
Loan loss reserve(t-1)	0.09364**	*0.00916***	**0.06299**
	(2.31)	*(2.01)*	**(1.56)**
Loan growth(t-1)	-0.18456	*-0.00540*	**-0.15494**
	(-1.11)	*(-0.29)*	**(-0.95)**
Profitability(t-1)	0.13725	*0.02997***	**0.23958***
	(1.06)	*(2.07)*	**(1.86)**
Time dummies	NO	*NO*	**NO**
Observations	677	*677*	**677**
R-squared	0.05	*0.07*	**0.07**

Reference list

Bowman, D., Cai, F., Davies, S. & Kamin, S., 2015. Quantitative easing and bank lending: evidence from Japan. *Journal of International money and finance* 57, 15-30.

Carpenter, S., Demiralp, S. & Eisenschmidt, J., 2013. The effectiveness of the non-standard policy measures during the financial crisis. ECB working paper series. European central bank.

Casiraghi, M., Gaiotti, E., Rodano, L. & Alessandro, S., 2013. The impact of unconventional monetary policy on the Italian economy during the sovereign debt crisis. *Questioni di economia e finanza*. Bank of Italy.

Ciccarelli, M., Maddaloni, A. & Peydro, J.-L., 2015. Trusting the bankers: a new look at the credit channel of monetary policy. *Review of economic dynamics* 18(4), 979-1002.

Creel, J., Hubert, P. & Viennot, M., 2016. The effects of ECB monetary policies on interest rates and volumes. *Applied economics* 4, 1-25.

Darracq-Paries, M. & De Santis, R., 2015. A non-standard monetary policy shock: the ECB's 3-year LTROs and the shift in credit supply. *Journal of International money and finance* 54, 1-34.

European Central Bank, 2016. ECB: Monetary policy: Instruments: Asset purchase programmes (web page). Available at: https://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html . Accessed: 12.7.2016.

Fratzscher, M., Lo Duca, M. & Straub, R., 2013. On the international spillovers of US quantitative easing. ECB working paper series. European central bank.

Fratzscher, M., Lo Duca, M. & Straub, R., 2016. ECB unconventional monetary policy: market impact and international spillovers. *IMF economic review* 64(1), 36-74.

Gambacorta, L., Hofmann, B. & Peersman, G., 2014. The effectiveness of unconventional monetary policy at the zero lower bound: a cross-country analysis. *Journal of money, credit and banking* 46(4), 615-642.

Gambacorta, L. & Marques-Ibanez, D., 2011. The bank lending channel: lessons from the crisis. *Economic policy* 26(66), 135-182.

Lenza, M., Pill, H. & Reichlin, L., 2010. Monetary policy in exceptional times. *Economic policy* 25(62), 295-339.

Peersman, G., 2011. Macroeconomic effects of unconventional monetary policy in the euro area. ECB working paper series. European central bank.

Rogers, H. J., Chiara, S. & Wright, J., 2014. Evaluating asset-market effects of unconventional monetary policy: a multi-country review. *Economic policy* 29(80), 749-799.

Roodman, D., 2009. An introduction to "difference" and "system" GMM in Stata. *The Stata journal* 9(1), 86-136.

Szczerbowicz, U., 2015. The ECB unconventional monetary policies: have they lowered market borrowing costs for banks and governments?. *International journal of central banking* 11(4), 91-127.