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Abstract

The paper examines the bank lending activities of banks in a low interest rate environ-ment. External financing of small- and medium-sized enterprises in the euro area primari-ly takes place via bank loans and not through capital markets. Based on the Bankscope database, bank balance sheet data is utilized. Control variables are included, such as for the system of banking regulation. The panel estimation includes 706 banks from 15 Euro area member states and is conducted for the period 2000 to 2015. All models show a significant positive impact of lower interest rates on net lending. In particular, the results do not indicate that credit is restricted if interest rates move towards the zero-lower bound.

JEL-Classification: E44, E51, E52

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Did interest rates at the zero lower bound affect lending of commercial banks? Evidence for the Euro area

by

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Abstract

The paper examines the bank lending activities of banks in a low interest rate environment. External financing of small- and medium-sized enterprises in the euro area primarily takes place via bank loans and not through capital markets. Based on the Bankscope database, bank balance sheet data is utilized. Control variables are included, such as for the system of banking regulation. The panel estimation includes 706 banks from 15 Euro area member states and is conducted for the period 2000 to 2015. All models show a significant positive impact of lower interest rates on net lending. In particular, the results do not indicate that credit is restricted if interest rates move towards the zero-lower bound.

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1 Introduction

The paper investigates the bank lending activities of banks under the conditions of a low interest rate environment. External financing of small- and medium-sized enterprises in the euro area primarily takes place via bank loans and not through capital markets. Evidence from micro-data shows that regional loan activity may drive regional growth (Belke, Haskamp and Setzer, 2016). To assess the effects of the low interest rate environment on credit in the Euro area, Bankscope balance sheet data is used at the level of individual banks. Several variables are included as controls, such as banking regulation. These provisions may have influenced the response of credit.

The credit channel of monetary policy describes how monetary policy affects the amount of credit that banks issue to firms and consumers, which in turn can influence the real economy (Kashyap and Stein, 1990). This channel is particularly relevant for the Euro area, where loans from banks represent the dominant source of external financing instead of stocks and other capital markets (Belke, Haskamp and Setzer, 2016, Levine, 2005).

Recently, the transmission might have been impaired due to policy measures. Several authors have argued that the pass-through of monetary policy is less effective if policy rates are set close to the zero-lower bound over long periods. One indication for this claim is that money demand is still in line with its macroeconomic fundamentals like income and opportunity costs of money holdings, despite the recent boost of liquidity (Dreger and Wolters, 2015). The money multipliers declined, probably due to subdued lending behaviour of financial institutions.

On the one hand, low policy interest rates can improve the macroeconomic conditions. The profits of banks are expected to increase via lower funding costs and better creditworthiness of borrowers, such as households and firms. Furthermore, the huge asset purchasing programs contributed to a consolidation of the balances of banks in financial distress and stimulated lending over some time (Darmouni and Rodnyansky, 2017). On the other hand, adverse effects may arise due to the compression of net interest income. Unconventional monetary policy measures led to an unprecedented decline of long-term interest rates, as documented by a flatter yield curve (Altavilla, Carboni and Motto, 2016, Weale and Wieladek, 2016). Normal banking activities became less profitable, as the returns from maturity transformation activities decreased. According to Altavilla, Boucinha and Peydro (2017), lower loan loss provisions and higher non-interest income can offset the decline of net interest income. Adverse effects can materialize only after a rather long period of time has passed, but they are counterbalanced by better macroeconomic conditions associated with low policy rates.

Borio, Gambacorta and Hofmann (2017) investigated the relationship between the level of short-term rates and the slope of the yield curve, on the one hand, and the main components of bank income, i.e. net interest income, non-interest income and loan provisions. In an environment of persistent low interest rates and declining term premiums, the compression in net interest income offsets potential gains from the other components, implying that the profitability of banks will likely decrease.

Based on a sample of German banks, Busch and Memmel (2017) stress that unconventional policy measures led to a reduction of interest margins for term deposits. According to Altunbas, Gambacorta and Marqués (2014) prolonged low interest rates can contribute to higher bank risk, as a higher frequency of default is expected. Valuations, net bank income and cash flows fall and a more intensive search process for higher yields would be required. At the end, monetary policy can undermine the financial stability of banks. Altunbas, Gambacorta and Marqués (2014) proxy the monetary policy stance by the deviation of the real policy rate (money-market rate less CPI inflation) from its natural level, the latter calculated by means of the Hodrick-Prescott filter.

If the policy rates approach the zero-lower bound, the capacity of monetary policy to influence banking loans loses momentum and seems to be completely ineffective below certain thresholds of the policy rate (Apergis and Christou, 2015). Similarly, Borio and Gambacorta (2017) emphasize that monetary policy becomes less effective if interest rates decrease towards lower bounds. Moreover, nonlinearities are present in the relationship. While the impact of the short-term rate on bank lending is negative, the interaction term, i.e. the product of a monetary policy indicator (3-month money market rate, respectively) and a dummy representing the low interest rate regime is positively signed, implying that lending growth is falling below the linear benchmark.

The former results may however be plagued by a simultaneity bias. As a rule, contemporaneous indicators for monetary policy enter the regressions, but they are influenced by the current and expected macroeconomic and financial conditions. While periods of low interest rates may coincide with a weaker profitability of banks, a causal relationship is not established.

Beyond that, several other factors can have a critical impact on the results. To derive robust evidence, the heterogeneity of the financial sector should be considered. Large banks tend to have a greater ability to manage interest rate risk by using derivatives. Due to their international presence, they may have more potential to raise lending abroad. Better diversified business models can allow them to expand non-interest income more easily to compensate for the effect of lower interest margins (Cetorelli and Goldberg, 2012).

The regulatory environment is also important. Policymakers have long been investigating the drivers which have the potential to change banks' lending behaviour and the role these play in affecting the economy on a more general level. The large body of literature reviewing the 'bank lending channel' for the effects of monetary policy on the volume of credit in the economy is but one strand of research reflecting this widespread interest (Bernanke and Gertler, 1995, Thakor, 1996, and Kashyap and Stein, 1995, 2000). The effect of regulation on lending behaviour has also received a lot of attention, above all in response to the adoption of the Basel risk-based capital standards in the early 1990's (Berger and Udell, 1994, Hancock and Wilcox, 1994, and Peek and Rosengren 1995).

While tighter standards may produce significant benefits such as greater financial stability and a lower probability of crisis events and may thus lead to higher lending, they may also have costs in terms of reduced loan supply (Francis and Osborne, 2009). Banks with weaker core capital positions, greater dependence on market funding and non-interest income might have restricted credit supply more severely (Gambacorta and Marques-Ibanez, 2011). Similarly, Kosak, Li, Loncarski and Marinc (2015) pointed out that the availability of high-quality bank capital (Tier 1 capital and retail deposits) affected bank lending during the financial crisis.

Following Altavilla, Canova and Ciccarelli, 2016), bank balance sheet characteristics like capital ratios and the exposure to sovereign debt are crucial for the heterogeneity of the monetary policy pass-through. The introduction of bank levies to internalize future financial risks had moderate net effects on lending, see Haskamp (2018) for some German evidence. While banks subject to the levy (systemically relevant banks) cut loan growth, local competitors (savings and cooperative banks) increased credit supply. On the aggregate, the response of credit to tighter regulation standards might be even positive. Although stricter rules may lead to a fall in lending, the default risk of credit positions can be lower.

In this paper, we investigate the impact of the low interest rate environment on the lending behaviour of individual banks. The results are based on a huge cross section of banks in the Euro area obtained from the Bankscope file. Annual balance sheet information is available for 706 banks over the 2000 to 2015 period. Furthermore, we control for the changes in banking regulation. Instead of the usual practice of including country and time fixed effects, the regulatory indicators reported by Barth, Caprio and Levine (2013) are considered. In principle, this strategy is superior, since fixed effects could also refer to elements independent of regulation.

Our paper comes up with some clear-cut results. All our estimations confirm a significant positive effect of lowering interest rates on the net lending behaviour of banks. Hence, the

interest rate channel of monetary transmission seems to have worked throughout the estimation period. According to the negative sign, this result can be interpreted in terms of the dominance of a (negative) credit demand over a (positive) credit supply effect. Low interest rates did not change the lending activity of banks in the whole sample. In contrast, savings banks appear to generally increase their net lending. In other words, demand for credit from savings banks increased more than proportionally during the low interest rate period.

What is more, the provisions of the Basel III banking regulation do not influence the credit behaviour of Euro area banks. However, if we focus only on savings banks, tighter banking regulation seems to have even increased bank lending activity.

The remainder of the paper is organized as follows. Section 2 provides a brief review of the regulatory changes implemented by the different Basel accords. The data and the empirical model description, including the choice of the monetary policy instruments, are outlined in Section 3. Empirical evidence based on panel regression models is presented in Section 4. Section 5 presents and discusses the empirical results. Section 5 finally concludes.

2 Banking regulation standards

Lending decisions of banks are heavily influenced by the institutional environment, especially by the prevailing system of financial regulation. Over the recent decades, the Basel Committee of Banking Supervision has developed different standards for the prudential regulation of banks with the aim to improve financial stability. In the event of defaulting loans and insufficient capital, banks can get into financial distress. Due to the close interconnectedness of the financial sector, this can pose a serious threat to the entire banking system. Therefore, the Basel I regulations (1988) introduced a minimum capital requirement of 8 percent relative to the total loan amount. Equity included share capital, supplementary capital (subordinated debt and loan loss provisions) and third-party funds.

The introduction of new financial instruments such as derivatives and deficiencies in the supervision of credit risk led to the three-pillar-approach outlined in the Basel II framework (2004). Basel II reformed the minimum capital requirements with respect to credit, market and operational risks (Deutsche Bundesbank, 2001). Moreover, the regulation introduced a review process of banking supervision, and expanded bank disclosure practices. The conditions also changed for borrowers. Banks are urged to apply tighter credit checks and rating systems. Borrowers who do not get loans from one bank tend to have worse chances to obtain loans from other banks.

Since the outbreak of the global financial crisis (2007/08), many banks had to be rescued from bankruptcy with the help of government funding. To aggravate speculative asset trading with potentially adverse effects on the real economy, the financial sector has become more regulated under the Basel III accord (Deutsche Bundesbank, 2018). The rules strengthen microprudential regulation to raise the resilience of individual banks in periods of stress. The focus is on capital adequacy and liquidity standards. Basel III also has a macroprudential dimension to address system-wide risks and their pro-cyclical amplification.

Higher shares of capital to risk-weighted assets have been introduced. If capital ratios fall below minimum levels, the banking supervisory authority is required to launch countermeasures. For instance, the quota of core capital (tier 1 capital) increased from 4 to 6 percent. The tier 1 ratio determines the extent to which the bank must cover risks by common equity. Basel III also stipulates that banks hold a capital conservation buffer of 2.5 percent of their risk weighted assets. If the value falls below, the bank needs to cut its dividend payments to comply the targets.

In addition, the so-called anti-cyclical buffer should provide further protection at the national level. It is directed to the reserves that banks should invest in periods of strong credit growth. Other components of the framework include leverage ratios and rules for liquidity coverage. Basically, the Basel III framework is intended to provide a comprehensive protection mechanism based on several buffers, which might provide more security in times of crisis and makes government support for banks superfluous. The regulation should ensure that taxpayers do not have to pay for bank bailouts in times of crisis.

According to the Macroeconomic Assessment Group (2010) of the Basel Committee and the OECD (2011) the regulation will reduce GDP growth over the medium-term horizon, where the losses fall between 0.1 and 0.2 percentage points per year. Production is mainly affected by an increase in the bank lending spreads. Because of the decline in GDP growth, the impact on bank lending could be also negative. Due to stricter regulatory requirements, banks pass a rise in funding costs to their customers via higher lending rates. The estimated effects assume no active response of monetary policy. To the extent that monetary policy would no longer be constrained by the zero-lower bound, the Basel III impact on economic output could be offset by a reduction in policy rates. Benefits arising from lower output volatility and the likely reduction of financial risk are however not covered by our analysis.

After the Basel III agreement in December 2010, the regulation has been adopted by European law through the capital requirements regulation. This amendment is still needed to be implemented by national law.

3 Empirical analysis

3.1 Data

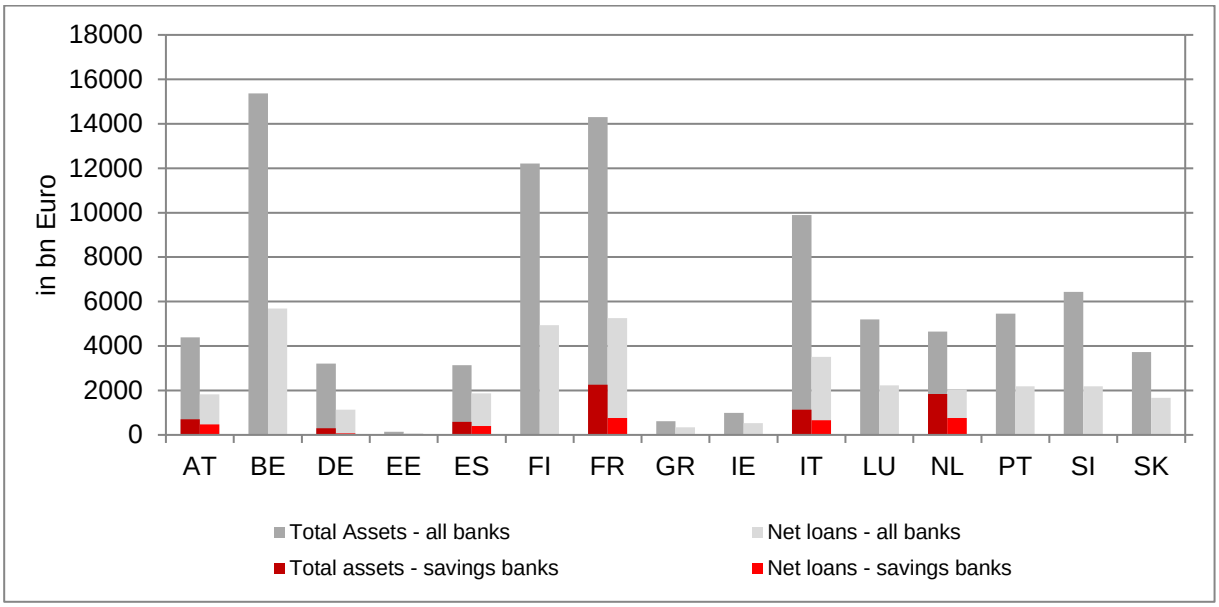
For our analysis we use bank-level data from Bankscope, a source containing detailed financial information about public and private banks. Our sample covers banks in Euro area countries in the period from 2000 to 2015, thus including the financial crisis and government debt crisis in Europe. The data frequency is annual, and data are used on a consolidated balance sheet level, thus not accounting for any intra-group liabilities.

We only use active banks which still reported to Bankscope in 2015. For our analysis, we only retained banks belonging to one of the following groups: bank holdings and holding companies, commercial banks, finance companies, private banking and asset management companies, real estate and mortgage banks, cooperative banks and savings banks. A few outliers have been removed, such as banks with negative net loans. The focus on active banks reduces the number of cross sections from 706 to 486.

The data set is highly unbalanced, with several observations missing. However, we feel legitimised to assume that these observations are not included for various independent reasons (e.g. submission errors, reporting issues etc.). Therefore, there is no systematic bias the results of our analysis.

Figure 1 gives a broad overview of the banks in our dataset, separated by countries. From the 485 active banks in our sample 105 are savings banks. The average total assets and net loans per country are exhibited, both for the sample of all banks and savings banks. Given the number of banks, most banks are located in France, followed by Italy, Germany, Austria, Spain and the Netherlands. Similarly, the largest sample of savings banks is in France, followed by Italy and Germany. Given the relatively smaller number of active banks in Belgium and Finland, those banks have larger total assets and net loans, compared to France or Germany.

Figure 1: Data overview by country



Country	AT	BE	DE	EE	ES	FI	FR	GR	IE	IT	LU	NL	PT	SI	SK
Number of banks	39	21*	53*	4	41*	14*	130*	7*	12*	75*	17*	36*	19*	9	8
Number of savings banks	8	1	10	0	4	1*	58	0	0	18	1	2	1	1	0

*Less banks reporting net loans. This means that, for instance, 21 Belgian banks report their total assets whereas less banks report their net loans.

Source: Own representation. Bankscope.

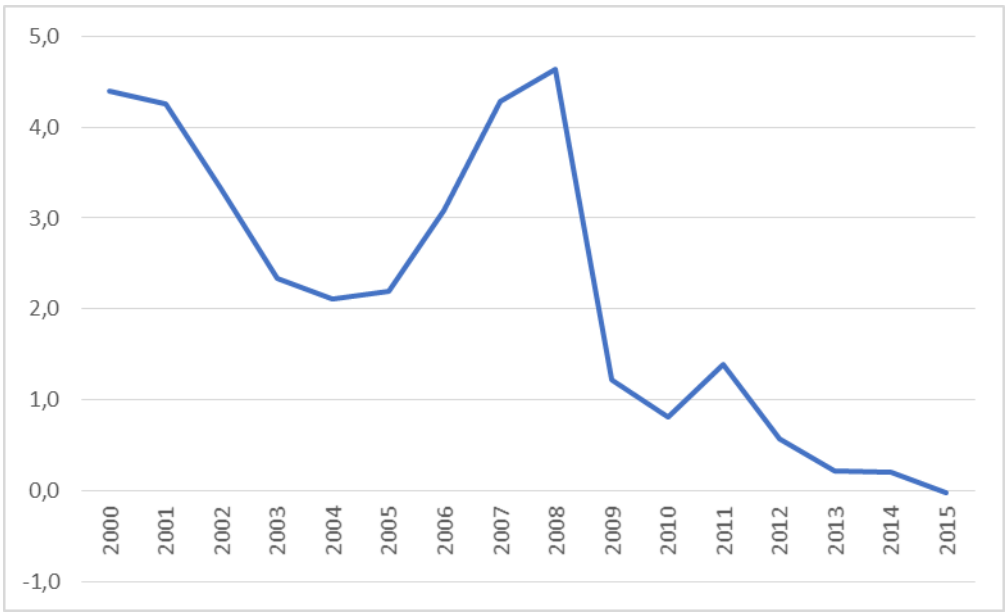
Furthermore, we control for the changes in banking regulation according to the indicators of Barth, Caprio and Levine (2013). In the analysis presented below, they are labelled as BCL indicators. In principle, this strategy is superior, since fixed effects could also refer to elements not related to regulation. Information on these regulatory indicators is based on banking surveys conducted by the World Bank. Among others, capital requirements, the powers of national supervisory agencies, information disclosure practices, external governance mechanisms, deposit insurance, barriers to entry and loan provisioning are reported. Four banking surveys on regulation are available (1999, 2003, 2007 and 2011).

While numerous indicators are reported, they are often highly correlated. In the empirical analysis the summary indicator of capital stringency is selected. It measures to which extent the capital requirements reflect certain risk bearing elements. The index ranges from 0 to 7, where higher values point to a stricter regulation. The index is reported at an ordinal scale, and values between the years of the surveys are interpolated. For the period beyond 2011, the index is extended, depending on whether regulation has become tighter or not. This is done with the help of regulatory experts from the Bundesbank. Since this index is ordinal scaled variable and its availability is limited the period until 2011, we feel legitimized to argue that it is only the change of the variable which is relevant and an assessment by experts is sufficient here.

We interpolate linearly between the four data points in which the survey was conducted to gain continuous series. What is more, we extend the series, assuming that the capital stringency increased until 2015 due to the announcement and implementation of Basel III, by increasing the value for all countries by two index points. We are aware of the possible criticism that this might seem arbitrary. However, the index is of ordinal scale, thus not being directly comparable between countries quantitatively and not measuring the exact increase or decrease of capital stringency between years, but only offering a tendency whether the regulation has become more restrictive or not.

The monetary policy instrument which is in the focus of our study is proxied by the short-term interest rate, i.e. the three-month Euribor taken from the Federal Reserve Economic Data of St. Louis Fed (FRED). Its pattern over time is displayed in Figure 2. The Euribor drops sharply in 2009, drops even more from 2012 on (after a brief recovery in 2011) and reaches the zero-lower bound at the end of our sample period, in 2015.

Figure 2: Euro area short-term interest rate (Euribor)

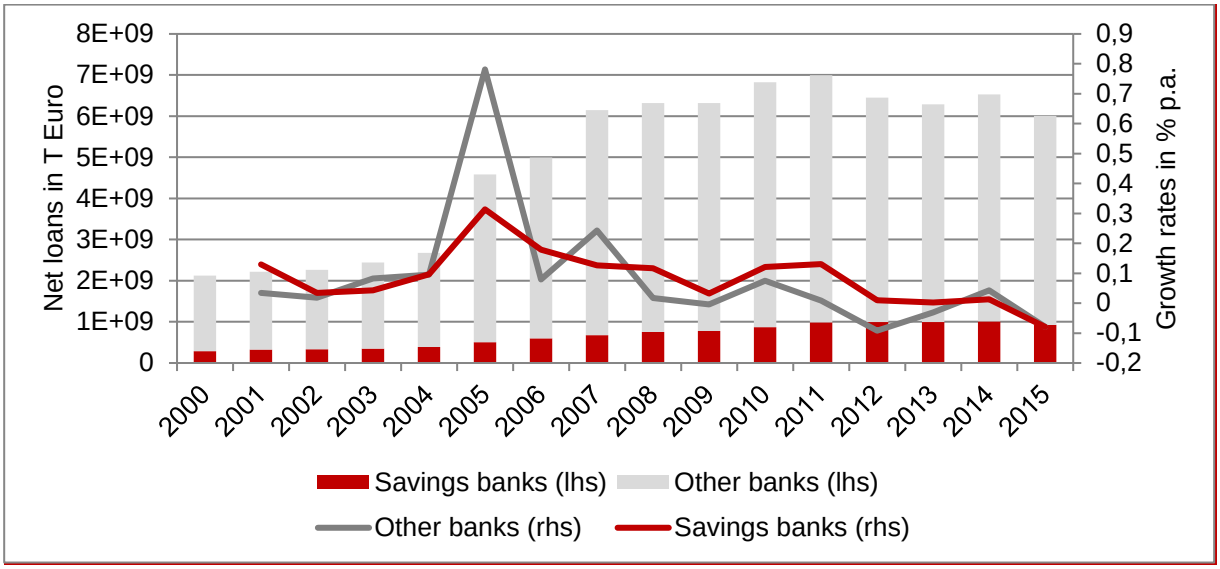


Source: Federal Reserve Economic Data of St. Louis Fed (FRED).

We finally augment our data set by including some macroeconomic variables, such as gross domestic product (GDP) and house prices. GDP is expressed in real terms. Data for GDP is taken from the FRED database. The house price index stems from the European Central Bank Statistical Data Warehouse (ECB SDW) and is only available from 2001 onwards.

Figure 3 displays the development of net loans starting in 2000 until 2015. Before the financial crisis in 2007, especially in 2005, growth rates of net loans accelerated. However, after 2007 they decreased significantly below pre-crisis level.

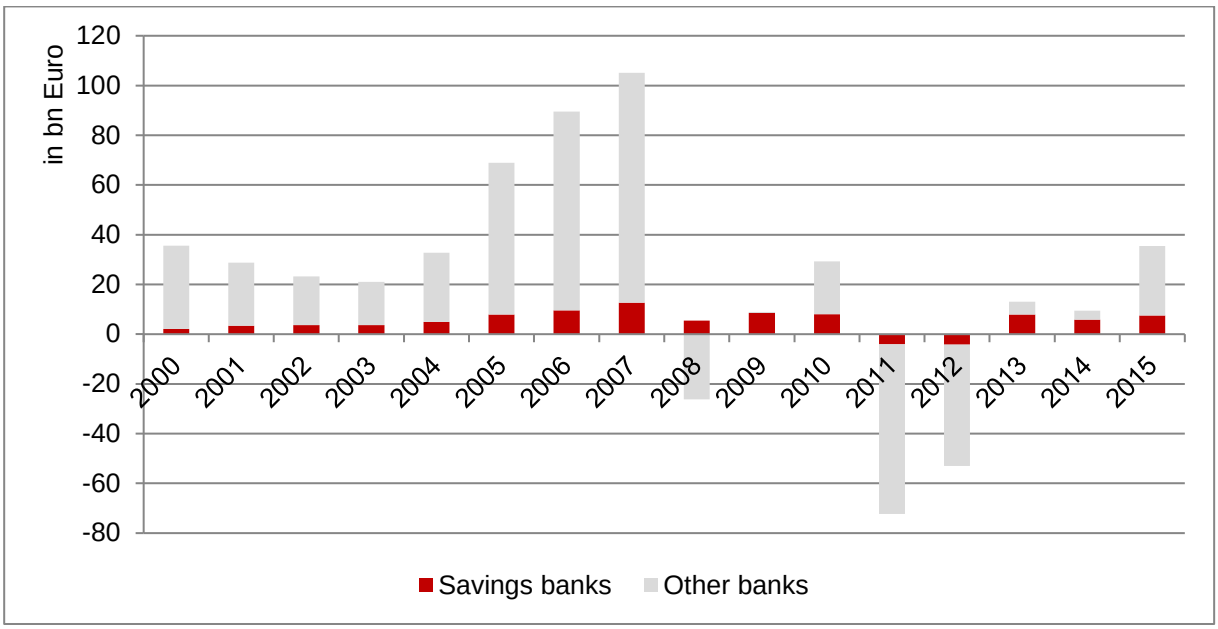
Figure 3: Net loans over 2000-2015



Source: Own presentation, Bankscope.

Figure 4 displays the development of the net income for the banks in the sample. Although the savings banks cover only a small part of the sample, as shown in Figure 1 measured by the fraction of total balance sheet size, the net income for this banking group was significantly more stable and did not undergo similar huge losses as for the whole sample. Especially since 2013, the fraction of total net income generated by the savings banks in our sample increased remarkably.

Figure 4: Banks' net income 2000-2015



Source: Own presentation, Bankscope.

In the analysis, the macroeconomic indicators and the bank-specific controls are lagged by one year to mitigate endogeneity problems. For the short-term policy rate, an instrument approach is conducted, where the interest rate is regressed on the one period lagged rate and lagged values of the other macroeconomic indicators.

3.2 The econometric model

We investigate whether there is a distinct effect of the short-term interest rates on bank lending which is specific for the low-interest rate environment. As a reference model, we first estimate a standard linear lending regression using the bank-level data in a panel structure, as presented in equation (1). In contrast to Borio et al. (2017) we use level data. Unit root tests may indicate that some of our series are integrated of order one.

Thus, the question arises whether one should take differences of the variables to eliminate the stochastic trend. Firstly, our panel has a very low time series dimension compared to the cross-section which in itself speaks again to attach too much importance to the order of integration of the included variables. Secondly, Sims et al. (1990) show that Ordinary Least Squares estimates of coefficients in linear time series models with some unit roots are consistent under a broad range of circumstances even if the variables are nonstationary. Therefore, we strictly follow this approach and estimate our empirical model in levels (see also Belke, Orth and Setzer, 2010, and Hamilton, 1994, pp. 553, 652).

$\ln(net\ loans)_{ijt} = \alpha_{jt} + \beta r_{ijt} + \delta Y_{ijt-1} + \rho X_{ijt-1} + \varepsilon_{ijt}$	(1)

The linear panel regression explains the dependent variable $\ln(net\ loans)_{ijt}$, the annual net loans in period *t* of bank *i* in country *j*, by the interest rate r_{ijt} and some control variables. The vector *Y* includes macroeconomic indicators and controls for loan demand. Especially, we include real GDP and house prices as controls. Furthermore, we include a vector *X* with bank-specific characteristics, which might influence the supply of loans, such as the total assets and the leverage ratio, defined as the ratio of equity to total assets. Additionally, we include country-specific fixed effects *α* to capture unobserved heterogeneity at the country level.

As an extension to Borio et al (2017) we explicitly model the change in the regulatory environment by the implementation of the Basel guidelines. For this purpose, we include the country-specific capital stringency indicator of Barth, Caprio and Levine (2011). While tighter

standards may produce significant benefits such as greater financial stability and a lower probability of crisis events and may thus lead to higher lending, they may also have costs in terms of reduced loan supply (Francis and Osborne, 2009). Hence, we do not have any prior concerning the sign of the estimated coefficient of the regulation indicator. The so called BCL indicator varies between banks by country and year. This yields the following modification of the first regression as displayed in equation (2).

$$\ln(net\ loans)_{ijt} = \alpha_{jt} + \beta r_{ijt} + \delta Y_{ijt-1} + \rho X_{ijt-1} + \theta BCL_{ijt} + \varepsilon_{ijt}$$	(2)

Since we want to test for a distinct effect on lending in the low-interest rate environment, we additionally include an interaction term and therefore modify equation (1). The interaction term is modelled as the product of the short-term interest rate r_{ijt} and a dummy for the low interest rate environment D_{ijt}, where:

$$\begin{cases} D_{ijt} = 1, & if\ r_{ijt} \leq 1.25\% \\ D_{ijt} = 0, & else. \end{cases}$$

In addition, we include the dummy D_{ijt} used in the interaction term separately l. This can account for a shift in the loan activity independently from the other regressors. Furthermore, the inclusion can be justified for econometric reasons. This is because a regression model with a higher-order term (the interaction) is generally misspecified if the component lower-order terms (the main effects) are not included (Belke and Potrafke, 2012, Friedrich, 1982, Jaccard and Turrisi, 2003). By proceeding this way we differ from Borio et al. (2017) who did not include the dummy variable separately, although used in the interaction term. Thus, the estimation equation runs as follows:

$$\ln(net\ loans)_{ijt} = \alpha_{jt} + \beta r_{ijt} + \gamma r_{ijt} * D_{ijt} + \sigma D_{ijt} + \delta Y_{ijt-1} + \rho X_{ijt-1} + \varepsilon_{ijt}$$	(3)

If the regulatory environment is explicitly incorporated as well, the estimation takes the following form:

$$\ln(net\ loans)_{ijt} = \alpha_{jt} + \beta r_{ijt} + \gamma r_{ijt} * D_{ijt} + \sigma D_{ijt} + \delta Y_{ijt-1} + \rho X_{ijt-1} + \theta BCL_{ijt} + \varepsilon_{ijt}$$	(4)

Using an exogenous threshold of 1.25 percent for the dummy of the low-interest rate environment in our estimations, we follow Borio et al. (2017) and Claessens et al. (2016). However, we are aware that the exogenous selection of the value is somewhat arbitrarily.

Therefore, we conduct a grid-search using different exogenous thresholds for the interaction term, ranging from 1.0 to 1.5 percent, and minimize the sum of squared residuals as the relevant selection criteria. The changes in the identified thresholds for our dummy variables and thus also the interaction term variables are marginal which seems to be mainly due to our short time series. Hence, we feel legitimised to proceed like Borio et al. (2017) and Claessens et al. (2016) and set the exogenous threshold at a value of 1.25.

According to economic theory, we expect the estimated coefficient β for the short-term interest rate to be negative, indicating that a reduction in the interest rate stimulates lending by banks in the Euro area. Note that a negative sign will indicate the dominance of a demand effect, i.e. borrowers lend more in case of declining financing costs. From the perspective of individual banks, a positive sign should be expected, as higher interest rates indicate a rise in profits. The coefficient γ is of special interest in the context of testing our main hypothesis that in a low interest rate environment lending expansion is less effective, implying a positive sign of the coefficient. In that case, bank lending would be less than under the conditions of the linear model.

Although the control variables are not of special interest in the analysis, the sign of their estimated coefficients needs to comply with economic theory as well. We expect the estimated coefficient of real GDP to be positive, since a prospering economy should stimulate investment and loan demand. The estimated coefficient of the house price index is expected to be positive as well, since growing property prices – also a sign of a prospering economy – might foster loan demand.

Both bank-specific variables should have a positive estimated coefficient as well, since larger and better leveraged banks should have more financial possibilities to extend their loan supply if it meets an increasing demand. The estimated coefficient of the BCL index should be negative, if stricter regulation, especially regarding capital requirements, limits the financial scope of banks to extend their loans. On the other hand, the quality of credit will increase, implying a lower probability of default and a positive sign.

4 Estimation results

As a first step, we estimate a benchmark regression, modelled as a pooled OLS regression for both the linear model and the model including the interaction term. The estimated coefficient of the policy variable, the interbank rate, turns out to be negative and significant in the linear equation. The estimated coefficient of the interbank rate is negative and significant in the second benchmark specification as well and the coefficient of the interaction term turns out to be negative, although not significant. This result holds for both the sample including

all banks and the sample only including savings banks. Hence, we feel legitimised to argue that our findings from the upcoming panel regressions are not solely driven by the choice of controls.

Let us now turn to the estimation results for the whole available sample of banks (Table 2). The estimation of specification (I) confirms the negative effect of increasing interest rates on the net lending behaviour of banks. The estimated effect is compatible with the dominance of the credit demand effect and statistically significant.

The estimated coefficients of the control variables display the theoretically expected signs as well. Higher total assets ceteris paribus raise net lending. What is more, a prospering economy, modelled by increasing house prices in the corresponding country of the bank, increases net lending by banks. Including additional control variables as in equation (II) confirms these results. The effect of the policy rate is still negative and significant.

In specification (III) we extend the linear panel regression by including the BCL index which controls explicitly for changes in the regulatory environment and thus in the lending behaviour due to the Basel regulation standards. If statistically significant, a negative sign of the estimated BCL coefficient would imply that a stricter regulatory environment, increasing e.g. capital requirements for exposures, limits lending of banks. However, in our case the estimated BCL coefficient turns out to be insignificant. We thus feel legitimised to argue that stricter regulation has not hampered lending, if all banks in our sample are considered.

Specifications (IV) and (V) include the interaction term to control for a distinct effect of interest rates in a low interest rate environment as we have experienced in the Euro area since the financial crisis. Here, we would have been able to confirm the main findings of Borio et al. (2017) if the estimated coefficient of the interaction term is significant and displays a positive sign, which could reduce the positive effect of lowering policy rates on bank lending if interest rates are below a certain threshold. In his case, the effect would remain positive, but to a smaller extent, indicating a lower effectiveness of the interest rate channel of monetary policy transmission.

A negative sign of the significant coefficient of the dummy, which is included separately in the estimation, could be interpreted as a shift in the lending behaviour specific for the low interest rate period. It would show that in the low interest rate environment, lending is (independent on higher bank regulation) restricted even more, and, given this restricted lending, each additional decrease in the interbank rate has a smaller stimulating effect on lending than outside the low interest environment.

However, both the interaction term and the dummy are not statistically significant in our estimations. Therefore, we would like to argue that the results found by Borio et al. (2017),

based on internationally (i.e. beyond the Euro area) active banks from 1995 to 2014, may not be valid for other country samples (here: only Euro area) and sample periods. Extending the nonlinear estimation by an explicit incorporation of the regulation index, we again obtain evidence that stricter capital requirements decrease the lending by banks, although still statistically insignificant. Again, like in specification (III), there is evidence that stricter regulation has not hampered lending activities of banks.

In general, it should be mentioned that the lack of statistical significance can be a result of the short sample and little variance over time of the variables under investigation.

Table 1: Regression results for all active banks

	Dependent variable: $\ln(Net\ loans)_{ijt}$				
Explanatory variables	Equation (1) (I)	Equation (1) (II)	Equation (2) (III)	Equation (3) (IV)	Equation (4) (V)
$Interest\ rate_{ijt}$	-0.0211***	-0.0217***	-0.0256***	-0.0353***	-0.0370***
	(0.0062)	(0.0063)	(0.0072)	(0.0114)	(0.0114)
$Interaction\ term_{ijt}$				0.0151	0.0007
				(0.0289)	(0.0332)
$Dummy\ (D_{ijt})$				-0.0619	-0.0540
				(0.0440)	(0.0457)
$\ln(Total\ assets_{ijt-1})$	0.5697***	0.5326***	0.5336	0.5338***	0.5290***
	(0.0133)	(0.0144)	(0.0144)	(0.0144)	(0.0143)
$\text{Leverage ratio}_{ijt-1}$		-0.0139***	-0.0139	-0.0139***	-0.0139***
		(0.0012)	(0.0012)	(0.0012)	(0.0012)
$\ln(Gdp_{ijt-1})$		-0.0944***	-0.0935***	-0.0914***	
		(0.0335)	(0.0335)	(0.0336)	
$\ln(House\ price\ index_{ijt-1})$	0.2790***	0.3977***	0.4166***	0.4300***	0.4098***
	(0.0511)	(0.0538)	(0.0565)	(0.0586)	(0.0599)
BCL_{ijt}			-0.0088		-0.0079
			(0.0080)		(0.0092)
Constant	yes	yes	yes	yes	yes
Year FE	no	no	no	no	no
Country FE	yes	yes	yes	yes	yes
Observations	4403	4354	4354	4354	4403
Overall R^2	0.7691	0.7656	0.7656	0.766	0.7651

*** p<0.01, ** p<0.05, * p<0.1.
A higher overall R^2indicates a better fit of the model.

A separate analysis for the group of savings banks can shed some light on the question whether savings banks have been confronted with the same lending constraints, given the fact that their funding structure and customer relationship might be different. The respective results are displayed in Table 3.

Some of the results differ from those obtained for the full bank sample displayed in Table 2. According to our linear panel estimations (I) and (II), the estimated coefficient of the interest

rate again turns out to be negative, thus confirming that credit demand dominates the credit supply effect. However, the quantitative effect turns out to be even larger than for the sample including all banks. Consequently, it can well be argued that savings banks increase their lending more strongly (i.e. react more strongly to increasing credit demand) when interest rates decrease than other banks.

This pattern is compatible with the results reported by Ferri, Kalmi and Kerola (2014) that savings banks did not smooth the impact of monetary policy on their lending during the crisis period (2008-2011) as much as, for instance, cooperative banks. The effect turns out to be statistically significant. Our empirical results for the control variables do not differ substantially from those for the whole sample.

What is more, the estimated coefficient of total assets is positive, and the coefficient of the house price index is positive and of larger size than for the whole sample. This could be an indication of significance of the household wealth channel (Albacete and Lindner, 2017, and Paiella, 2009), which may be more important for savings banks with private customers than for those commercial banks who involve more in interbank trading, corporate financing and asset management.

The coefficient of the BCL index is positive and statistically significant. This implies that stricter capital requirements due to Basel III increase the lending of savings banks. This result might be influenced by the small sample of savings banks and a delayed implementation of the regulatory changes in the internal risk approaches.

The most important deviation from the results gained for all banks can, however, be found regarding the estimations (IV) and (V) including the interaction term, i.e. the product of the short-term interest rate r_{ijt} and a dummy for the low interest rate environment D_{ijt},. The estimated coefficients of the interest rate and the interaction term turn out to be significant and negative whereas the estimated coefficient of the isolated dummy variable for the low interest rate environment is significant and positive.

This empirical pattern leads us to conclude that, in the low interest rate environment, savings banks generally increase their net lending and, additionally to the positive shift in the level of lending, they react stronger to further interest rate changes than outside the low interest rate environment. According to our estimation of specification (IV), the effect is even statistically significant. However, the findings should be taken with caution given the limited sample of banks included in the estimation of savings banks.

Table 2: Regression results for all active savings banks

	Dependent variable: $\ln(Net\ loans)_{ijt}$				
Explanatory variables	Equation (1) (I)	Equation (1) (II)	Equation (2) (III)	Equation (3) (IV)	Equation (4) (V)
$Interest\ rate_{ijt}$	-0.0792***	-0.0834***	-0.0707***	-0.0713***	-0.0691***
	(0.0056)	(0.0055)	(0.0064)	(0.0099)	(0.0101)
$Interaction\ term_{ijt}$				-0.0893***	-0.0450
				(0.0252)	(0.0312)
$Dummy\ (D_{ijt})$				0.0718*	0.0290
				(0.0393)	(0.0425)
$\ln(Total\ assets_{ijt-1})$	0.2104***	0.1718***	0.1592***	0.1636***	0.1674***
	(0.0191)	(0.0195)	(0.0195)	(0.0197)	(0.0198)
$\text{Leverage ratio}_{ijt-1}$		-0.0276***	-0.0281***	-0.0275***	-0.0279***
		(0.0040)	(0.0039)	(0.0040)	(0.0040)
$\ln(Gdp_{ijt-1})$		-0.1119**		-0.1271***	
		(0.0435)		(0.0438)	
$\ln(House\ price\ index_{ijt-1})$	0.5014***	0.6740***	0.5335***	0.6740***	0.5547***
	(0.0438)	(0.0493)	(0.0536)	(0.0546)	(0.0622)
BCL_{ijt}			0.0276***		0.0190
			(0.0077)		(0.0096)
Constant	yes	yes	yes	yes	yes
Year FE	no	no	no	no	no
Country FE	yes	yes	yes	yes	yes
Observations	1243	1243	1243	1243	1243
Overall R^2	0.5009	0.4579	0.4449	0.4495	0.4528

*** p<0.01, ** p<0.05, * p<0.1.

A higher overall R^2indicates a better fit of the model.

5 Conclusions

In this paper, we have investigated whether and to what extent unconventional monetary policy measures of the European Central Bank have affected the lending activities of banks. All estimations confirm a significant positive effect of lowering interest rates on the net lending behaviour of banks. We thus feel legitimised to conclude that the interest rate channel of monetary transmission seems to have worked throughout or estimation period and that the credit demand effect dominates the credit supply effect.

However, according to our panel estimation results for all banks in our sample, the unconventional monetary policies did not have a significant specific additional effect on lending activity of banks. In contrast, our specific estimations for savings banks even reveal that savings banks generally increase their net lending during the low interest rate environment and, additionally to the positive shift in the level of lending, they react stronger to further interest rate changes than outside the low interest rate environment.

In other words, demand for credit from savings banks increased more than proportionally during the low interest rate period. Our results thus suggest that the ownership structures of banks play a statistically significant and economically relevant role in transmitting changes in short-term interest rates to the availability of credit (Ferri, Kalmi and Kerola, 2014) - especially in times of unconventional monetary policies.

To assess the effects of unconventional monetary policies on the extension of bank credit in the Euro area, we have also factored in the provisions of the new Basel III banking regulation as control variables. According to our estimations, these provisions do not have influenced the impact of the ECB's unconventional monetary policies on the extension of credit, if we consider all banks in our sample. However, if we focus only on savings banks in the Euro area, we come up with empirical evidence that tighter banking regulation has even increased lending activity.

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