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Key Determinants of 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 net interest margin (NIM) of EU banks and market interest rates in a low-interest rate environment. We contribute to the literature when examining a large sample of annual data on 629 banks from EU member countries during the 2011-2016 period, which also covers the period of zero and negative rates. We test three hypotheses and come to the 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 of NIM with short-term interest rate observed in previous studies, which supports the suspected non-linearity in situation of zero lower bound of interest rates. Contrary to other researchers, we find a negative relationship between NIM and the yield curve slope.

JEL: C33, E43, G21
Keywords: banks, net interest margin, Herfindahl index, interest rates, profitability, system GMM

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1. Introduction

The last decade was characterized by an unprecedented situation of very low – even negative – interest rates in major economies, what was a new situation not covered by the literature. As a result, this topic has got an attraction from many researchers such as Borio et al. (2017) or Claessens et al. (2017) who 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 when examining key determinants of net interest margin (NIM) of EU banks in the situation of ZLB. By definition, NIM is closely linked to 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, and specifically NIM, was thus mainly concerned by its link to unconventional monetary policy measures and resulting low or negative rate environment and the problem of ZLB. For instance, Borio *et al.* (2015) found a positive concave relationship of short-term interest rate with bank profitability, i.e. higher sensitivity in case of interest rate close to zero.

The objective of this paper is to build on previous studies on the link between NIM and interest rate structure and consider also other factors influencing the NIM. Previous studies on the link of NIM and interest rate structure did control for the impact of specific market characteristics, e.g. market concentration which may lead to higher profitability when banking institutions possess higher oligopolistic power.[1]

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

The paper is structured as follows. Section 2 provides a review of existing literature on impact of interest rates and monetary policy on bank profitability. Based on this overview, we state three hypotheses. In section 3 we conduct 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 net interest margin (NIM) as one of the most common measures of banks' profitability.[2] The existing literature considering bank profitability from recent years was concerned mainly with the impact of very low and in some cases even negative interest rate environment resulting from

[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 as ZLB situation contrary to the 2011-2016 period covered in this paper.
[2] Other common profitability measures used in banking industry include return on average assets (ROAA), return on average equity (ROAE) or cost-to-income ratio (Mejstřík et al., 2014, Golin & Delhaise, 2013).

unconventional monetary policy of major central banks pursued since the outbreak of the global financial crisis in 2007-2009.

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 Bankscope database covering the period 1995-2012. They used the system GMM method to estimate multiple models, each with certain income component as dependent variable. The explanatory variables included three-month interbank rate and the difference between 10-year government bond and three-month interbank rate as a proxy for slope of the yield curve, both variables serving as monetary policy indicators. To capture assumed non-linearity in their impact, they included also quadratic form of these two variables. The models included other variables controlling for various macroeconomic or bank specific factors. They found positive correlation of bank return on assets 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 its positive impact on net interest margin.

Another study of the impact of "low-for-long" interest rates on banks' 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 for period 2005-2013 obtained from Bankscope. NIM in their model is regressed on the three-month government bond yield, the spread between 10-year and three-month government bond yield, dummy variable detecting whether the country was in a "low rate environment" (defined as three-month rate below 1.25 percent), and a set of country specific and bank specific variables. The regression is done for the whole sample as well as for various subsamples, e.g. for low rate environment and high rate environment separately, or they decomposed NIM to interest income margin and interest expense margin and used them as dependent variable instead. They found out that the impact of interest rates on NIM is higher in situation of low interest rates than of high interest rates. Also, the impact is stronger on interest income margin than on interest expense margin. On the other hand, they admit that there might be non-linearities in transmission from interest rate changes to NIM not captured by their methodology, specifically they mention differences between banking systems.

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

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

Other studies on somewhat similar topic include Arsenau (2017) and Kerbl & Sigmund (2017). Beside empirical evidence paper of Borio *et al.* (2015) provides theoretical explanation of impact of decreasing interest rate and flattening yield curve on banks' profitability, i.e. the impact of unconventional monetary policy transmission. 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 & Reinhart (2004), Jung *et al.* (2005), Svensson (2003), Franta *et al.* (2014) or McCallum (2000). Based on the previous literature survey, we formulate three hypotheses for our research:

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

Hypothesis #2 (influence of market concentration): Profitability depends on specific market characteristics. Specifically, higher market concentration in general leads to lower decrease in NIM. The **s**econd hypothesis assumes that situation differs for each country based on specific market characteristics such as bank ownership structure or market concentration. The previous literature did not focus on the impact of these factors on bank profitability, what makes our research unique. Due to the fact, that the used dataset does not allow to consider the ownership structure, the focus is put on the market concentration. The assumption is that a higher market concentration will result in a lower decrease of banks' NIM.

Hypothesis #3 (non-linearity 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 in case the level of interest rate is low. In other words, the closer the market rates to zero the more sensitive the NIM should be on changing interest rate.

3. Empirical analysis

3.1 Dataset

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

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 variables data for the whole observed period were obtained from other sources.

The source for the country specific variables was Eurostat with 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 Euro Area, Denmark, Sweden, and United Kingdom, but for other countries outside the Euro Area the last available year was 2014. Therefore, the data for years 2015 and 2016 for the Czech Republic were obtained from the Czech National Bank, for Hungary and Poland from OECD. Banks from Bulgaria, Croatia and Romania were removed from the sample (together 35 banks) due to unavailability of reliable source of data for short-term rate in 2015 and 2016. Long-term rates were proxied by EMU convergence criterion bond yields. Unfortunately, this yield is not available for Estonia because Estonian government has issued no such instrument. Hence the only one 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 is based on the previous literature on the topics of banks' profitability and the impact of interest rate on it including Arseneau (2017), Borio *et al.* (2015), Borio et al. (2017), Claessens *et al.* (2017), and Fišerová *et al.* (2015). Description of bank specific variables is provided in Table 1, description of bank specific dummy variables in Table 2, and description of country specific variables in Table 3.

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 out large differences in size of individual banks.	*lta*
Net loans to total assets ratio	Indicates what portion of total assets is made up of loans. Hence it can be considered a credit risk ratio. Expected sign of the coefficient is ambiguous because higher value of the ratio may relate to lack of liquidity while low value may lead to 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 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. Particularly, this should hold for NIM since NIM is directly linked to the denominator of cost to income ratio.	*cir*
Liquid assets to deposits and short-term funding ratio	Liquidity measure capturing the liquid part of 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 low ratio may indicate insufficient capital, while high ratio can be result of foregone investment opportunities.	*eq_ta*

Note: 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*

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

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 Eurostat. Higher unemployment should have negative impact on NIM.	*unem*
Short-term interest rate	For most observations 3M interbank rate obtained from Eurostat, except for Czech Republic, Hungary and Poland in years 2015 and 2016 as described in the text.	*st_ir*
Square of the short-term interest rate	Due to assumed non-linearity in 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 non-linearity.	$spread^2$
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 country which had negative short-term interest rate in given year.	*negrate*

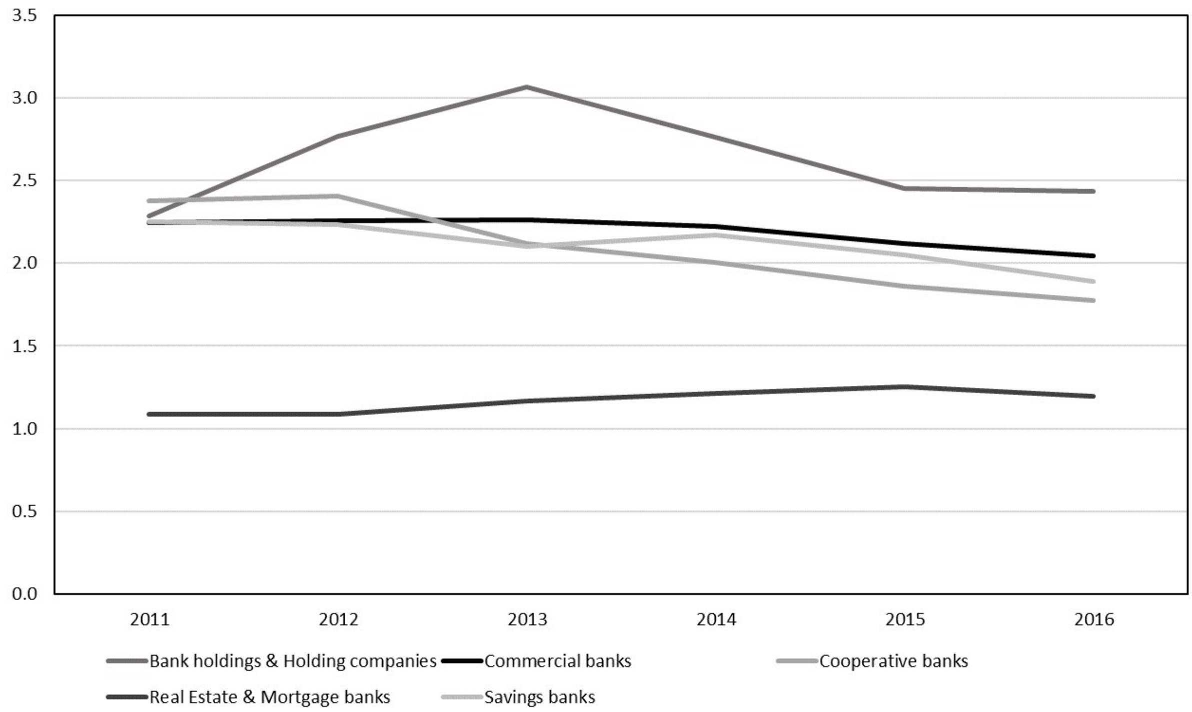
Note: Source of 3M interbank rate data in 2015 and 2016 for Czech Republic is CNB, for Hungary and Poland OECD.

3.3 Descriptive Analysis

Our dataset includes 132 large banks, 268 medium size banks, and 229 small banks. In terms of bank specialisation, 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 A.5., summary statistics of all variables are reported in Table A.1. in Appendix.

[3] Except the Herfindahl index, market concentration may be proxied also 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 other factors rather than market concentration.

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

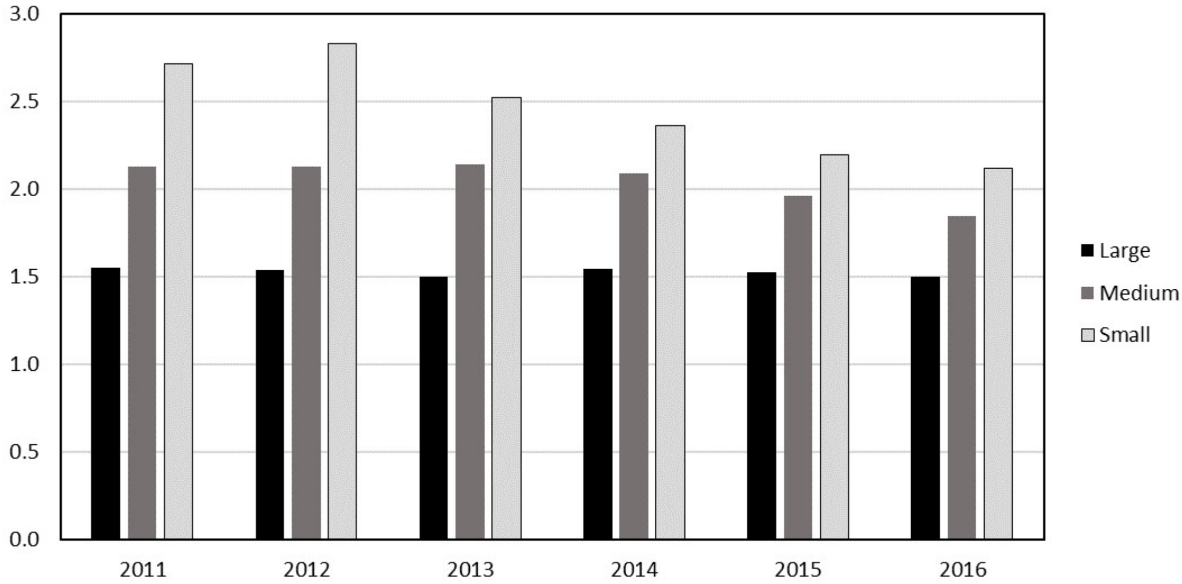


Source: Authors based on Orbis Bank Focus.

Figure 1 shows the development of average NIM for each of the bank specialisations. We can see that in case of bank holdings & holding companies the time series is relatively unstable. It may be caused by the fact that in the dataset restricted only to EU based banks there is a very low share of this type of a 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 banks, we can distinguish two cases. In case of cooperative and savings banks, we see quite sustained and relatively substantial decrease during the period 2011-2016 (about 60 basis points for cooperative and about 36 basis points for savings banks). On the other hand, in case of commercial and real estate & mortgage banks, we see more stable NIM (20 basis points decrease for commercial banks and 11 basis points increase for real estate & mortgage banks). Overall, these results suggest for the Hypothesis #1 to 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 banks to the same extent.

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



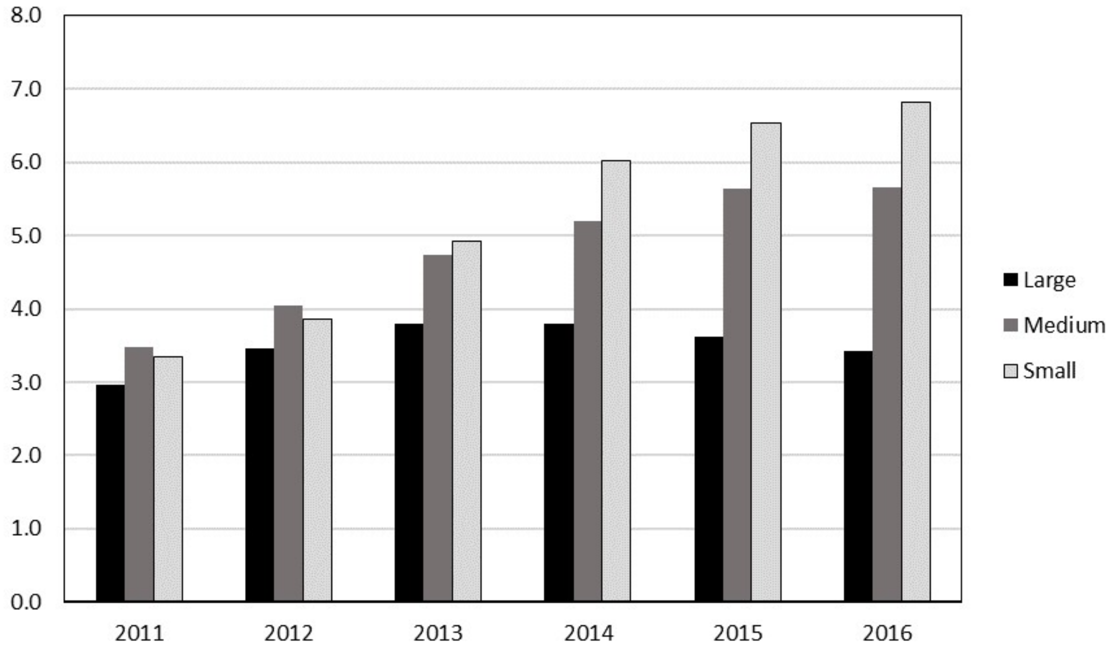
Source: Authors based on Orbis Bank Focus.

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 case of the large banks, the average NIM is quite stable during the whole observed period, while on the other hand the small banks' average NIM between 2012 and 2016 dropped by almost 71 basis points. This 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.

Theoretical explanation for this difference in NIM by size may be the fact that large banks have an advantage in management of their interest spread since they are likely to have more diversified both the loan and the deposit portfolios as well as better position in obtaining funding from the interbank market. The diversification of the loan and deposit portfolios is determined by multiple factors of which we may think of territorial diversification or client segments 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 homogenous region. Regarding client segmentation we assume that large banks are likely to serve all or majority of client segments, i.e. retail clients, SMEs, private banking clients, or large corporations, while small banks may be focused on just one or few of these segments.

Another important feature of the loan and deposit portfolios of small and medium banks, which is likely partially influenced by the diversification opportunity, is that they tend to have higher risk profile compared to the risk profile of the large banks' portfolios. This may explain the faster decrease in NIM visible in Figure 2. Moreover, the assumption of riskier portfolios is supported by Figure 3 which shows significant increase in loan loss reserves to gross loans ratio for small and medium banks as well as 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 standard methodology used for panel data. For estimation with 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 to estimate at least consistently model of the following form:

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

where $i = 1, \ldots, N$ (cross-sectional units) and $t = 1, \ldots, T$ (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:

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

where $y_{i,t-1}$ is 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 using instrumental variables within generalized method of moments (GMM) framework. The difference GMM developed in Arellano & Bond (1991) and system GMM proposed by Arellano & Bover (1995) and Blundell & Bond (1998). Due to the disadvantage of difference GMM, that we can get the model estimated only in first differences and using this approach we would not be able to use the set of group specific dummy variables, 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 model including set of dummy variables.

The basic set up of estimated model is:

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

where $\boldsymbol{x'}_{\boldsymbol{it}}$ is a vector of bank specific variables described in Table 1, $\boldsymbol{d'}_{\boldsymbol{it}}$ is a vector of bank specific dummy variables described in Table 2, $\boldsymbol{z'}_{\boldsymbol{it}}$ 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 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 get more robust evidence of validity of estimated relationships, we performed the estimation of the dynamic model using the static methods as well as the estimation of static model (without lagged dependent variable). The results are presented in Appendix in Tables A.3 and A.4.

5. Results and Findings

As presented in the previous section, our estimates are conducted by 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 equation in levels. For the estimation Stata command *xtabond2* developed in Roodman (2009) is used. More precisely the command is used with a two-step GMM option and robust option which requests the Windmeijer (2005) correction. Theoretically, this should be the superior method 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 case of the slope of the yield curve, we see significant (at least on a 10% level) negative coefficient at linear term, but insignificant coefficient of quadratic term. This suggests that it might be more accurate to specify the relationship as linear. For the other macroeconomic variables, we see significant positive impact of GDP growth and also for inflation. The coefficient of unemployment is in contrary to other macroeconomic variables insignificant.

The Herfindahl index is the most interesting country specific variable in our model. We have estimated a significant positive coefficient of this variable. This is in line 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 variables *net loans to deposits & short-term funding* and *liquid assets to deposits & short-term funding*. In this case, it may be problem of the correlation with *net loans to total assets*. We see significant negative coefficient of *logarithm of total assets* which probably captures most of the size effects, because the dummy variable for small banks is insignificant and while the dummy variable for large banks is significant, it has positive coefficient contradictory to the patterns in Figure 2.

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 in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculation in Stata 11.2.

Positive coefficient of *loan loss reserves to gross loans* may signal that banks taking higher level of credit risk attain higher NIM. 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. And 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 into government bonds and similar instruments that bore low yields during the observed period. For the specialisation bank specific dummy variables, we observe behaviour consistent with the patterns in Figure 1. The coefficient at *bank holdings & holding companies* is positive, but insignificant. On the contrary, the coefficients of other dummies are significant negative, suggesting generally lower NIM or faster decrease in NIM.

The bottom lines of Table 4 report the estimation diagnostic results. The Wald statistics show overall significance of the models. Arellano-Bond AR(1) and AR(2) tests both do not reject the null hypothesis. This result suggests, that we would have not make a big mistake, if we had estimated the model using static approach. On the other hand, as mentioned before, system GMM allows us to estimate the model using the time invariant dummy variables. As the results of estimation in Table A.4 in Appendix show, in case of using 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.

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 of the fact that the Hansen test could be weakened by too many instruments, especially if the number of instruments exceeds the number of groups. However, this is not the case, since we have only 31 instruments, but the number of groups is 629.

As another robustness check we compare the estimates of the coefficient at lagged dependent variable from 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.[4]

[4] All results from this comparison are presented in Table A.3 in Appendix.

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 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 dropping certain variables. Following the estimation results of basic model, it made sense to consider dropping square of the slope of the yield curve as the results suggest rather linear than quadratic relationship. Another possibility was due to some correlation between *net loans to total assets*, *net loans to deposits & short-term funding*, and *liquid assets to deposits & short-term funding*, to consider using just some of these three variables.

The estimation results for modified models are presented in other columns of Table 4. All models are again estimated using two-step GMM with 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*. As we can see, dropping of *net loans to total assets* generally leads to decrease in Hansen test statistic and to increase of significance of both other variables. On the other hand, dropping any of the variables reduces the Wald statistic. Hence, we are facing kind of a trade-off. But generally, the results suggest using only some of these three variables. We have experimented with other modifications of our original model omitting some of the variables, but none of them have brought significantly better performance than reported versions.

Table 6: System GMM estimation results with a dummy of negative short-term rate

	(5)	(6)	(7)	(8)
	NIM	*NIM*	*NIM*	*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 in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculation in Stata 11.2.

In Table 6 we present results for models with a dummy variable for negative interest rate environment as another robustness check for the assumed non-linearity in the impact of short-term interest rate on NIM. We can see that in case we continue including both the linear and quadratic term for the short-term rate the negative rate dummy is insignificant, as the results for models (5) and (6) show. On the other hand, in case 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 non-linear, specifically positive concave.

5.1 Summary of Results

This section confronts the estimation results with the three hypotheses tested in this paper to reject or not 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 to the situation of low and later negative short-term rates, present during the observed period 2011-2016 in the EU, in the same way (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 specialisation 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. Since the estimated coefficient was significant and positive, it supports the claim that higher market concentration leads to higher NIM. Therefore, this hypothesis cannot be rejected.

Hypothesis #3 (non-linearity in the impact of market rate) - not rejected: The estimated coefficient on short-term rate is significant positive and the coefficient on its square significant negative. In other words, the estimated relationship of short-term rate and NIM is positive concave and hence non-linear. 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, as well as bank types' variety. Moreover, different estimation approaches are employed in each of the 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 brings comparable results for the coefficients of lagged dependent variable, for short-term rate and its square, GDP growth, and equity to total assets ratio.

On the contrary, our results differ especially for the coefficients of the slope of the yield curve from those 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 specialisation dummies, as well as in including the Herfindahl index as another explanatory variable.

To sum up, the main contribution of the analysis is further exploration of the factors influencing the banks' NIM in situation of ZLB or even negative rates. In this paper, we considered beside the impact of interest rate structure also the impact of the market concentration on NIM together with controlling for the differences between various bank specialisations and for distinct size categories as well as exploiting of a unique dataset of EU banks of various size and specialisation.

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	Specialisation	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 & 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
Arsenau (2017)	22 bank holdings (U.S. stress testing scenarios)	GLS	no	no	no	no	no	no	no	no	no	no	yes
Kerbl & 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] regulatory capital ratio.

Source: Author based on individual papers and own results.

5.2 Further Research Opportunities

In this section we discuss four 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. This seems to be in contradiction with the theoretical assumptions and results in previous studies. But on the other hand, this result may be caused by reaching a certain point at which 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. But 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 it would certainly help to better understand the determinants of NIM.

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

6. Conclusion

This paper focused on the determinants of net interest margin of banks in the EU member countries in situation of the 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 as well as by 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 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 of short-term rate and NIM confirming the assumed non-linearity in the impact of market rate on the bank profitability.

Second, we considered other factors which 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 of NIM with market concentration which practically means that higher oligopolistic power of banking institution is connected to higher profitability. This suggests that 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 banking industry, it implies a trade-off they face within their objectives (ensuring financial stability of the system and simultaneously protection of consumers).

Third, we applied a standard methodology on a unique panel data on EU banks including banks from the Euro Area as well as from countries with national currencies. Moreover, we were able to distinguish between distinct types of banks, 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 of NIM with short-term interest rate observed in previous studies. On the other hand, we found a negative relationship of NIM with the yield curve slope to contrary to other researchers such as Borio *et al.* (2017). We also found out significant differences arising from different bank specialisations and to some extent, we have observed differences linked to the bank size.

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7. Appendix

Table A.1: 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	1
coop	0.43	0.50	0	1
rem	0.07	0.26	0	1
savings	0.08	0.27	0	1
large	0.21	0.41	0	1
small	0.36	0.48	0	1
Number of observations	3774			
Number of groups	629			
Observations per group	6			

Source: Authors' calculation in Stata 11.2.

Table A.2: 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 (0.00)	0.03 (0.07)	-0.17 (0.00)	0.16 (0.00)	0.02 (0.20)	-0.23 (0.00)	-0.00 (0.98)
savings	0.01 (0.71)	-0.01 (0.41)	-0.06 (0.00)	0.02 (0.17)	-0.02 (0.35)	-0.04 (0.01)	-0.03 (0.05)
large	-0.19 (0.00)	0.06 (0.00)	-0.08 (0.00)	0.14 (0.00)	-0.00 (0.91)	0.04 (0.01)	0.18 (0.00)
small	0.18 (0.00)	-0.11 (0.00)	0.24 (0.00)	-0.27 (0.00)	-0.02 (0.19)	0.20 (0.00)	-0.24 (0.00)
	lta	*llr_gl*	*eq_ta*	*cir*	*nl_ta*	*nl_dstf*	*la_dstf*
lta	1.00 -						
llr_gl	-0.14 (0.00)	1.00 -					

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

Note: p-values in parentheses.

Source: Authors' calculation in Stata 11.2.

Table A.3: Comparison of S-GMM, FE, and Pooled OLS with lagged dependent variable

	FE *NIM*	S-GMM *NIM*	Pooled OLS *NIM*
NIM (first lag)	0.110 (0.0951)	0.862*** (0.0159)	0.928*** (0.0748)
short-term rate	0.328*** (0.0971)	0.143*** (0.0231)	0.110** (0.0442)
short-term rate squared	-0.0332*** (0.00834)	-0.0268*** (0.00541)	-0.0256*** (0.00774)
spread	0.0820*** (0.0236)	-0.0226* (0.0128)	-0.0545*** (0.0206)
spread squared	-0.00391*** (0.00109)	-0.000912 (0.000751)	0.000805 (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 A.4: 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 A.5: 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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