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Key Determinants of the Net Interest Margin of EU Banks in the Zero Lower Bound of Interest Rates*

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Abstract

In this paper, we analyse a relationship between the net interest margin (NIM) of EU banks and market interest rates in a low-interest rate environment. We contribute to the literature by examining a large sample of annual data on 629 banks from EU member countries for the 2011-2016 period, which also covers the period of zero and negative rates. When testing three research hypotheses, we draw three main conclusions. First, NIM eroded during the whole observed period for all types of investigated banks. Second, a higher market concentration, proxied by the Herfindahl index, leads to higher NIM. Finally, we show a positive concave relationship between NIM and short-term interest rates observed in previous studies, which supports the suspected nonlinearity in an interest rate zero lower bound situation. In contrast to other researchers, we find a negative relationship between the NIM of EU banks and the yield curve slope.

1. Introduction

The last decade was characterized by an unprecedented situation of very low – even negative – interest rates in major economies, which was a new situation not covered in the literature. As a result, this topic has attracted many researchers, such as Borio et al. (2017) and Claessens et al. (2017), who have tried to estimate an impact of the zero lower bound of interest rates (ZLB) on bank profitability and the effectiveness of monetary policy.

We contribute to the literature by examining key determinants of the net interest margin (NIM) of EU banks in the situation of ZLB. By definition, NIM is closely linked to the overall interest rate environment, which reflects macroeconomic conditions and the monetary policy in a given country. The relevant literature on the determinants of bank profitability, specifically including NIM, was thus mainly concerned with the link between bank profitability and unconventional monetary policy measures, the resulting low or negative rate environment and the problem of

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ZLB. For instance, Borio *et al.* (2015) found a positive concave relationship between short-term interest rates and bank profitability, i.e., a higher sensitivity in the case of interest rates close to zero.

The objective of this paper is to build on previous studies on the link between NIM and interest rate structure and to consider other factors influencing the NIM. Some previous studies considered the impact of specific market characteristics such as market concentration. However, in contrast to our paper, they have not focussed on the impact of interest rate structure on NIM in a ZLB situation as their main objective.[1] Findings of these studies suggest that banking institutions with higher oligopolistic power may attain higher profitability, which is worthwhile to take into account when considering other determinants.

We also aim to include certain bank-specific variables that reflect various business models of individual banks or their size in our analysis because there are likely to be differences in bank profitability based on these characteristics. For this purpose, we use unique annual data on 629 banks located in 24 EU member countries from 2011-2016. This period was characterized by interest rates close to zero and even below zero in 2015 and 2016. The sample thus allows us to examine the impact of market rates on NIM in a situation of ZLB, which makes our research unique.

The remainder of the paper is structured as follows. Section 2 provides a review of the literature on the impact of interest rates and monetary policy on bank profitability. Based on this overview, we state three hypotheses. In section 3, we conduct an empirical analysis. We describe the used dataset, introduce selected variables and provide descriptive analysis of the data. Section 4 contains the description of our methodology. Results and findings are presented in section 5, where we also discuss further research opportunities. Finally, section 6 concludes the paper.

2. Literature Review

The main purpose of this paper is to consider the impact of numerous factors on NIM, which is one of the most common measures of bank profitability.[2] The literature on bank profitability from recent years is concerned mainly with the impact of the very low and in some cases even negative interest rate environment resulting from the unconventional monetary policy major central banks have pursued since the outbreak of the global financial crisis in 2007-2009.

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[1] The impact of market concentration on the NIM was considered by Claeys & Vander Vennet (2008), who studied the interest margin of banks in Central and Eastern Europe. However, their study uses data from the 1994-2001 period, which cannot be considered a ZLB situation, in contrast to the 2011-2016 period covered in this paper. Similarly, Saona (2016) uses an approach similar to our methodology, including concentration as one of the regressors, but his sample includes only Latin American banks. One of the earlier studies considering the impact of market concentration on bank performance is Bourke (1989). Market concentration as one of the determinants of bank profitability is used also in Kok *et al.* (2015) within the EU Financial Stability Report, but they use return on assets (ROA) rather than NIM.

[2] Other common profitability measures used in the banking industry include return on assets (ROA), return on equity (ROE) and cost-to-income ratio (Mejstřík et al., 2014, Golin and Delhaise, 2013).

Borio *et al.* (2017) studied the impact of monetary policy on bank profitability. They used annual data for 109 large international banks headquartered in 14 major advanced economies from the Bankscope database covering the period 1995-2012. They used the system GMM method to estimate multiple models, each with a certain income component as the dependent variable. The explanatory variables included the three-month interbank rate and the difference between 10-year government bonds and the three-month interbank rate as a proxy for the slope of the yield curve, both variables serving as monetary policy indicators. To capture assumed nonlinearity in their impact, they also included the quadratic forms of these two variables. The models included other variables controlling for various macroeconomic or bank-specific factors. They found a positive correlation of bank return on assets (ROA) with both the level of interest rate and the steepness of the yield curve. According to their findings, this positive impact of higher short-term rate and steeper yield curve is driven by their positive impact on net interest margin.

Another study of the impact of "low-for-long" interest rates on bank profitability, specifically on NIM, was done by Claessens *et al.* (2017). Their study uses balance sheet and income statement annual data on 3385 banks from 47 countries obtained from Bankscope for 2005-2013. NIM in their model is regressed on the three-month government bond yield, the spread between 10-year and three-month government bond yield, a dummy variable detecting whether the country was in a "low rate environment" (defined as the three-month rate being below 1.25 per cent), and a set of country specific and bank-specific variables. The regression is done for the whole sample and for various subsamples, e.g., for a low-rate environment and a high-rate environment separately, or they decomposed NIM to interest income margin and interest expense margin and used them as dependent variables instead. They discovered that the impact of interest rates on NIM is higher in a situation of low interest rates than in one of high interest rates. Additionally, the impact is stronger on interest income margin than on interest expense margin. On the other hand, they admit that there might be nonlinearities in transmission from interest rate changes to NIM not captured by their methodology; specifically, they mention differences between banking systems.

A similar modelling approach is used by Bikker and Vervliet (2017), who consider the impact of low interest rates on bank profitability and risk taking. Using data on 3582 U.S. banks obtained mainly from the Federal Deposit Insurance Corporation, they considered the impact on NIM using variables capturing the effect of the interest rate environment, other macroeconomic factors, and bank-specific factors. The results are comparable to those of both Borio *et al.* (2015) and Claessens *et al.* (2017), finding a positive and concave impact of short-term interest rates. They also determined that larger banks tend to have somewhat lower margins, which may be explained by an assumption that larger banks' profitability includes a larger portion of interest income.

The impact of unconventional monetary policy and a low-interest rate environment on bank profitability was studied by Altavilla *et al.* (2017). The paper focusses solely on the Euro Area, exploiting a cross section of European bank accounting data with quarterly frequency from June 2007 to January 2017. The models used ROA as a profitability measure and individual profitability components, such as net interest income or non-interest income. They found a rather insignificant short-term impact of monetary policy, represented by the short-term rate and slope of the yield curve variables on overall profitability (when treated for its endogeneity) using various settings of models including bank specific and country-specific variables. In the case of the net interest income itself, they found a positive impact of short-term rates but an insignificant impact of the slope of the yield curve. However, they estimated both relationships only as linear.

Other studies on a somewhat similar topic include Arsenau (2017) and Kerbl and Sigmund (2017). In addition to empirical evidence, Borio *et al.* (2015) provide a theoretical explanation of the impact of decreasing interest rate and flattening yield curve on bank profitability, i.e., the impact of unconventional monetary policy transmission. More recently, Brei et al. (2019) find that low interest rates induce banks to shift their activities from interest-generating to fee-related and trading activities, what has partially offset the fall in banks' interest margin.

Theoretical papers regarding the problem of zero lower bound on nominal interest rate and providing the reasoning for various unconventional monetary policy tools such as quantitative easing or use of exchange rate include, e.g., Bernanke and Reinhart (2004), Jung *et al.* (2005), Svensson (2003), Svensson (2006), Cúrdia and Woodford (2011), Franta *et al.* (2014) and McCallum (2000). Based on the previous literature survey, we formulate three hypotheses for our research:

Hypothesis #1 (erosion of NIM): The NIM of EU banks eroded in the low or even negative interest rate environment regardless of bank type (bank holdings, commercial, cooperative, savings, or real estate & mortgage banks). We hypothesize that a low-interest rate period (since 2015, including even negative short-term rates in the Euro Area and a few other EU member countries) will have a negative impact on the NIM of all those types of bank.

Hypothesis #2 (influence of market concentration): Profitability depends on specific market characteristics. Specifically, higher market concentration in general leads to a lower decrease in NIM. The second hypothesis assumes that the situation differs for each country based on specific market characteristics such as bank ownership structure or market concentration. Previous studies on the link between NIM and interest rate structure in a situation of ZLB did not control for the impact of these factors on bank profitability, which makes our research unique. Because the used dataset does not allow consideration of the ownership structure, the focus is placed on market concentration. The assumption is that a higher market concentration will result in a lower decrease of bank NIM.

Hypothesis #3 (nonlinearity in the impact of market rate): Following the results of previous studies, we assume that the impact of a change in interest rate should be significantly greater when the level of interest rate is low. In other words, the closer the market rates are to zero, the more sensitive the NIM should be to changing interest rate.

3. Empirical analysis

3.1 Dataset

Our dataset, which is based on the Orbis Bank Focus database, includes 629 banks from 24 EU member countries. Data were selected for active banks from EU28 countries whose specialization was ranked as bank holdings & holding companies, commercial banks, cooperative banks, real estate & mortgage banks, or savings banks. The data were then filtered by variables assumed for use in the model to achieve a balanced panel for 2011-2016 with no missing observations.

Table 1 Bank-Specific Variables

Natural logarithm of total assets of the bank	This variable serves commonly as an approximation of the size of the bank. Transformation by natural logarithm is used to smooth large size differences of individual banks.	*lta*
Net loans to total assets ratio	Indicates what portion of total assets is made up of loans. Hence, that portion can be considered a credit risk ratio. Expected sign of the coefficient is ambiguous because a higher value of the ratio may relate to lack of liquidity, while low value may lead to a decrease in net interest income.	*nl_ta*
Net loans to deposits and short-term funding ratio	Reflects structure of the balance sheet and especially the liquidity of the bank.	*nl_dstf*
Loan loss reserves to gross loans ratio	Measures the quality of a bank's assets by evaluating the part of loans put aside for potential charge-off.	*llr_gl*
Cost to income ratio	Indicator of bank's operational efficiency. Generally, the impact on profitability is supposed to be negative. Specifically, this effect should hold for NIM since NIM is directly linked to the denominator of the cost to income ratio.	*cir*
Liquid assets to deposits and short-term funding ratio	Liquidity measure capturing the liquid part of the asset side of the bank's balance sheet.	*la_dstf*
Equity to total assets ratio	Leverage ratio measuring the indebtedness of the bank and its ability to absorb potential losses. The expected sign of the coefficient is unclear since a low ratio may indicate insufficient capital, while a high ratio can be the result of foregone investment opportunities.	*eq_ta*

Notes: Source of all variables is Orbis Bank Focus database.

Table 2 Bank-Specific Dummy Variables

Bank holdings & holding companies	Equals 1 for specialisation Bank holdings & holding companies.	*bhhc*
Cooperative banks	Equals 1 for specialisation Cooperative banks.	*coop*
Real estate & mortgage banks	Equals 1 for specialisation Real estate & mortgage banks.	*rem*
Savings banks	Equals 1 for specialisation Savings banks.	*saving*
Large banks	Equals 1 for banks whose total assets in 2016 were at least USD 30 billion.	*large*
Small banks	Equals 1 for banks whose total assets in 2016 were below USD 1 billion.	*small*

Notes: Variables calculated by authors based on Orbis Bank Focus data.

The dataset was then extended by a set of country-specific variables, i.e. GDP growth rate, inflation rate, unemployment rate, 3M interbank rate, 10Y government bond yield, and the Herfindahl index of total assets of credit institutions. GDP growth, inflation rate, and unemployment rate were available in Orbis Bank Focus only for the 2013-2016 period. Short-term interest rate, long-term interest rate and the Herfindahl index variables were not available in Orbis Bank Focus at all. For this reason, country-specific variable data for the whole observed period were obtained from other sources.

The source for the country-specific variables was Eurostat, with the exception of the Herfindahl index data, which were obtained from the Statistical Data Warehouse of the European Central Bank. The 3M interbank rate data for the whole observed period were available only for the Euro Area, Denmark, Sweden, and the United Kingdom; for other countries outside the Euro Area, the last available year was 2014. Therefore, the data for 2015 and 2016 for the Czech Republic were obtained from the Czech National Bank, and for Hungary and Poland, they were obtained from the OECD. Banks from Bulgaria, Croatia and Romania were removed from the sample (35 banks altogether) due to unavailability of a reliable source of data for short-term rates in 2015 and 2016. Long-term rates were proxied by EMU convergence criterion bond yields. Unfortunately, this yield is not available for Estonia because the Estonian government has issued no such instrument. Hence, the only remaining bank located in Estonia was also removed from the dataset. The final dataset is a balanced panel of 629 cross-sectional units and 6 time units. Other variables, i.e., various dummies or logarithms and squares of certain variables, were computed within this panel.

3.2 Variable Selection

We selected variables based on studies on the topic of bank profitability and the impact of interest rate on that profitability, including Arseneau (2017), Borio *et al.* (2015), Borio et al. (2017), Claessens *et al.* (2017), and Fišerová *et al.* (2015). Descriptions of bank-specific variables are provided in Table 1, of bank-specific dummy variables in Table 2, and of country-specific variables in Table 3.

Table 3 Country-Specific Variables

Real annual GDP growth rate	Annual growth rate of real GDP obtained from Eurostat. The coefficient is likely to be positive.	*gdp*
Inflation rate	Annual inflation rate obtained from Eurostat. The expected impact on NIM is ambiguous.	*infl*
Unemployment rate	Annual unemployment rate obtained from the Eurostat. Higher unemployment should have a negative impact on NIM.	*unem*
Short-term interest rate	For most observations, the 3M interbank rate is obtained from Eurostat, except for the Czech Republic, Hungary and Poland in 2015 and 2016 as described in the text.	*st_ir*
Square of the short-term interest rate	Due to assumed nonlinearity in the impact of short-term rate, its square is used.	st_ir^2
Slope of the yield curve	Approximated by spread between 3M interbank rate and 10Y government bond yield.	*spread*
Square of the slope of the yield curve	Similarly to short-term rate, the square of the yield curve slope is included to capture assumed	$spread^2$

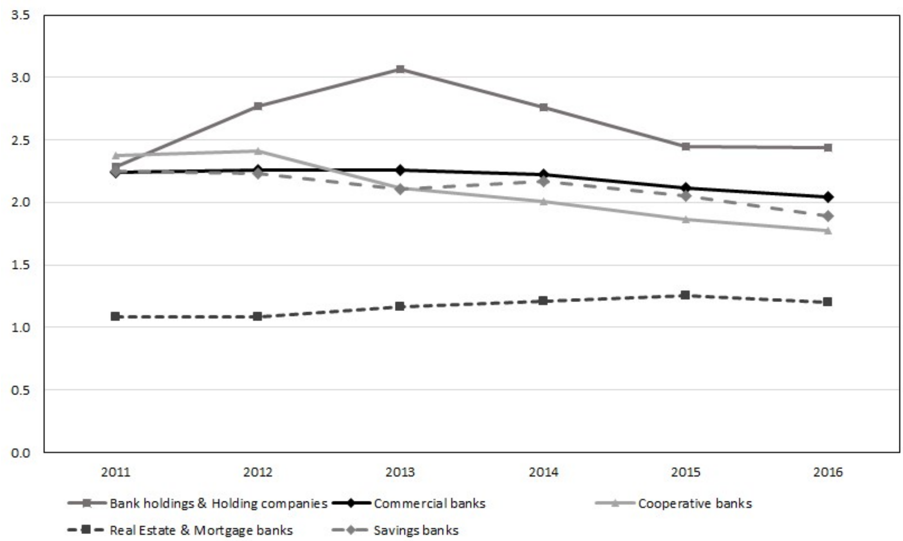
	nonlinearity.	
Herfindahl index[3]	Measure of market concentration in terms of total assets of credit institutions as defined by EU legislation. Obtained from SDW of ECB.	*hi*
Negative short-term interest rate dummy	Equals 1 for each country that had a negative short-term interest rate in a given year.	*negrate*

Notes: Source of 3M interbank rate data in 2015 and 2016 for Czech Republic is CNB; for Hungary and Poland, OECD.

3.3 Descriptive Analysis

Our dataset includes 132 large banks, 268 medium size banks, and 229 small banks. In terms of bank specialization, it covers 26 bank holdings & holding companies, 235 commercial banks, 272 cooperative banks, 45 real estate & mortgage banks, and 51 savings banks. Numbers of banks from individual countries are provided in Table A5; summary statistics of all variables are reported in Table A1 in the Appendix.

Figure 1 Average NIM by Bank Specialization (%) in EU in 2011-2016



Source: Authors based on Orbis Bank Focus.

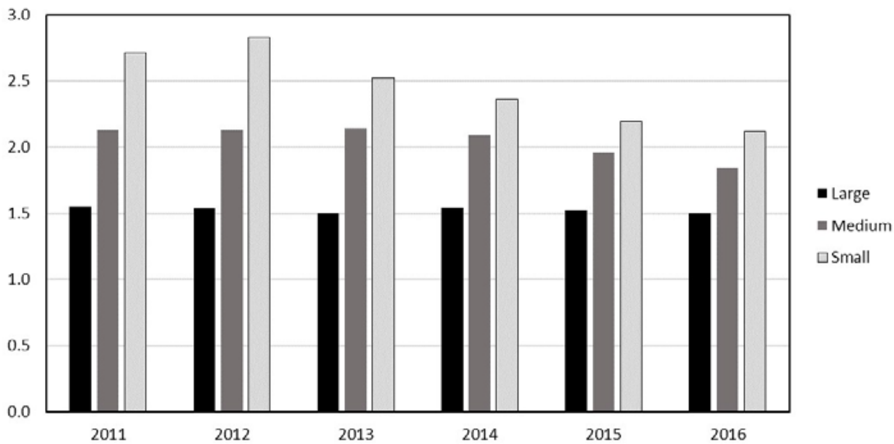
Figure 1 shows the development of average NIM for each of the bank specializations. We can see that in the case of bank holdings & holding companies, the time series is relatively unstable. This instability may be caused by the fact that in

[3] Except for the Herfindahl index, market concentration may also be proxied by the Lerner index or by a concentration ratio. The Herfindahl index was chosen mainly due to the best data availability compared to the other measures. The concentration ratio is used by SDW of ECB only in connection with payment services, while the Lerner index is available in the FRED database, but only until 2014. Moreover, as Kraft (2006) shows, the Lerner index, which measures the price mark-up, may be influenced by factors other than market concentration.

the dataset restricted only to EU-based banks, there is a very low share of this type of bank. Hence, in such a small sample, an irregularity, caused, e.g., by repricing, may influence the time series' behaviour significantly. Therefore, the figure for bank holdings & holding companies is rather inconclusive.

For the other types of bank, we can distinguish two cases. In the case of cooperative and savings banks, we see a quite sustained and relatively substantial decrease in the period 2011-2016 (approximately 60 basis points for cooperative and approximately 36 basis points for savings banks). On the other hand, in the case of commercial and real estate & mortgage banks, we see a more-stable NIM (20 basis point decrease for commercial banks and 11 basis point increase for real estate & mortgage banks). Overall, these results suggest that Hypothesis #1 be rejected, since we cannot conclude that the protracted period of low and later negative rates in the EU would erode profitability of all types of bank to the same extent.

Figure 2 Average NIM by Bank Size (%) in EU in 2011-2016



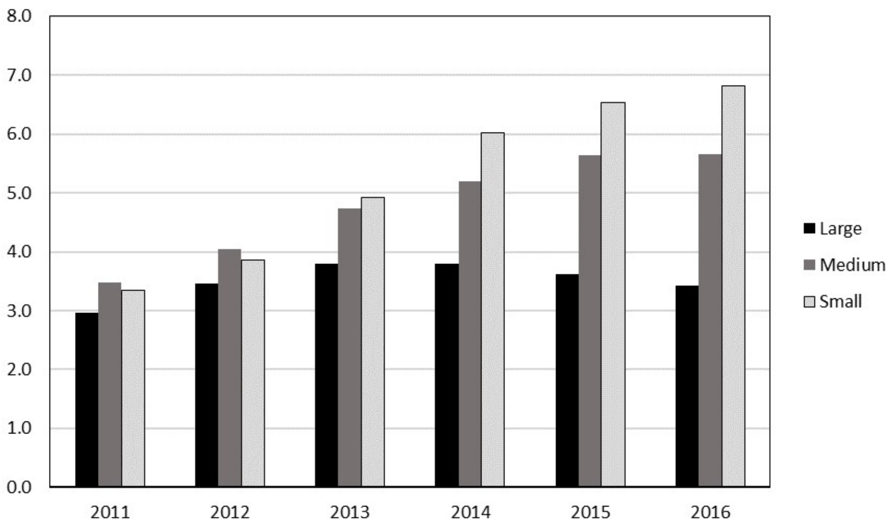
Source: Authors based on Orbis Bank Focus

Figure 2 displays that the large banks in the EU reported the lowest average NIM, the highest NIM was reported by small banks, while the medium-sized banks came second. Another interesting result is that in the case of the large banks, the average NIM is quite stable during the whole observed period. On the other hand, the small banks' average NIM between 2012 and 2016 dropped by almost 71 basis points, which is another source of evidence that there are likely to be differences in response to changing interest environment due to bank heterogeneity, in this case heterogeneity by size.

A theoretical explanation for this difference in NIM by size may be that large banks have an advantage in management of their interest spread since they are likely to have diversified more both the loan and the deposit portfolios and have a better position in obtaining funding from the interbank market. The diversification of the loan and deposit portfolios is determined by multiple factors, for example, territorial diversification or client segment diversification. Under territorial diversification, we mean that large banks are more likely to operate in multiple regions with different economic conditions, while small banks usually operate in certain relatively small and economically homogeneous regions. Regarding client segmentation, we assume that large banks are likely to serve all or a majority of client segments, i.e., retail clients, SMEs, private banking clients, or large corporations, while small banks may be focussed on just one or a few of these segments.

Another important feature of the loan and deposit portfolios of small and medium banks, which is likely partially influenced by diversification opportunities, is that they tend to have a higher risk profile compared to the risk profile of the large banks' portfolios. This feature may explain the faster decrease in NIM visible in Figure 2. Moreover, the assumption of riskier portfolios is supported by Figure 3, which shows a significant increase in the loan loss reserves to gross loans ratio for small and medium banks and relative stability of this ratio for large banks over the observed period.

Figure 3 Average Loan Loss Reserves to Gross Loans Ratio (%) by Size in 2011-2016



Source: Authors based on Orbis Bank Focus.

4. Methodology

We applied a standard methodology used for panel data. For estimation with the panel dataset, we can consider using either static or dynamic panel data methods. Static methods such as pooled OLS, fixed effects (within or LSDV estimator) or random effects (FGLS estimator) allow under certain assumptions the estimation of at least a consistent model of the following form:

$$y_{it} = \alpha + \boldsymbol{x'}_{it}\boldsymbol{\beta} + c_i + \epsilon_{it} \quad (1)$$

where $i = 1,\dots,N$ (cross-sectional units) and $t = 1,\dots,T$ (time periods), c_i is the unobservable group-specific fixed or random effect, and $\epsilon_{it} \sim i.i.d.\ N(0,\sigma^2)$.
On the other hand, if we need to estimate a dynamic panel data model of the form:

$$y_{it} = \alpha + \delta y_{i,t-1} + \boldsymbol{x'}_{it}\boldsymbol{\beta} + c_i + \epsilon_{it} \tag{2}$$

where $y_{i,t-1}$ is a one-period-lagged dependent variable, we cannot use any of those methods because they would produce biased and inconsistent estimates.

For dynamic panel data, we have available two methods that use instrumental variables within a generalized method of moments (GMM) framework. The difference GMM was developed in Arellano and Bond (1991), and the system GMM was proposed by Arellano and Bover (1995) and Blundell and Bond (1998). A disadvantage of difference GMM is that we can estimate the model only in first differences; using this approach, we would not be able to use the set of group-specific dummy variables. Therefore, we use the other option – system GMM. In this method, the model is estimated in levels and differences jointly and instrumented by both lagged differences and lagged levels of the dependent variable, respectively. Therefore, it allows us to estimate the model including a set of dummy variables.

The basic setup of the estimated model is as follows:

$$\begin{aligned} nim_{it} = \alpha + \delta nim_{i,t-1} + \theta_1 st\_ir_{it} + \theta_2 st\_ir_{it}^2 + \theta_3 spread_{it} + \theta_4 spread_{it}^2 \\ + \boldsymbol{x'}_{it}\boldsymbol{\beta} + \boldsymbol{d'}_{it}\boldsymbol{\gamma} + \boldsymbol{z'}_{it}\boldsymbol{\phi} + c_i + \epsilon_{it} \end{aligned} \tag{3}$$

where $\boldsymbol{x'}_{it}$ is a vector of bank-specific variables described in Table 1, $\boldsymbol{d'}_{it}$ is a vector of bank-specific dummy variables described in Table 2, and $\boldsymbol{z'}_{it}$ is a vector of country-specific variables described in Table 3 except for short-term interest rate, slope of the yield curve and their squares, which are pointed out as the variables of main interest. Finally, the error term consists of a fixed effects component c_i and an exogenous component ϵ_{it}.

System GMM is used as the main estimation methodology in this paper. However, to obtain more-robust evidence of the validity of estimated relationships, we performed the estimation of the dynamic model using static methods and the estimation of a static model (without a lagged dependent variable). The results are presented in the Appendix in Tables A.3 and A.4.

5. Results and Findings

As presented in the previous section, our estimates are conducted using the system GMM method. The estimation is performed using second and further lags of the dependent variable as instruments for the differenced equation and using second and further lags of differences of the dependent variable as instruments for the equation in levels. For the estimation, the Stata command *xtabond2* developed in Roodman (2009) is used. More precisely, the command is used with a two-step GMM option and a robust option that requests the Windmeijer (2005) correction. Theoretically, this method should be superior, according to Roodman (2009).

System GMM estimation results of the basic model are reported as column (1) in Table 4. The results confirm that the relationship between NIM and short-term interest rate is concave as suggested by previous studies. On the other hand, in the case of the slope of the yield curve, we see a significant (at least on a 10% level), negative coefficient for the linear term but an insignificant coefficient for the quadratic term,[4] suggesting that it might be more accurate to specify the relationship as linear. For the other macroeconomic variables, we see a significant positive impact of GDP growth and for inflation. In contrast to other macroeconomic variables, the coefficient of unemployment is insignificant.

The Herfindahl index is the most interesting country-specific variable in our model besides interest rate structure. We have estimated a significantly positive coefficient of this variable. This estimation is consistent with the assumed relation that in general, a higher market concentration should lead to a higher NIM.

Bank-specific variables are mostly significant. The only two exceptions are the variables *net loans to deposits & short-term funding* and *liquid assets to deposits & short-term funding.* In this case, it may be a problem with the correlation with *net loans to total assets*. We see a significantly negative coefficient for *logarithm of total assets*, which probably captures most of the size effects because the dummy variable for small banks is insignificant; while the dummy variable for large banks is significant, it has a positive coefficient contradictory to the patterns in Figure 2.

The positive coefficient of *loan loss reserves to gross loans* may signal that banks accepting a higher level of credit risk attain higher NIM. The positive coefficient of *equity to total assets* somewhat surprisingly suggests that lower leverage leads to higher NIM. Unsurprisingly, the coefficient of *cost to income ratio* is still negative. Finally, the positive coefficient of *net loans to total assets* suggests that the more the banks are able to lend to clients, the higher NIM they attain. Otherwise they would have to invest in government bonds and similar instruments that bore low yields during the observed period. For the specialization bank-specific dummy variables, we observe behaviour consistent with the patterns in Figure 1. The coefficient of *bank holdings & holding companies* is positive but insignificant. In contrast, the coefficients of other dummies are significantly negative, suggesting generally lower NIM or a faster decrease in NIM.

The bottom lines of Table 4 report the estimation diagnostic results. The Wald statistics show the overall significance of the models. Neither the Arellano-Bond AR(1) nor the AR(2) test rejects the null hypothesis. This result suggests that we would not have made a significant mistake had we estimated the model using a static approach. On the other hand, as mentioned previously, system GMM allows us to estimate the model using time-invariant dummy variables. As the results of the

[4] The negative relation to NIM may seem to be counterintuitive and contradictory to the previous empirical results. However, Borio *et al.* (2015) provide a theoretical explanation for the possibility of the existence of such a situation: "*Changes in the slope of the yield curve will also have quantity effects, notably influencing the volume of banks' fixed-rate mortgages. Similarly, to what is discussed above, to the extent that, on balance, the demand for mortgages is more responsive (elastic) to changes in the slope than that for medium-term deposits, at some point a higher level of the slope would erode profitability.*"

estimation in Table A4 in the Appendix show, in the case of using a static model, we could use only the fixed effects estimation since the estimation by random effects would be inconsistent as confirmed by the result of the Hausman test. Due to this fact, it is still correct to prefer using system GMM.

Table 4 System GMM Estimation Results

	(1) *NIM*	*(2)* *NIM*	*(3)* *NIM*	*(4)* *NIM*
NIM (first lag)	0.862*** (0.0159)	0.859*** (0.00156)	0.863*** (0.0149)	0.865*** (0.0148)
short-term rate	0.143*** (0.0231)	0.147*** (0.0232)	0.147*** (0.0231)	0.150*** (0.0228)
short-term rate squared	-0.0268*** (0.00541)	-0.0287*** (0.00561)	-0.0290*** (0.00535)	-0.0292*** (0.00529)
spread	-0.0226* (0.0128)	-0.0374*** (0.00842)	-0.0365*** (0.00844)	-0.0357*** (0.00824)
spread squared	-0.000912 (0.000751)	-	-	-
GDP growth	0.00848** (0.00418)	0.00769* (0.00429)	0.00918** (0.00442)	0.00835* (0.00443)
inflation	0.0547*** (0.0106)	0.0598*** (0.00963)	0.0632*** (0.00976)	0.0635*** (0.00980)
unemployment	0.00247 (0.00301)	0.00410 (0.00288)	0.00247 (0.00294)	0.00261 (0.00297)
Herfindahl index	0.490** (0.208)	0.478** (0.197)	0.464** (0.214)	0.548** (0.214)
log (total assets)	-0.0210** (0.00819)	-0.0221*** (0.00806)	-0.0210*** (0.00791)	-0.0203*** (0.00756)
loan loss reserves/gross loans	0.00746*** (0.00195)	0.00760*** (0.00187)	0.00760*** (0.00185)	0.00704*** (0.00184)
equity/total assets	0.00588** (0.00262)	0.00619** (0.00255)	0.00704*** (0.00262)	0.00742*** (0.00262)
cost/income ratio	-0.000778** (0.000309)	-0.000790** (0.000318)	-0.000787** (0.000311)	-0.000896*** (0.000309)
net loans/total assets	0.00436*** (0.000819)	0.00431*** (0.000802)	-	-
net loans/deposits & short-term funding	-0.000283 (0.000204)	-0.000255 (0.000203)	0.000704*** (0.000174)	-
liquid assets/deposits & short-term funding	-0.000109 (0.000505)	-0.000138 (0.000494)	-0.00175*** (0.000434)	-0.00162*** (0.000535)
bank holdings & holding companies dummy	0.0274 (0.0462)	0.0269 (0.0455)	0.00145 (0.467)	0.00309 (0.0472)
cooperative banks dummy	-0.0835*** (0.0190)	-0.0824*** (0.0189)	-0.103*** (0.0203)	-0.0906*** (0.0205)
real estate & mortgage banks dummy	-0.116*** (0.0373)	-0.121*** (0.0359)	-0.122*** (0.0384)	-0.0684** (0.0349)
savings banks dummy	-0.0486** (0.0230)	-0.0488** (0.0232)	-0.0389* (0.0237)	-0.0306 (0.0240)
large banks dummy	0.0603** (0.0286)	0.0583** (0.0285)	0.0456 (0.0287)	0.0508* (0.0277)
small banks dummy	0.00796 (0.0230)	0.00878 (0.0229)	-0.00394 (0.0242)	-0.00589 (0.0244)
Constant	0.216 (0.148)	0.243* (0.145)	0.443*** (0.150)	0.474*** (0.144)
Number of observations	3145	3145	3145	3145
Number of groups	629	629	629	629
Number of instruments	31	30	29	28
Wald statistic	13576.7***	13364.4***	13018.6***	12936.8***
Arellano-Bond AR(1)	-1.31	-1.31	-1.31	-1.31
Arellano-Bond AR(2)	0.44	0.45	0.44	0.44
Hansen test	12.89	12.67	10.22	9.57

Notes: Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Source: Authors' calculation in Stata 11.2.

The results of the Hansen test lead to not rejecting the null hypothesis of exogenous instruments, i.e., to the desired outcome. We must be aware that the Hansen test could be weakened by too many instruments, especially if the number of instruments exceeds the number of groups. However, this effect is not present, since we have only 31 instruments, but the number of groups is 629.

As another robustness check, we compare the estimates of the coefficient on the lagged dependent variable with fixed effects, system GMM, and pooled OLS estimation to verify the condition $\hat{\delta}_{FE} \leq \hat{\delta}_{S-GMM} \leq \hat{\delta}_{OLS}$, which must hold (Roodman, 2009). The estimated coefficients of lags are presented in Table 5, confirming that this condition holds.[5]

Table 5 Lagged Dependent Variable Coefficients in S-GMM, FE and Pooled OLS – Robustness Check

	FE	**S-GMM**	**Pooled OLS**
	NIM	**NIM**	**NIM**
NIM (first lag)	0.110 (0.0951)	0.862*** (0.00159)	0.928*** (0.0748)

Notes: Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Source: Authors' calculation in Stata 11.2.

Finally, we tried to estimate various modifications of the model when dropping certain variables. Following the estimation results of the basic model, it made sense to consider dropping the square of the slope of the yield curve, as the results suggest a linear rather than a quadratic relationship. Another possibility, due to some correlations among *net loans to total assets*, *net loans to deposits & short-term funding,* and *liquid assets to deposits & short-term funding,* was to consider using fewer than all three of these variables.

The estimation results for the modified models are presented in other columns of Table 4. All models are again estimated using two-step GMM with the robust option. Model (2) is estimated omitting only *square of the slope of the yield curve*. As the estimation diagnostic shows, the performance is comparable to the original model.

Models (3) and (4) are two model specifications omitting certain variables of the balance sheet structure, i.e., *net loans to total assets*, *net loans to deposits & short-term funding,* and *liquid assets to deposits & short-term funding*. The dropping of *net loans to total assets* generally leads to a decrease in the Hansen test statistic and to an increase of significance of both other variables. On the other hand, dropping any of the variables reduces the Wald statistic. Hence, we are facing a sort of trade-off. However, the results generally suggest using fewer than all three of these variables. We have experimented with other modifications of our original model by omitting

[5] All results from this comparison are presented in Table A3 in the Appendix.

some of the variables, but none of experiments have shown significantly better performance than reported versions.[6]

Table 6 System GMM Estimation Results with a Dummy of Negative Short-Term Rate

	(5) *NIM*	(6) *NIM*	(7) *NIM*	(8) *NIM*
NIM (first lag)	0.862*** (0.0137)	0.861*** (0.0133)	0.859*** (0.0133)	0.859*** (0.0134)
short-term rate	0.149*** (0.0315)	0.142*** (0.0302)	-0.00184 (0.0205)	-
short-term rate squared	-0.0277*** (0.00670)	-0.0281*** (0.00677)	-	-
spread	-0.0214 (0.0148)	-0.0385*** (0.00925)	-0.0299*** (0.00878)	-0.0301*** (0.00899)
spread squared	-0.000966 (0.000827)	-	-	-
GDP growth	0.00815* (0.00421)	0.00776* (0.00431)	0.0101** (0.00456)	0.00997** (0.00455)
inflation	0.0546*** (0.0110)	0.0606*** (0.00972)	0.0639*** (0.00962)	0.0640*** (0.0101)
unemployment	0.00231 (0.00307)	0.00433 (0.00286)	0.00181 (0.00295)	0.00192 (0.00311)
Herfindahl index	0.480** (0.211)	0.464** (0.198)	0.449** (0.194)	0.452** (0.192)
log (total assets)	-0.0210** (0.00790)	-0.0220*** (0.00767)	-0.0209*** (0.00793)	-0.0210*** (0.00795)
loan loss reserves/gross loans	0.00742*** (0.00209)	0.00774*** (0.00190)	0.00666*** (0.00182)	0.00667*** (0.00183)
equity/total assets	0.00600** (0.00270)	0.00625** (0.00258)	0.00572** (0.00256)	0.00571** (0.00254)
cost/income ratio	-0.000788** (0.000307)	-0.000784** (0.000313)	-0.000874*** (0.000327)	-0.000872*** (0.000326)
net loans/total assets	0.00439*** (0.000804)	0.00436*** (0.000790)	0.00445*** (0.000795)	0.00446*** (0.000792)
net loans/deposits & short-term funding	-0.000290 (0.000206)	-0.000250 (0.000202)	-0.000202 (0.000200)	-0.000206 (0.000197)
liquid assets/deposits & short-term funding	-0.0000609 (0.000498)	-0.000101 (0.000485)	-0.000125 (0.000495)	-0.000125 (0.000493)
bank holdings & holding companies dummy	0.0294 (0.0458)	0.0293 (0.0448)	0.0205 (0.0467)	0.0202 (0.0466)
cooperative banks dummy	-0.0842*** (0.0190)	-0.0822*** (0.0186)	-0.0847*** (0.0186)	-0.0849*** (0.0188)
real estate & mortgage banks dummy	-0.116*** (0.0366)	-0.122*** (0.0349)	-0.139*** (0.0344)	-0.139*** (0.0344)
savings banks dummy	-0.0489** (0.0232)	-0.0498** (0.0232)	-0.0507** (0.0226)	-0.0510** (0.0230)
large banks dummy	0.0590** (0.0287)	0.0570** (0.0280)	0.0620** (0.0277)	0.0620** (0.0277)
small banks dummy	0.00648 (0.0230)	0.00652 (0.0226)	0.00690 (0.0224)	0.00691 (0.0224)
negative rate dummy	0.00831 (0.0200)	-0.00305 (0.0182)	-0.0535*** (0.0164)	-0.0526*** (0.0133)
Constant	0.210 (0.143)	0.236* (0.137)	0.275* (0.141)	0.275* (0.142)
Number of observations	3145	3145	3145	3145
Number of groups	629	629	629	629
Number of instruments	32	31	30	29
Wald statistic	14308.3***	14558.9***	15398.0***	14973.0***
Arellano-Bond AR(1)	-1.31	-1.31	-1.31	-1.31
Arellano-Bond AR(2)	0.45	0.44	0.41	0.41
Hansen test	13.16	12.88	7.23	7.23

Notes: Standard errors are in parentheses.

[6] Estimation results for model specifications denoted (1)-(4) in this paper were also presented in Hanzlík (2018).

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Source: Authors' calculation in Stata 11.2

In Table 6, we present results for models with a dummy variable for a negative interest rate environment as another robustness check for the assumed nonlinearity in the impact of short-term interest rates on NIM. When we continue including both the linear and quadratic terms for the short-term rate, the negative rate dummy is insignificant, as the results for models (5) and (6) show. On the other hand, when the quadratic term is dropped, the negative rate dummy captures most of the effect, causing the linear term in model (7) to be insignificant. This result clearly supports the hypothesis that the impact on NIM is nonlinear, specifically, positive concave.[7]

5.1 Summary of Results

This section confronts the estimation results with the three hypotheses tested in this paper to reject or not to reject them. The estimation results are then compared to the results of previous studies.

Hypothesis #1 (erosion of NIM) – rejected: The estimation results do not confirm that the NIM of all bank types would respond similarly to the situation of low and later negative short-term rates, as present during the observed period 2011-2016 in the EU (see also Figure 1, which shows differences in both the pace and the direction of the average NIM for each bank type). Similarly, the significance of most of the bank specialization dummies is in favour of differences in NIM.

Hypothesis #2 (influence of market concentration) – not rejected: The models estimated in this paper included the Herfindahl index as a measure of market concentration. The estimated coefficient being significantly positive supports the claim that higher market concentration leads to higher NIM. Therefore, this hypothesis cannot be rejected.

Hypothesis #3 (nonlinearity in the impact of market rate) – not rejected: The estimated coefficient on short-term rate is significantly positive, and the coefficient on its square is significantly negative. In other words, the estimated relationship of short-term rate and NIM is positively concave and hence nonlinear. As a result, the third hypothesis is therefore not rejected.

Table 7 compares our estimation results with other studies, which differ in using datasets of various sizes, geographic location, and bank type variety. Moreover, different estimation approaches are employed in each paper. For this reason, only some of the most commonly included variables are considered in the table. We can find comparable results for certain variables. Our estimation yields comparable

[7] The results presented in Tables 4 and 6 show that some of the variables are insignificant, especially when they are correlated with other explanatory variables, e.g., logarithm of total assets and large and small dummies. In our estimations, we have tried multiple specifications in which we omitted certain variables with insignificant coefficients, but the results did not change substantially. Therefore, we prefer to present the models with the original set of variables.

results for the coefficients of lagged dependent variable, for short-term rate and its square, GDP growth, and equity to total assets ratio.

In contrast, our results differ, especially for the coefficients of the slope of the yield curve, from those results presented by Borio *et al.* (2015). Some of the authors considered the impact of the size of the bank, at least by including total assets or their logarithm as an explanatory variable. However, our estimation is unique in including the specialization dummies and in including the Herfindahl index as another explanatory variable.

Table 7 Comparison of Estimated Signs and Significance Levels for the Coefficients of NIM Determinants in Previous Studies

Author	*Data*	*Methodology*	*NIM (1st lag)*	*Short-term rate*	*Short-term rate^2*	*Spread*	*Spread^2*	*GDP growth*	*Inflation*	*Herfindahl index*	*Equity/total assets*	*Specialization*	*Size*[1]
Borio *et al.* (2017)	Bankscope (109 large banks, 14 major economies, 1995-2012)	System GMM	+	+	-	+	-	0	no	no	+	no	no
Claessens *et al.* (2017)	Bankscope (3385 banks, 47 countries, 2005-2013)	Fixed effects	+	+	no	0	no	0/-	no	no	+	no	no
Bikker and Vervliet (2017)	Federal Deposit Insurance Corporation (3582 U.S. banks)	System GMM & static methods	+	+	-	+[3]	no	+	-	no	-[4]	no	yes
Altavilla *et al.* (2017) – ECB working paper	ECB datasets (288 banks, Q1 2000 – Q4 2016)	OLS	+	+	no	0	no	+	0	no	0[5]	no	no
Arseneau (2017)	22 bank holdings (U.S. stress testing scenarios)	GLS	no	no	no	no	no	no	no	no	no	no	yes
Kerbl and Sigmund (2017)	OeNB (946 banks, Q1 1998 – Q1 2016)	Fixed effects	no	+	0	+	no	+	no	no	no	no	yes
This paper	Orbis Bank Focus (629 banks, 2011-2016, EU)	System GMM	+	+	-	-	0	+	+	+	+	yes	yes

Notes: +/− – estimated positive/negative coefficient (at least at 10% significance level); 0 – insignificant estimate; no – variable not included in the model; yes – model includes variables/dummy variables for a given effect; [1] Considered both (log of) total assets and size dummies; [2] low interest rate environment dummy; [3] long-term interest rate used instead of slope of the yield curve; [4] total capital ratio; [5] and regulatory capital ratio.

Source: Authors based on individual papers and own results

To summarize, the main contribution of the analysis is further exploration of the factors influencing the bank NIM in a situation of ZLB or even negative rates. In this paper, in addition to the impact of interest rate structure, we considered the impact of the market concentration on NIM together with controlling for the differences between various bank specializations and for distinct size categories, and we exploited a unique dataset of EU banks of various sizes and specializations.

5.2 Further Research Opportunities

In this section, we discuss three opportunities for further research: a further analysis of the impact of the slope of the yield curve, an assessment of other market characteristics besides market concentration, and a larger data sample.

The first opportunity is further analysis of the influence of the slope of the yield curve. Our result for the slope of the yield curve suggests the impact to be negative and linear, which seems to be in contradiction with the theoretical assumptions and results in previous studies. On the other hand, this result may be caused by reaching a certain point at which a steeper yield curve may cause decreasing profitability, as predicted in Borio *et al.* (2017).

The second research opportunity would be to collect data for other variables reflecting different specific market characteristics. We have used the Herfindahl index as a measure of market concentration in this paper. However, we were not able to consider other important characteristics such as ownership structure within our dataset. It is not an easy task to find a good proxy for modelling its impact, but doing so would certainly help to better understand the determinants of NIM.

The third opportunity lies in obtaining data from following years. Having more data from a longer time period would be desirable to obtain more-robust results, which will be possible as data from following years become available. While a negative interest rate environment in the Euro Area is still present, it will eventually end. Hence, we could obtain more observations on both the negative rate period and on "normal" times. Moreover, how exactly the banks will cope with the end of a negative interest rate era will be interesting.

6. Conclusion

This paper focussed on the determinants of NIM of banks in the EU member countries in the situation of a zero lower bound. Moreover, we tested hypotheses that while the NIM is highly influenced by the overall interest rate environment, there exist significant differences between individual banks arising from different business models and from country-specific market characteristics, e.g., market concentration. For this purpose, we have used a unique dataset of annual data on 629 banks from 24 EU countries from the 2011-2016 period.

The main contribution of this paper may be summarized in three points. First, the composition of the sample allowed us to consider the impact of market rate on NIM in a situation commonly referred to as the zero lower bound, i.e., when interest rates were close to zero or, as in 2015 and 2016 in some countries, even negative. Similarly to Borio *et al.* (2017) and Bikker and Vervliet (2017), we found a positive, concave relation between short-term rates and NIM, confirming the assumed nonlinearity in the impact of market rate on bank profitability.

Second, we considered other factors that may influence the NIM in our analysis, most importantly market concentration proxied by the Herfindahl index. Our results confirm that there is a positive relation between NIM and market concentration, which practically means that higher oligopolistic power of a banking institution is connected to higher profitability. This result suggests that a certain level of concentration may be desirable to support the stability of the whole banking sector. On the other hand, as in other industries, higher oligopolistic power is likely to relate to worse and more-expensive services for clients. For the regulators of the banking industry, higher oligopolistic power implies a trade-off that the regulators face within their objectives (ensuring financial stability of the system and simultaneously the protection of consumers).

Third, we applied a standard methodology on unique panel data on EU banks, including banks from the Euro Area and from countries with national currencies. Moreover, we were able to distinguish between distinct types of bank, i.e., commercial banks, bank holdings, cooperative banks, savings banks and real estate & mortgage banks, for which we found significant differences in their NIM.

To conclude, we confirmed a positive concave relationship between NIM and short-term interest rates observed in previous studies. On the other hand, we found a negative relationship between NIM and the yield curve slope in contrast to that of other researchers such as Borio *et al.* (2017). We also identified significant differences arising from different bank specializations, and, to some extent, we have observed differences linked to bank size.

APPENDIX

Table A1 Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
nim	2.09	1.55	-0.53	31.65
st_ir	0.47	0.79	-0.49	8.05
spread	2.40	1.78	-0.41	21.93
gdp	0.70	2.09	-9.10	25.60
infl	1.30	1.32	-1.50	5.70
unem	9.74	3.59	4.00	27.50
hi	0.06	0.04	0.03	0.37
lta	15.19	2.51	10.31	21.75
llr_gl	4.69	4.45	-2.20	46.41
eq_ta	9.56	5.03	-3.93	63.57
cir	66.55	29.28	0.03	851.20
nl_ta	59.47	17.57	1.80	97.57
nl_dstf	91.37	47.68	3.78	827.06
la_dstf	23.05	25.18	0.04	391.32
bhhc	0.04	0.20	0.00	1.00
coop	0.43	0.50	0.00	1.00
rem	0.07	0.26	0.00	1.00
savings	0.08	0.27	0.00	1.00
large	0.21	0.41	0.00	1.00
small	0.36	0.48	0.00	1.00
Number of observations		3774		
Number of groups		629		
Observations per group		6		

Source: Authors' calculation in Stata 11.2.

Table A2 Cross-Correlation Table

	nim	*st_ir*	*spread*	*gdp*	*infl*	*unem*	*hi*
nim	1.00 -						
st_ir	0.13 (0.00)	1.00 -					
spread	0.06 (0.00)	0.09 (0.00)	1.00 -				
gdp	-0.04 (0.01)	0.05 (0.00)	-0.61 (0.00)	1.00 -			
infl	0.06 (0.00)	0.59 (0.00)	0.36 (0.00)	-0.28 (0.00)	1.00 -		
unem	-0.02 (0.13)	-0.14 (0.00)	0.54 (0.00)	-0.35 (0.00)	-0.20 (0.00)	1.00 -	
hi	0.04 (0.01)	0.02 (0.30)	-0.02 (0.33)	0.13 (0.00)	-0.05 (0.00)	0.05 (0.00)	1.00 -
lta	-0.26 (0.00)	0.09 (0.00)	-0.21 (0.00)	0.24 (0.00)	0.02 (0.26)	-0.12 (0.00)	0.23 (0.00)
llr_gl	0.14 (0.00)	-0.10 (0.00)	0.18 (0.00)	-0.06 (0.00)	-0.24 (0.00)	0.37 (0.00)	0.11 (0.00)
eq_ta	0.29 (0.00)	-0.02 (0.27)	0.03 (0.03)	-0.03 (0.07)	-0.02 (0.26)	0.02 (0.22)	-0.09 (0.00)
cir	-0.02 (0.19)	0.01 (0.44)	-0.00 (0.93)	0.02 (0.14)	0.08 (0.00)	-0.12 (0.00)	-0.09 (0.00)
nl_ta	0.14 (0.00)	0.12 (0.00)	0.08 (0.00)	-0.02 (0.14)	0.09 (0.00)	-0.02 (0.34)	0.06 (0.00)
nl_dstf	-0.01 (0.40)	0.13 (0.00)	0.05 (0.00)	-0.06 (0.00)	0.11 (0.00)	-0.04 (0.01)	0.05 (0.00)
la_dstf	-0.12 (0.00)	0.00 (0.79)	-0.17 (0.00)	0.12 (0.00)	0.06 (0.00)	-0.21 (0.00)	0.06 (0.00)
bhhc	0.07 (0.00)	0.04 (0.02)	-0.09 (0.00)	0.09 (0.00)	0.03 (0.03)	-0.12 (0.00)	0.03 (0.04)
coop	0.00 (0.87)	-0.12 (0.00)	0.26 (0.00)	-0.33 (0.00)	-0.02 (0.19)	0.25 (0.00)	-0.34 (0.00)
rem	-0.17	0.03	-0.17	0.16	0.02	-0.23	-0.00

	(0.00)	(0.07)	(0.00)	(0.00)	(0.20)	(0.00)	(0.98)
savings	0.01	-0.01	-0.06	0.02	-0.02	-0.04	-0.03
	(0.71)	(0.41)	(0.00)	(0.17)	(0.35)	(0.01)	(0.05)
large	-0.19	0.06	-0.08	0.14	-0.00	0.04	0.18
	(0.00)	(0.00)	(0.00)	(0.00)	(0.91)	(0.01)	(0.00)
small	0.18	-0.11	0.24	-0.27	-0.02	0.20	-0.24
	(0.00)	(0.00)	(0.00)	(0.00)	(0.19)	(0.00)	(0.00)
	lta	***llr_gl***	***eq_ta***	***cir***	***nl_ta***	***nl_dstf***	***la_dstf***
lta	1.00						
	-						
llr_gl	-0.14	1.00					
	(0.00)	-					
eq_ta	-0.49	0.04	1.00				
	(0.00)	(0.01)	-				
cir	-0.07	-0.01	0.08	1.00			
	(0.00)	(0.38)	(0.00)	-			
nl_ta	-0.01	-0.08	-0.10	-0.15	1.00		
	(0.41)	(0.00)	(0.00)	(0.00)	-		
nl_dstf	0.05	-0.15	-0.04	-0.19	0.59	1.00	
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	-	
la_dstf	0.21	-0.07	0.11	0.07	-0.52	-0.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.82)	-
bhhc	0.23	-0.11	0.00	0.03	-0.11	-0.03	0.12
	(0.00)	(0.00)	(0.92)	(0.08)	(0.00)	(0.10)	(0.00)
coop	-0.52	0.08	0.20	-0.06	-0.01	0.03	-0.25
	(0.00)	(0.00)	(0.00)	(0.00)	(0.54)	(0.11)	(0.00)
rem	0.13	-0.20	-0.16	-0.09	0.25	0.36	0.02
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.13)
savings	0.06	0.01	-0.04	0.01	0.12	-0.02	-0.06
	(0.00)	(0.41)	(0.01)	(0.50)	(0.00)	(0.14)	(0.00)
large	0.77	-0.14	-0.33	-0.07	-0.06	0.07	0.17
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
small	-0.75	0.09	0.38	0.02	-0.05	-0.00	-0.14
	(0.00)	(0.00)	(0.00)	(0.22)	(0.00)	(0.85)	(0.00)
	bhhc	***Coop***	***rem***	***savings***	***large***	***small***	
bhhc	1.00						
	-						
coop	-0.18	1.00					
	(0.00)	-					
rem	-0.06	-0.24	1.00				
	(0.00)	(0.00)	-				
savings	-0.06	-0.26	-0.08	1.00			
	(0.00)	(0.00)	(0.00)	-			
large	0.21	-0.33	0.08	-0.05	1.00		
	(0.00)	(0.00)	(0.00)	(0.00)	-		
small	-0.14	0.55	-0.13	-0.20	-0.39	1.00	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	-	

Notes: p-values in parentheses.
Source: Authors' calculation in Stata 11.2

Table A3 Comparison of S-GMM, FE, and Pooled OLS with Lagged Dependent Variable

	FE	***S-GMM***	***Pooled OLS***
	NIM	***NIM***	***NIM***
NIM (first lag)	0.110	0.862***	0.928***
	(0.0951)	(0.0159)	(0.0748)
short-term rate	0.328***	0.143***	0.110**
	(0.0971)	(0.0231)	(0.0442)
short-term rate squared	-0.0332***	-0.0268***	-0.0256***
	(0.00834)	(0.00541)	(0.00774)
spread	0.0820***	-0.0226*	-0.0545***
	(0.0236)	(0.0128)	(0.0206)
spread squared	-0.00391***	-0.000912	0.000805
	(0.00109)	(0.000751)	(0.000868)

GDP growth	0.0156** (0.00701)	0.00848** (0.00418)	0.00801 (0.00520)
inflation	0.0134 (0.0295)	0.0547*** (0.0106)	0.0735*** (0.0168)
unemployment	-0.0289 (0.0194)	0.00247 (0.00301)	0.0112* (0.00592)
Herfindahl index	-1.116 (1.053)	0.490** (0.208)	0.206 (0.199)
log (total assets)	-0.240 (0.195)	-0.0210** (0.00819)	-0.0145 (0.0149)
loan loss reserves/gross loans	-0.000603 (0.00667)	0.00746*** (0.00195)	0.00535 (0.00401)
equity/total assets	0.0174 (0.0168)	0.00588** (0.00262)	0.00850 (0.00595)
cost/income ratio	-0.00258*** (0.000747)	-0.000778** (0.000309)	-0.000298 (0.000562)
net loans/total assets	0.0157*** (0.00422)	0.00436*** (0.000819)	0.00334* (0.00195)
net loans/deposits & short-term funding	-0.00102 (0.000653)	-0.000283 (0.000204)	-0.000188 (0.000396)
liquid assets/deposits & short-term funding	0.000760 (0.00106)	-0.000109 (0.000505)	0.0000810 (0.000492)
bank holdings & holding companies dummy	-	0.0274 (0.0462)	0.110 (0.136)
cooperative banks dummy	-	-0.0835*** (0.0109)	-0.0745*** (0.0271)
real estate & mortgage banks dummy	-	-0.116*** (0.0373)	-0.0493 (0.0692)
savings banks dummy	-	-0.0486** (0.0230)	-0.0533** (0.0227)
large banks dummy	-	0.0603** (0.0286)	0.0501 (0.0404)
small banks dummy	-	0.00796 (0.0230)	-0.0139 (0.0368)
Constant	4.744 (3.028)	0.216 (0.148)	-0.0360 (0.316)
Number of observations	3145	3145	3145
F/Wald statistic	58.12***	13576.7***	619.46***
R-squared	0.209	-	0.887

Notes: Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Source: Authors' calculation in Stata 11.2

Table A4 Static Panel Methods Estimation Results (estimation without lagged dependent variable)

	RE ***NIM***	**FE** ***NIM***	**Pooled OLS** ***NIM***
short-term rate	0.113*** (0.0275)	0.0936*** (0.0274)	0.395*** (0.0656)
short-term rate squared	-0.0114** (0.00500)	-0.0116*** (0.00498)	-0.0385** (0.0126)
spread	0.0891*** (0.0179)	0.0844*** (0.0128)	-0.0971** (0.0359)
spread squared	-0.00374*** (0.000890)	-0.00394*** (0.000908)	0.00558** (0.00209)
GDP growth	-0.0142** (0.00641)	0.00936 (0.00645)	-0.0524** (0.0145)
inflation	-0.000859 (0.0124)	0.00689 (0.0125)	-0.00438 (0.0290)
unemployment	-0.0283*** (0.0697)	-0.0245** (0.00749)	-0.0475*** (0.00959)
Herfindahl index	-0.279 (0.805)	-1.474 (1.033)	1.020* (0.551)
log (total assets)	-0.0400 (0.0359)	0.104** (0.0489)	-0.192*** (0.0230)

loan loss reserves/gross loans	0.0104*** (0.00413)	0.00747* (0.00429)	0.0566*** (0.00569)
equity/total assets	0.0167** (0.00436)	0.0154** (0.00471)	0.0639*** (0.00529)
cost/income ratio	-0.00235*** (0.000374)	-0.00197*** (0.000378)	-0.00377*** (0.000783)
net loans/total assets	0.0209*** (0.00190)	0.0220*** (0.00206)	0.0208*** (0.00214)
net loans/deposits & short-term funding	-0.00130** (0.000510)	-0.00121** (0.000527)	-0.00281*** (0.000695)
liquid assets/deposits & short-term funding	0.000498 (0.000885)	0.00135 (0.000912)	-0.00266** (0.00128)
bank holdings & holding companies dummy	0.807** (0.270)	-	0.841*** (0.117)
cooperative banks dummy	-0.716*** (0.138)	-	-0.597*** (0.0648)
real estate & mortgage banks dummy	-1.276*** (0.213)	-	-1.020*** (0.102)
savings banks dummy	-0.311 (0.203)	-	-0.286** (0.0890)
large banks dummy	-0.385** (0.182)	-	0.354** (0.0974)
small banks dummy	0.557** (0.162)	-	0.0902 (0.0814)
Constant	1.857** (0.612)	-0.656 (0.789)	4.125*** (0.407)
Number of observations	3774	3774	3774
F/Wald statistic	811.11***	45.67***	60.00***
R-squared	0.188	0.180	0.251
Hausman test	91.83***	-	-

Notes: Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Source: Authors' calculation in Stata 11.2

Table A5 Number of Banks by Countries

Country	***Number of banks***
Austria	23
Belgium	5
Cyprus	3
Czech Republic	6
Germany	57
Denmark	34
Spain	12
Finland	6
France	47
United Kingdom	42
Greece	5
Hungary	5
Ireland	6
Italy	300
Lithuania	5
Luxembourg	8
Latvia	2
Malta	4
Netherlands	13
Poland	13
Portugal	6
Sweden	15
Slovenia	6
Slovakia	6
Total	629

Source: Authors based on Orbis Bank Focus

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