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$$\frac{n!}{(n-1)!} p^{m-1} (1-p)^{n-m} = p \sum_{\ell=0}^{n-1} \frac{\ell+1}{n} \frac{(n-1)!}{(n-1-\ell)! \ell!} p^{\ell} (1-p)^{n-1-\ell} = p \frac{n-1}{n} \sum_{\ell=0}^{n-1} \left[\frac{\ell}{n-1} + \frac{1}{n-1} \right] \frac{(n-1)!}{(n-1-\ell)! \ell!} p^{\ell} (1-p)^{n-1-\ell} = p^2 \frac{n-1}{n} +$$

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Institutional and Other Determinants of the Net Interest Margin of US and European Banks in a Low Interest Rate Environment

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Abstract:

In this paper, we analyze the relationship between the net interest margin (NIM) of US and European 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 1,155 banks from United States and EU member countries during the 2011-2016 period, which also covers periods of zero and negative rates in many of the observed countries. We test three hypotheses and come to three main conclusions. First, NIM is significantly influenced by the different institutional designs of bank-based or capital-based financial markets. Second, there are differences in NIM caused by bank size, although these are not fully captured by our methodology. Finally, we show significant differences by bank type: savings banks, real estate and mortgage banks, and cooperative banks report consistently lower NIMs than commercial banks and bank holdings. Contrary to other researchers, we observe a negative relationship between NIM and the yield curve slope.

JEL: C33, E43, G21

Keywords: Banks, bank-based market, capital-based market interest rates, institutional design, net interest margin, profitability, system GMM

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1. Introduction

In this paper, we contribute to the literature examining the determinants of net interest margin (NIM) of US and European banks in a zero lower bound (ZLB) situation while controlling for important institutional design factors – the difference between bank-based and capital-based financial markets. NIM is by definition closely linked to the overall interest rate environment, which reflects macroeconomic conditions and monetary policy in a certain country. During the last decade, we observed in major economies an unprecedented situation of very low – even negative – interest rates. This was a new situation previously not covered by the literature. As a result, this topic has attracted the attention of many researchers, such as Borio *et al.* (2017) or Claessens *et al.* (2017), who tried to estimate the impact of the ZLB of interest rates on bank profitability and the effectiveness of monetary policy.

The relevant literature on the determinants of bank profitability, specifically NIM, has thus mainly been concerned with the link between NIM and a low or negative rate environment resulting from unconventional monetary policy measures and the problem of the ZLB. For instance, Borio *et al.* (2017) found a positive concave relationship of the short-term interest rate with bank profitability, i.e., higher sensitivity in the case of an interest rate close to zero.

This paper builds on the previous literature on the link between NIM and interest rate structure and considers other factors influencing NIM. Previous studies on the link between NIM and interest rate structure controlled 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 However, the studies from recent years of low and negative rate environment did not consider the possible differences in bank profitability arising from different institutional designs of the financial market. In regards to these different institutional designs, we investigate whether the financial market is considered to be bank-based (typically continental Europe) or capital-based (typically the United States or the United Kingdom) as defined by Demirgüç-Kunt & Levine (1999).

We also 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 banks' profitability based on these characteristics. For this purpose, we use unique annual data on 1,155 banks located in the United States and 24 EU member countries from 2011-2016 (thereof 526 banks from the US and 629 banks from the EU). This period was characterized by interest rates close to zero and in 2015 and 2016 even below zero in the case of the majority of European countries. The diversity of the sample thus allows us to examine the impact of market rates on NIM in the negative rate context of many European countries, in contrast to the US and other European countries that opted for different unconventional monetary policy measures in the years following the financial crisis of 2007-2009, which makes our research unique.

¹ The impact of market concentration on NIM was considered by Claeys & 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, contrary to the 2011-2016 period covered in this paper. Other studies considering the impact of market concentration on bank profitability or specifically NIM include Hanzlík & Teplý (2019), Saona (2016), Kok *et al.* (2015), or Bourke (1989).

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

2. Literature Review

In this paper, we aim to consider the impact of numerous determinants of net interest margin (NIM), one of the most common measures of bank profitability.² The existing literature considering bank profitability from recent years has been concerned mainly with the impact of very low and, in some cases, even negative interest rate environments resulting from the unconventional monetary policy of major central banks pursued since the outbreak of the global financial crisis in 2007-2009. In the following paragraphs, we provide a review of the most relevant studies for the subject of our paper.

Borio *et al.* (2017) consider the impact of unconventional monetary policy on bank profitability. Using annual data from the Bankscope database for 109 large international banks headquartered in 14 major advanced economies covering the period 1995-2012, they estimate multiple models using the system GMM method, each with a certain profitability ratio as the dependent variable. As the explanatory variables, they use, e.g., the three-month interbank rate and the difference between the 10-year government bond and three-month interbank rates as a proxy for the slope of the yield curve, both variables serving as monetary policy indicators. Due to the assumed nonlinearity in impact, the authors propose a quadratic estimation that includes the squares of these two variables in the models. In addition, the models include other control variables for various macroeconomic or bank-specific factors. The study finds a positive correlation of bank return on assets with both the level of interest rate and the steepness of the yield curve. According to the findings, the positive impact of a higher short-term rate and steeper yield curve is driven mainly by its positive impact on net interest margin.

Claessens *et al.* (2017) published another study of the impact of "low-for-long" interest rates on banks' profitability, specifically on NIM. This study uses balance sheet and income statement annual data on 3,385 banks from 47 countries for the period 2005-2013 obtained from Bankscope. In their model, NIM 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 three-month rate below 1.25 %), and a set of country-specific and bank-specific variables. The authors perform the regression for the whole sample as well as for various subsamples, e.g., for a low rate environment and high rate environment separately, or they decompose NIM to interest income margin and interest expense margin and use these as dependent variables instead. The findings of this study are that the impact of interest rates on NIM is higher in situations of low interest rates than in high interest rates. Moreover, the impact is stronger on interest income margins than on interest expense margins. However, the authors admit that there might be

² Other common profitability measures used in the banking industry include return on average assets (ROAA), return on average equity (ROAE) and cost-to-income ratio (Mejstrik *et al.*, 2014, Golin & Delhaise, 2013).

nonlinearities in transmission from interest rate changes to NIM not captured by their methodology; they specifically mention differences between banking systems.

A similar modeling approach is also used in a study by Bikker & Vervliet (2017), who consider the impact of low interest rates on banks' profitability and risk-taking. This study is based on data on 3,582 US banks obtained mainly from the Federal Deposit Insurance Corporation and considers the impact of variables capturing the effect of the interest rate environment, other macroeconomic factors, and bank-specific factors on NIM. The results are comparable to both Borio *et al.* (2015) and Claessens *et al.* (2017) since the study finds a positive and concave impact of the short-term interest rate. Another finding is 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 noninterest income.

Other studies of the impact of unconventional monetary policy and a low interest rate environment on banks' profitability include Altavilla *et al.* (2017), Arsenau (2017) and Kerbl & Sigmund (2017), but these studies generally use different methodologies than our paper. In addition to empirical evidence, Borio *et al.* (2015) provide a theoretical explanation of the impact of decreasing interest rates and a flattening yield curve on banks' profitability, i.e., the impact of unconventional monetary policy transmission. Theoretical papers regarding the problem of the zero lower bound on nominal interest rate and providing rationales for various unconventional monetary policy tools, such as quantitative easing or the use of exchange rates, include Bernanke & Reinhart (2004), Jung *et al.* (2005), Svensson (2003), Franta *et al.* (2014) and McCallum (2000).

The differences between bank-based and capital-based financial markets (in some studies capital-based markets are referred to as "market-based") were considered, e.g., in a book by Demirgüç-Kunt & Levine (1999) and in a paper by Levine (2000), in which he runs a broad data-based cross-country examination of which type of the financial market performs better in promotion of economic growth. Levine (2000) concludes that there is no support for either the bank-based or market-based view. A more recent study by Bats & Houben (2017) focuses on the implications of bank-based vs. market-based financing for the level of systemic risk.

Based on the previous literature, we formulate the following three hypotheses in this paper:

Hypothesis #1 (institutional determination of NIM): NIM is lower in bank-based financial markets (Europe) than in capital market-based financial markets (the US and the UK), and it is also more sensitive to changes in the interest rate structure. The first hypothesis tested in this paper is whether there exists a significant difference in NIM between banks in EU countries and banks in the United States and whether there is a difference in the sensitivity to changes in the interest rate structure. Except for the United Kingdom, most EU countries are usually considered bank-based financial markets. This means that the banking sector plays a substantial role in the intermediation of loanable funds from surplus agents to deficit agents. Banks are thus the main risk carriers. In contrast, the United States and the United Kingdom are usually considered capital-based financial markets. In this setting, the capital market has a much more substantial role in financial intermediation, and the risk is carried to a large extent by investors themselves. Further descriptions of the characteristics of both types can be found in Demirgüç-Kunt & Levine (1999), Levine (2002) and Mejsstrik *et al.* (2014). We should highlight that in the real world, there do not exist countries that perfectly fit the definition of either type. However, for the purpose of this paper, we stick to

the assumption that capital-based markets are in our sample represented by the United States and the United Kingdom, while the rest of the EU countries are considered bank-based markets.

We assume that the general level of NIM is lower and that the decrease caused by the lowering short-term rate and flattening yield curve could be larger in bank-based markets than in capital-based markets. This assumption is based on the fact that in bank-based countries, capital markets are rather underdeveloped. Hence, debtors in bank-based countries can more easily enter the capital market to obtain a favorable lending rate while seeking – or at least threaten to do so – while negotiating with possible bank lenders to obtain a lower rate. On the other hand, there are also arguments drawing an opposite conclusion. Banks in a bank-based market may have generally higher monopolistic power over the interest rate they offer to their customers (especially retail customers) on both loans and deposits. Moreover, the decrease in NIM may indeed have been deeper in Europe but for different reasons – namely, the negative rates introduced in Eurozone and some non-Eurozone member countries in 2015. In the United States, in contrast, the rate did not go under zero during the observed period.

Hypothesis #2 (higher sensitivity of small banks' NIM): NIM eroded most significantly in small banks in both the EU and the US. The second tested hypothesis is that NIM decreased most significantly in small banks in both the EU and the United States. In this paper, banks are divided into three size categories. Large banks are those whose amount of total assets in 2016 was at least USD 30 billion. In contrast, banks are considered small banks when their total assets in 2016 were below USD 1 billion. The rest fall into the category of medium banks. The reason why the NIM of smaller banks is likely to decrease more is that they rely more on funding from retail deposits and hence they cannot lower their interest costs as easily as larger banks that rely on institutional deposits or interbank lending. This may become especially important in the case of negative market rates, which may not be easily transmitted into deposit rates.

Hypothesis #3 (savings banks' NIM): Savings banks reported the highest NIM in both types of financial markets. The third hypothesis predicts that savings banks will have reported the highest NIM. In our dataset, we follow the categorization of banks in the Orbis Bank Focus database, the main source of the data. Five types of banks are considered: bank holdings and holding companies, commercial banks, cooperative banks, real estate and mortgage banks and savings banks. The assumption for savings banks is that they generally tend to have a business model based on collecting longer-maturity retail deposits and lending to retail clients; thus, their profitability and especially net interest income are less sensitive than those of other types of banks to changes in the short-term interest rate. On the other hand, these banks are of rather smaller size, and hence the arguments discussed in the previous paragraph may apply for them.

3. Empirical analysis

3.1 Dataset

In this paper, we use a dataset that includes 526 banks from the United States and 629 banks from 24 EU member countries. The major source of the data was the Orbis Bank Focus database. Data were obtained as two separate datasets. The first includes active banks from EU28 countries whose specialization was listed as bank holdings and holding companies, commercial banks, cooperative banks, real estate and mortgage banks, or savings banks. The second dataset includes active banks from the United States within the same set of five specializations and belonging to the "Classic US coverage" category in the database. Data were then filtered to achieve a balanced panel for the time period 2011-2016 with no missing observations for any of the bank-specific variables used in the model.

The datasets were further extended by a set of country-specific macroeconomic variables, i.e., GDP growth rate, inflation rate, unemployment rate, 3M interbank rate, and 10Y government bond yield. Due to the availability of GDP growth, inflation rate, and unemployment rate data in Orbis Bank Focus only for 2013-2016 and the unavailability of short-term and long-term interest rate variables in this database at all, macroeconomic data for the whole observed time period were obtained from other sources.

For EU countries, the source for all macroeconomic variables was Eurostat. Unfortunately, the 3M interbank rate for the whole observed period was 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. For this reason, the data for 2015 and 2016 for the Czech Republic were obtained from the Czech National Bank for Hungary and for Poland from the OECD. Due to the unavailability of reliable sources of data for the relevant short-term rate in 2015 and 2016, banks from Bulgaria, Croatia and Romania were removed from the sample (altogether 35 banks). For the long-term rate EMU convergence criterion, bond yields were used as a proxy. This yield is not available for Estonia because the Estonian government has issued no such instrument. Therefore, the one bank located in Estonia was also removed from the dataset.

Macroeconomic data for the United States were obtained from the FRED database of the Federal Reserve Bank of St. Louis, Missouri. Except for the GDP growth rate, inflation rate, and unemployment rate, proxies for short-term and long-term interest rate were obtained. They are the 3M LIBOR for USD-denominated transactions and 10Y Treasury constant maturity rate, respectively. These two datasets were combined and made up a final balanced panel of 1155 cross-sectional units in 6 time periods. 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 the previous literature on the topics of banks' profitability and the impact of the interest rate on it, including Arseneau (2017), Borio *et al.* (2015), Borio *et al.* (2017), Claessens *et al.* (2017), Fišerová *et al.* (2015) and Hanzlík & Teplý (2019). The description of bank-specific variables is provided in Table 1, the description of bank-specific dummy variables in Table 2, the description of country-specific variables in Table 3 and the description of country-specific variables in Table 4.

Table 1: Bank-Specific Variables

<i>Natural logarithm of total assets of the bank</i>	Commonly serves as an approximation of the size of the bank. Transformation by natural logarithm is used to smooth out large differences in the size of individual banks.	<i>lta</i>
<i>Net loans to total assets ratio</i>	Indicates what portion of total assets is made up of loans. Hence, it can be considered a credit risk ratio. The expected sign of the coefficient is ambiguous because a higher value of the ratio may relate to a lack of liquidity, while a low value may lead to a decrease in net interest income.	<i>nl_ta</i>
<i>Net loans to deposits and short-term funding ratio</i>	Reflects structure of the balance sheet and especially the liquidity of the bank.	<i>nl_dstf</i>
<i>Loan loss reserves to gross loans ratio</i>	Measures the quality of a bank's assets by evaluating the part of loans put aside for potential charge-off.	<i>llr_gl</i>
<i>Cost to income ratio</i>	Indicator of a 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 the cost to income ratio.	<i>Cir</i>
<i>Liquid assets to deposits and short-term funding ratio</i>	Liquidity measure capturing the liquid part of the asset side of the bank's balance sheet.	<i>la_dstf</i>
<i>Equity to total assets ratio</i>	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.	<i>eq_ta</i>

Note: The source of all variables is the Orbis Bank Focus database.

Table 2: Bank-Specific Dummy Variables

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

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

Table 3: Country-Specific Variables

<i>Real annual GDP growth rate</i>	Annual growth rate of real GDP obtained from Eurostat (EU countries) or FRED database (United States). The coefficient is likely to be positive.	<i>gdp</i>
<i>Inflation rate</i>	Annual inflation rate obtained from Eurostat (EU countries) or FRED database (United States). The expected impact on NIM is ambiguous.	<i>infl</i>
<i>Unemployment rate</i>	Annual unemployment rate obtained from Eurostat. Higher unemployment should have a negative impact on NIM.	<i>unem</i>
<i>Short-term interest rate</i>	For EU countries, the 3M interbank rate obtained from Eurostat, except for Czech Republic, Hungary and Poland in years 2015 and 2016 as described in the text. For United States, the 3M LIBOR in USD from FRED.	<i>St_ir</i>
<i>Square of the short-term interest rate</i>	Due to assumed nonlinearity in impact of the short-term rate, its square is used.	<i>st_ir²</i>
<i>Slope of the yield curve</i>	Approximated by the spread between the 3M interbank rate and 10Y government bond yield.	<i>spread</i>
<i>Square of the slope of the yield curve</i>	As for the short-term rate, the square of the yield curve slope is included to capture assumed nonlinearity.	<i>spread²</i>

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

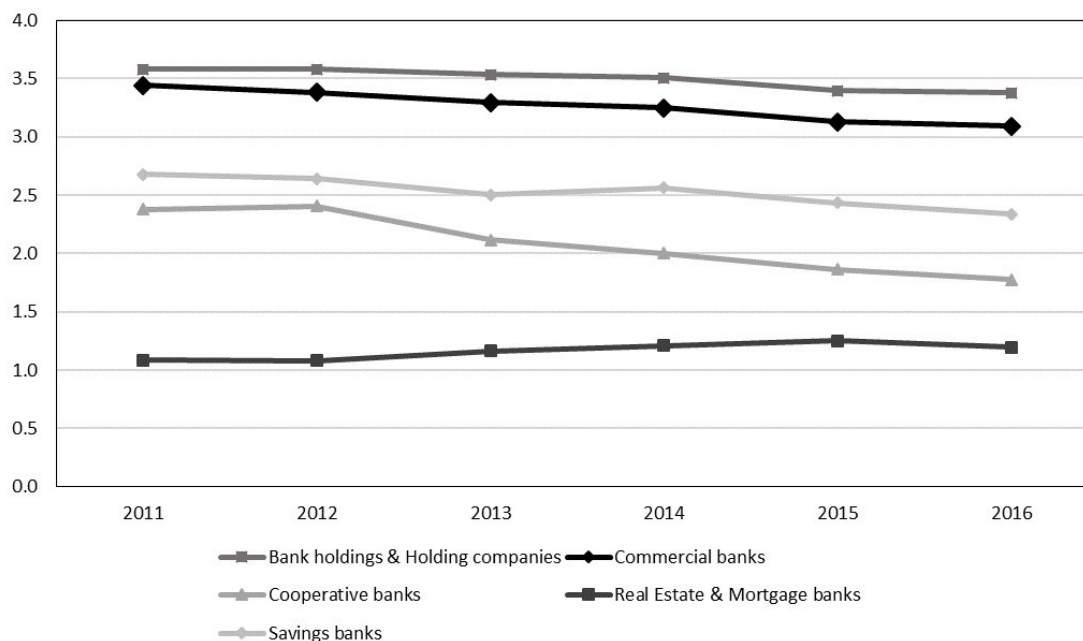
Table 4: Country-Specific Dummy Variables

<i>Negative short-term interest rate dummy</i>	Equals 1 for a country that had a negative short-term interest rate in a given year.	<i>negrate</i>
<i>Capital-based financial market</i>	Equals 1 for a country considered to have a capital-based financial market, i.e., for the United Kingdom and the United States. (The rest of the countries in the dataset are considered bank-based financial markets.)	<i>capbas</i>

3.3 Descriptive Analysis

Our dataset consists of 192 large banks, 732 medium-sized banks, and 231 small banks. Regarding bank specialization, the dataset includes 195 bank holdings and holding companies, 570 commercial banks, 272 cooperative banks, 45 real estate and mortgage banks, and 73 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 the Appendix.

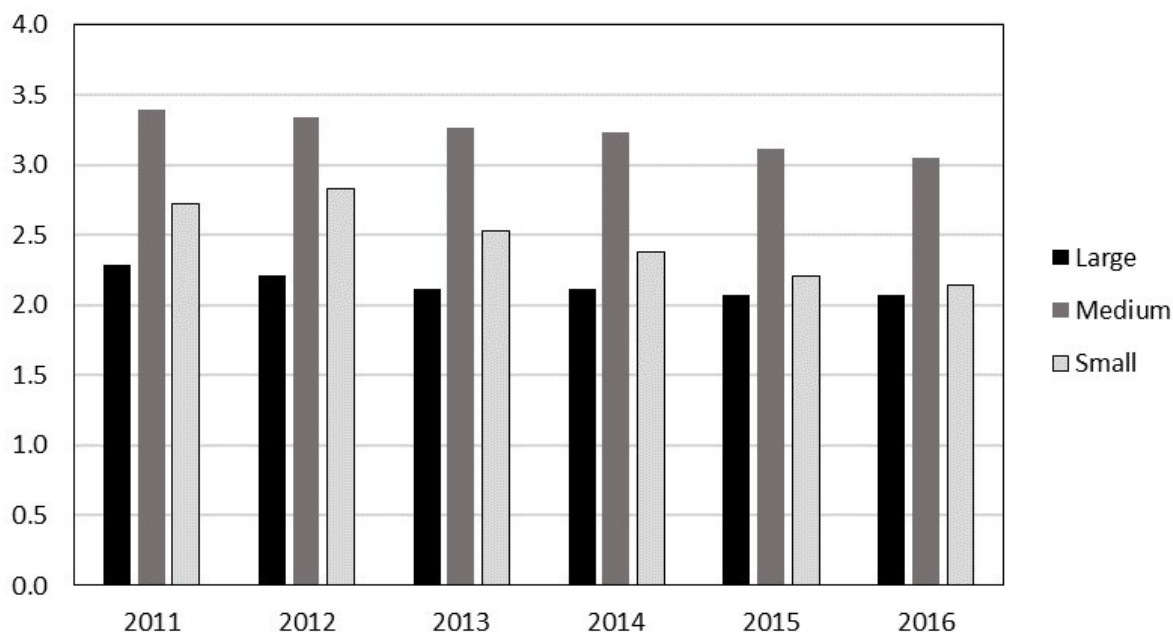
Figure 1: Average NIM by Bank Specialization (%) in 2011-2016



Source: Authors based on Orbis Bank Focus.

Figure 1 shows the development of average NIM by different bank specializations. We can see that the highest average NIM throughout the whole observed period reported bank holdings and holding companies, closely followed by commercial banks. In both cases, NIM slightly decreased; in the case of commercial banks, the decrease was more significant, when during the observed period, the average NIM fell from approximately 3.5 % to approximately 3 %. The lowest average NIM, just slightly above 1 %, was observed in real estate and mortgage banks, but on the other hand, these were the only type of banks that saw a slight increase in NIM during the observed period. In contrast, the sharpest decrease can be seen in cooperative banks. Finally, the figure contradicts Hypothesis #3, which states that savings banks reported the highest NIM, as their average NIM appears to be in the middle of the five bank types.

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



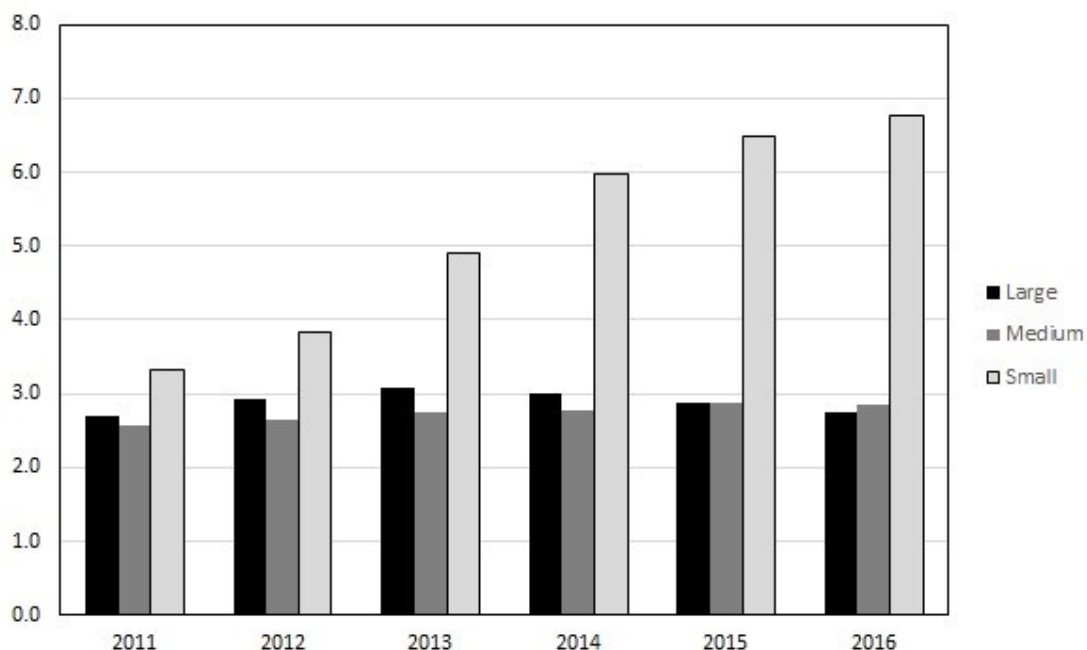
Source: Authors based on Orbis Bank Focus.

Figure 2 suggests that the highest average NIM was reported by banks whose size is considered medium. Large banks reported the lowest average NIM. This is quite consistent with the theoretical assumption that large banks rely less on retail deposits, which are relatively cheaper sources of funding in normal times, than on large institutional deposits, which allow the bank to better steer the spread. We can also assume that they may often have a larger portion of their income from other sources, e.g., net fee and commission income or off-balance-sheet activities. The assumption about the relative importance of retail deposit funding depending on size is further supported by the development of NIM by small banks, which at the beginning was higher than in the case of large banks, but throughout the period, it fell to almost the same level. This decrease may have been caused by low or even negative short-term market rates not being fully transmitted into the deposit rates.

A further theoretical explanation for the differences in NIM by size may come from the fact that in addition to the advantage large banks enjoy in management of their interest spread, large banks are likely to have more diversified loan and deposit portfolios as well as a better position in obtaining funding from the interbank market. Such banks may also have larger territorial and client segment diversification (Hanzlík & Teplý, 2019)

Moreover, loan and deposit portfolios of smaller banks are likely to have a higher risk profile than the risk profile of the larger banks' portfolios. The assumption of riskier portfolios is supported by Figure 3, which shows a significant increase in the average ratio of loan loss reserves to gross loans for small banks, while this ratio remains relatively stable for large and medium banks over the observed period.

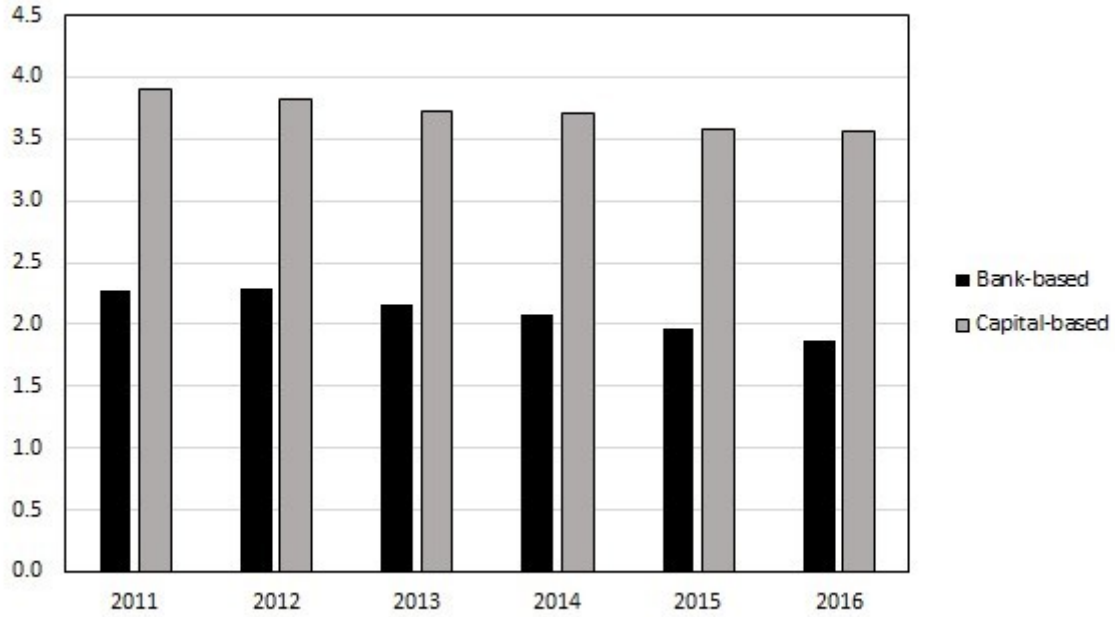
Figure 3: Average ratio of loan loss reserves to gross loans (%) by bank size in 2011-2016



Source: Authors based on Orbis Bank Focus.

The difference in average NIM between bank-based and capital-based financial markets is depicted in Figure 4. We can see clearly that during the whole observed period, there is a substantial and relatively stable gap when the NIM of banks operating in capital-based markets is more than 50 % higher than that of banks operating on bank-based markets. Furthermore, we see a slight widening of the gap, but on the other hand, this may be attributed to other factors, such as the negative short-term rate in most of the European countries that appeared during 2015 and 2016.

Figure 4: Average NIM in bank-based and capital-based markets in 2011-2016 (%)



Source: Authors based on Orbis Bank Focus.

4. Methodology

We applied a standard methodology used for panel data. For estimation with a panel dataset, we considered 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 us, under certain assumptions, to estimate at least consistently a model of the following form:

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

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:

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

where $y_{i,t-1}$ is the 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 the generalized method of moments (GMM) framework. The difference GMM was developed in Arellano & Bond (1991), and system GMM was proposed by Arellano & Bover (1995) and Blundell & Bond (1998). Due to the disadvantage of difference GMM that we can estimate the model only in first differences and thus 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 a model including a set of dummy variables.

The basic setup of the estimated model is as follows:

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

where \mathbf{x}'_{it} is a vector of bank-specific variables described in Table 1, \mathbf{d}'_{it} is a vector of bank-specific dummy variables described in Table 2, \mathbf{z}'_{it} is a vector of the country-specific variables described in Table 3 (except for the short-term interest rate, slope of the yield curve and their squares, which are identified as main variables of interest), and \mathbf{D}'_{it} is a vector of the country-specific dummy variables described in Table 4. 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, we performed the estimation of the dynamic model using static methods as well as the estimation of a static model (without a lagged dependent variable) to obtain more robust evidence of the validity of the estimated relationships. The results are presented in the Appendix in Tables A.3 and A.4.

5. Results and Findings

In this section, we present our estimation results from estimates conducted by the system GMM method. In the estimation, we use second and further lags of the variable *NIM* as instruments for the differenced equation and second and further lags of differences of *NIM* as instruments for the equation in levels. This is consistent with the fact that the first lag of the dependent variable *NIM* used as an explanatory variable is endogenous by definition; therefore, we follow the treatment of endogeneity recommended in Roodman (2009). For the estimation, we use the Stata command *xtabond2* developed in Roodman (2009). More precisely, the command is used with a two-step GMM option and robust option that requests the Windmeijer (2005) correction. Theoretically, this should be the superior method according to Roodman (2009).

The system GMM estimation results of the basic model are reported in column (1) in Table 4. Columns (2)-(4) then present the estimation results for models with certain variables omitted. The results show that the relationship between *NIM* and short-term interest rate is concave, confirming the results of most previous studies. However, in the case of the slope of the yield curve, we see a negative coefficient in both the linear and quadratic terms, although both are insignificant. Following this result, we tried to re-estimate the model modeling the relation as linear. The results presented in column (2) then show a significant negative linear relationship between *NIM* and the slope of the yield curve. We follow this estimation approach in the rest of the estimated models. For the other macroeconomic variables, we see a significant positive impact of GDP growth and inflation. The coefficient of unemployment is, in contrast to other macroeconomic variables, insignificant.³

³ For this reason, we have also tried estimation of the models omitting the variable *unemployment*, but it has not changed the results substantially.

The majority of the bank-specific variables are significant. The variable *logarithm of total assets* is insignificant, suggesting that the size effects do not play a large role as a determinant of NIM. The other two insignificant variables are *net loans to deposits & short-term funding* and *liquid assets to deposits & short-term funding*. In this case, the insignificance may be a result of the correlation with *net loans to total assets*. We then omit these two variables in model (4), and the estimation results do not differ substantially, showing that the variable *net loans to total assets* is a sufficient proxy for the balance sheet structure. The positive coefficient of *net loans to total assets* then suggests that the higher the portion of their assets that banks are able to lend to their clients, the higher is the NIM they can achieve.

Table 5: System GMM Estimation Results

	(1) <i>NIM</i>	(2) <i>NIM</i>	(3) <i>NIM</i>	(4) <i>NIM</i>
<i>NIM (first lag)</i>	0.846*** (0.0286)	0.846*** (0.0283)	0.838*** (0.0290)	0.846*** (0.0280)
<i>short-term rate</i>	0.108*** (0.0325)	0.0984*** (0.0292)	-	0.0998*** (0.0286)
<i>short-term rate squared</i>	-0.0223*** (0.00633)	-0.0218*** (0.00620)	-	-0.0220*** (0.00616)
<i>spread</i>	-0.00847 (0.0131)	-0.0204*** (0.00729)	-0.0209*** (0.00718)	-0.0199*** (0.00729)
<i>spread squared</i>	-0.000895 (0.000822)	-	-	-
<i>GDP growth</i>	0.0145** (0.00518)	0.0144*** (0.00529)	0.0135*** (0.00496)	0.0142*** (0.00529)
<i>inflation</i>	0.0591*** (0.0112)	0.0607*** (0.0105)	0.0653*** (0.0100)	0.0599*** (0.0103)
<i>unemployment</i>	-0.00322 (0.00337)	-0.00255 (0.00339)	-0.00375 (0.00347)	-0.00181 (0.00330)
<i>log (total assets)</i>	-0.0108 (0.00926)	-0.0103 (0.00932)	-0.0128 (0.00940)	-0.00930 (0.00572)
<i>loan loss reserves/gross loans</i>	0.0128*** (0.00403)	0.0130*** (0.00388)	0.0122*** (0.00399)	0.0129*** (0.00383)
<i>equity/total assets</i>	0.0128** (0.00551)	0.0130** (0.00536)	0.0122** (0.00551)	0.0129** (0.00532)
<i>cost/income ratio</i>	-0.00114** (0.000461)	-0.00116** (0.000459)	-0.00122*** (0.000469)	-0.00116** (0.000457)
<i>net loans/total assets</i>	0.00535*** (0.000920)	0.00530*** (0.000915)	0.0560*** (0.000945)	0.00543*** (0.000846)
<i>net loans/deposits & short-term funding</i>	-0.0000578 (0.000301)	0.00000289 (0.000296)	-0.0000810 (0.000306)	-
<i>liquid assets/deposits & short-term funding</i>	-0.000244 (0.000507)	-0.000292 (0.000502)	-0.000233 (0.000504)	-
<i>bank holdings & holding companies dummy</i>	0.0285 (0.0225)	0.0284 (0.0225)	0.0252 (0.0230)	0.0271 (0.0224)
<i>cooperative banks dummy</i>	-0.106*** (0.0282)	-0.103*** (0.0287)	-0.111*** (0.0291)	-0.0938*** (0.0258)

<i>real estate & mortgage banks dummy</i>	-0.177*** (0.0565)	-0.183*** (0.0553)	-0.201*** (0.0568)	-0.183*** (0.0523)
<i>savings banks dummy</i>	-0.0608** (0.0235)	-0.0613** (0.0234)	-0.0646*** (0.0240)	-0.0648*** (0.0236)
<i>large banks dummy</i>	0.0261 (0.0380)	0.0228 (0.0385)	0.0302 (0.0385)	-
<i>small banks dummy</i>	0.0194 (0.0315)	0.0223 (0.0317)	0.0270 (0.0323)	-
<i>negative rate dummy</i>	-0.00686 (0.0227)	-0.0182 (0.0191)	-0.0515*** (0.0150)	-0.0164 (0.0187)
<i>capital based market dummy</i>	0.0902** (0.0379)	0.0910** (0.0377)	0.100*** (0.0380)	0.0914** (0.0364)
<i>Constant</i>	0.0216 (0.170)	0.0277 (0.1467)	0.127 (0.170)	0.000385 (0.136)
<i>Number of observations</i>	5775	5775	5775	5775
<i>Number of groups</i>	1155	1155	1155	1155
<i>Number of instruments</i>	32	31	29	27
<i>Wald statistic</i>	26351.0***	26136.3***	24678.9***	24438.5***
<i>Arellano-Bond AR(1)</i>	-1.83*	-1.83*	-1.83*	-1.83*
<i>Arellano-Bond AR(2)</i>	0.54	0.53	0.52	0.53
<i>Hansen test</i>	13.26	12.77	13.35	12.81

Notes: Standard errors in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculation in Stata 11.2.

The positive coefficient of *loan loss reserves to gross loans* suggests that banks assuming higher levels of credit risk tend to have higher NIMs. The positive coefficient of *equity to total assets* indicates that better capitalized banks generally have higher NIMs. This is in line with the results of some previous studies, including Terraza (2015). The coefficient of *cost to income ratio* is negative, implying that banks with higher operational efficiency are able to attain higher NIMs. For the bank-specialization-specific dummy variables, we see results in line with the patterns in Figure 1. The coefficient of *bank holdings and holding companies* is positive but insignificant, suggesting no clear evidence between bank holdings and commercial banks. In contrast, the coefficients of other dummies are significantly negative, suggesting generally lower NIMs or a faster decrease in NIMs.

In this paper, we are most interested in the results for the last two variables – the *negative rate dummy* and *capital-based market dummy*. Regarding the *negative rate dummy*, we can see that it becomes significantly negative only when the model specification does not include the short-term interest rate variable; otherwise, the assumed nonlinear impact is well captured by the modeled quadratic impact. In the case of the capital-based market dummy, we can see that the variable is significant at the 5 % level in all specifications.

The bottom lines of Table 5 report the estimation diagnostic results. The Wald statistics show that the models are significant. Arellano-Bond AR(1) tests are significant at least at the 10% level, while AR(2) tests do not reject the null hypothesis. This result, together with the significance of the lagged dependent variable, suggests that using the dynamic panel

estimation method is the correct approach. Moreover, system GMM allows us to estimate the model using the time-invariant dummy variables.

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 32 instruments at most, but the number of groups is 1155.

As another robustness check, we compare the estimates of the coefficient of the lagged dependent variable from the fixed effects, system GMM, and pooled OLS estimations 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 the lags are presented in Table 6, confirming that this condition holds.⁴

Table 6: Lagged Dependent Variable Coefficients in S-GMM, FE and Pooled OLS - Robustness Check

	FE	S-GMM	Pooled OLS
	NIM	NIM	NIM
NIM (first lag)	0.238*** (0.0708)	0.846*** (0.0286)	0.941*** (0.0270)

Notes: Standard errors in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculation in Stata 11.2.

In Table 7, we present estimation results for additional model specifications. Model (5) is a further modification of model (4), also dropping the *unemployment* variable. We can see that the omission brings no substantial change to the signs and significance of the estimated coefficients. Models (6), (7) and (8) then present the results of the same model specifications as in models (2), (3) and (4), but with a restricted sample dropping all Italian banks. We can see that although there are some differences in the magnitudes of the estimated coefficients, their signs and significance remain comparable, as do the estimation diagnostics.

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

Table 7: System GMM estimation results

	(5)	(6)	(7)	(8)
	<i>NIM</i>	<i>NIM</i>	<i>NIM</i>	<i>NIM</i>
<i>NIM (first lag)</i>	0.845*** (0.0282)	0.850*** (0.0304)	0.848*** (0.0306)	0.850*** (0.0296)
<i>short-term rate</i>	0.100*** (0.0288)	0.528* (0.0318)	-	0.0532* (0.0316)
<i>short-term rate squared</i>	-0.0221*** (0.00615)	-0.0144** (0.00636)	-	-0.0145** (0.00638)
<i>spread</i>	-0.0214*** (0.00654)	-0.0277*** (0.00932)	-0.0284*** (0.00873)	-0.0277*** (0.00941)
<i>spread squared</i>	-	-	-	-
<i>GDP growth</i>	0.0144*** (0.00525)	0.00880* (0.00507)	0.00823* (0.00485)	0.00863* (0.00507)
<i>inflation</i>	0.0608*** (0.0101)	0.0393*** (0.0125)	0.0378*** (0.0130)	0.0389*** (0.0124)
<i>unemployment</i>	-	0.000913 (0.00395)	0.000860 (0.00399)	0.00109 (0.00385)
<i>log (total assets)</i>	-0.00965* (0.00571)	-0.00306 (0.0115)	-0.00479 (0.0114)	-0.00659 (0.00662)
<i>loan loss reserves/gross loans</i>	0.0125*** (0.00349)	0.0196*** (0.00642)	0.0188*** (0.00657)	0.0194*** (0.00623)
<i>equity/total assets</i>	0.0130** (0.00537)	0.0134* (0.00723)	0.0129* (0.00736)	0.0132* (0.00724)
<i>cost/income ratio</i>	-0.00114** (0.000447)	-0.00111** (0.000510)	-0.00113** (0.000520)	-0.00112** (0.000510)
<i>net loans/total assets</i>	0.00545*** (0.000855)	0.00487*** (0.00107)	0.00497*** (0.00109)	0.00557*** (0.00110)
<i>net loans/deposits & short-term funding</i>	-	0.000300 (0.000378)	0.000201 (0.000387)	-
<i>liquid assets/deposits & short-term funding</i>	-	-0.000562 (0.000639)	-0.000486 (0.000636)	-
<i>bank holdings & holding companies dummy</i>	0.0272 (0.0225)	0.0306 (0.0224)	0.0309 (0.0227)	0.0299 (0.0223)
<i>cooperative banks dummy</i>	-0.0963*** (0.0260)	-0.0656* (0.0371)	-0.0679* (0.0374)	-0.0739* (0.0391)
<i>real estate & mortgage banks dummy</i>	-0.182*** (0.0523)	-0.169*** (0.0645)	-0.171*** (0.0655)	-0.158*** (0.0576)
<i>savings banks dummy</i>	-0.0650*** (0.0234)	-0.0330 (0.0266)	-0.0320 (0.0270)	-0.0373 (0.0269)
<i>large banks dummy</i>	-	-0.00316 (0.0474)	0.00255 (0.0471)	-
<i>small banks dummy</i>	-	0.0736 (0.0791)	0.0815 (0.0793)	-

<i>negative rate dummy</i>	-0.0168 (0.0187)	-0.0408 (0.0260)	-0.0614*** (0.0207)	-0.0405 (0.0260)
<i>capital based market dummy</i>	0.0951** (0.0376)	0.129*** (0.0443)	0.134*** (0.0445)	0.121*** (0.0401)
<i>Constant</i>	-0.00741 (0.137)	-0.0952 (0.189)	-0.0364 (0.189)	-0.0594 (0.149)
<i>Number of observations</i>	5775	4275	4275	4275
<i>Number of groups</i>	1155	855	855	855
<i>Number of instruments</i>	26	31	29	27
<i>Wald statistic</i>	24415.4***	19323.0***	18518.1***	19293.9***
<i>Arellano-Bond AR(1)</i>	-1.83*	-1.74*	-1.74*	-1.74*
<i>Arellano-Bond AR(2)</i>	0.53	0.52	0.52	0.52
<i>Hansen test</i>	12.79	12.38	13.34	12.61

Notes: Standard errors in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculation in Stata 11.2.

5.1 Summary of Results

In this section, we analyze the estimation results to reject or not reject the three hypotheses tested in this paper. We also compare the estimation results to the results of previous studies.

Hypothesis #1 (institutional determination of NIM) – not rejected: Inclusion of the *capital-based market dummy* allowed us to consider the possible difference in the level of NIM between banks located in the United States and United Kingdom as capital-based markets compared to banks located in other European countries as bank-based markets. The estimated significant positive coefficient of this dummy, together with the pattern visible in Figure 4, shows evidence of the impact of institutional design on the level of NIM. Hence, the decision on this hypothesis is not to reject it.

Hypothesis #2 (higher sensitivity of small banks' NIMs) – not rejected: The estimation results provide mixed evidence on the second hypothesis. On one hand, we can see in Figure 2 that there are clear differences in NIMs according to size and, moreover, that the NIM of small banks decreases over the observed period while the NIM of large banks remains relatively stable and the NIM of medium banks decreases only modestly. On the other hand, the estimation results show significance neither of the *logarithm of total assets* nor of the *large* and *small* dummy variables. Hence, the conclusion on the hypothesis is not to reject it, but this decision is mainly due to the mixed evidence.

Hypothesis #3 (savings banks' NIMs) – rejected: We predicted that savings banks would report the highest NIMs. However, Figure 1 indicates that an average NIM of this type of bank is steadily lower than for bank holdings and commercial banks. This is also supported by the negative coefficient of the *savings banks* dummy, which is significant for all specifications with the full dataset. The insignificance of the coefficient in the case of the sample with excluded Italian banks is caused by a lower estimated magnitude but is still negative, while the standard error of the estimated coefficient remains relatively stable. Overall, this gives us relatively clear evidence for the decision to reject this hypothesis.

In Table 8, we compare our estimation results with those of other studies, which differ in using datasets of various sizes, geographic location, and variety of bank types. Moreover, different estimation approaches are employed in each of the papers. For this reason, only some of the most commonly included variables are considered in the table. We find comparable results for certain variables. Our estimation brings comparable results for the coefficients of the lagged dependent variable, the short-term rate and its square, GDP growth, and the ratio of equity to total assets.

Our results differ, especially in terms of the coefficients of the slope of the yield curve, from those presented by Borio *et al.* (2017). Some 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 as well as the capital-based market dummy. Moreover, we have used a unique dataset combining data for US and European banks from the very recent period 2011-2016. In summary, the main contribution of the analysis is further exploration of the factors influencing banks' NIMs in ZLB or even negative rate situations. In this paper, we considered, in addition to the impact of the interest rate structure, the impact of the institutional design of the market on NIM while controlling for differences between various bank specializations and for distinct size categories.

Table 8: Comparison of Estimated Signs and Significance Levels for the Coefficients of NIM Determinants in Previous Studies

Author	Data	Methodology	NIM (1 st lag)	Short-term rate	Short-term rate ²	Spread	Spread ²	GDP growth	Inflation	Equity/total assets	Specialization	Size ¹	Low/negative rate	Capital-/Bank-based
Borio <i>et al.</i> (2017)	Bankscope (109 large banks, 14 major economies, 1995-2012)	System GMM	+	+	-	+	-	0	no	+	no	no	no	no
Claessens <i>et al.</i> (2017)	Bankscope (3385 banks, 47 countries, 2005-2013)	Fixed effects	+	+	no	0	no	0/-	no	+	no	no	yes ²	no
Bikker & Vervliet (2017)	Federal Deposit Insurance Corporation (3582 U.S. banks)	System GMM & static methods	+	+	-	+ ³	no	+	-	- ⁴	no	yes	no	no
Altavilla <i>et al.</i> (2017) – ECB working paper	ECB datasets (288 banks, Q1 2000 – Q4 2016)	OLS	+	+	no	0	no	+	0	0 ⁵	no	no	no	no
Arsenau (2017)	22 bank holdings (U.S. stress testing scenarios)	GLS	no	no	no	no	no	no	no	no	no	yes	yes ⁶	no

Kerbl & Sigmund (2017)	OeNB (946 banks, Q1 1998 – Q1 2016)	Fixed effects	no	+	0	+	no	+	no	no	no	yes	yes ⁷	no
This paper	Orbis Bank Focus (1155 banks, 2011-2016, EU & US)	System GMM	+	+	-	-	0	+	+	+	yes	yes	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, ⁶ negative interest rate environment dummy; ⁷ impact of negative rate considered as forecast in separate ARIMA model.

Source: Author based on individual papers and own results.

5.2 Further Research Opportunities

In this section, we discuss opportunities for further research: a further analysis of the impact of the slope of the yield curve; a more sophisticated approach to size effects, especially regarding the impact of the yield curve; 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. However, 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.* (2015). Another possible explanation can be attributed to the different time periods we are using compared to Borio *et al.* (2017), who use data from 1995-2012, while we use data from 2011-2016. The development of the yield curve shape was quite different in the years after the Great Recession, which may be one of the causes of the different estimated impacts.

The second opportunity is related to the yield curve as well. We can suppose that another cause for the different impact of the yield curve in our results may be related to the size effects. Borio *et al.* (2017) use data on 109 large international banks. In contrast, we use a much larger sample of 1,155 banks of various sizes. It is likely that smaller banks, which rely more on retail deposit financing, may respond differently to changes in the yield curve than large international banks, which are likely to rely more on wholesale funding.

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

6. Conclusion

This paper focused on the determinants of the net interest margin of banks in the United States and European countries in a zero lower bound situation. Moreover, we tested hypotheses stating that while NIM is highly influenced by the overall interest rate

environment, there exist significant differences between individual banks arising from their different business models as well as country-specific market characteristics, specifically, the institutional design feature of whether the financial market is bank-based or capital-based. For this purpose, we have used a unique dataset of annual data on 1,155 banks from the United States and 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. Similar to Borio *et al.* (2017) and Bikker and Vervliet (2017), we found a positive concave relation between the short-term rate and NIM, confirming the assumed nonlinearity in the impact of market rate on bank profitability. On the other hand, we found a negative linear impact of the slope of the yield curve on NIM, contrary to Borio *et al.* (2017), who found a positive concave impact. This result opens a space for more detailed research on the impact of the varying shape of the yield curve on NIM, which is beyond the scope of this paper.

Second, we considered other factors that may influence NIM in our analysis, mainly the institutional design of whether the bank operates within a bank-based or capital-based financial market. Our results confirm that banks operating in capital-based markets attain higher NIMs. This suggests that underdeveloped capital markets are harming the ability of banks to optimize their NIMs.

Third, we applied a standard methodology on unique panel data of US and European banks, including banks from the euro area and 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 and mortgage banks, for which we found significant differences in NIMs.

In summary, we confirmed a positive concave relationship of NIM with the short-term interest rate observed in previous studies, but we found a negative relationship of NIM with the yield curve slope, contrary to other researchers. We also found significant differences arising from different bank specializations, and we found a significant impact of institutional factors on bank profitability.

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Appendix

Table A.1: Summary statistics

Variable	Mean	Std. Dev.	Min	Max
<i>nim</i>	2.90	2.11	-0.53	31.65
<i>st ir</i>	0.43	0.59	-0.49	8.05
<i>spread</i>	2.15	1.38	-0.41	21.93
<i>gdp</i>	1.33	1.73	-9.10	25.60
<i>infl</i>	1.44	1.16	-1.50	5.70
<i>unem</i>	8.40	3.18	4.00	27.50
<i>lta</i>	15.31	2.10	10.31	21.75
<i>llr gl</i>	3.26	3.73	-2.20	46.41
<i>eq ta</i>	10.34	4.49	-3.93	63.57
<i>cir</i>	65.22	24.66	0.03	851.20
<i>nl ta</i>	61.61	16.39	1.80	98.73
<i>nl dstf</i>	84.54	38.09	2.40	827.06
<i>la dstf</i>	16.83	22.31	0.01	391.32
<i>bhhc</i>	0.17	0.37	0	1
<i>coop</i>	0.24	0.42	0	1
<i>rem</i>	0.04	0.19	0	1
<i>savings</i>	0.06	0.24	0	1
<i>large</i>	0.17	0.37	0	1
<i>small</i>	0.20	0.40	0	1
<i>negrate</i>	0.16	0.37	0	1
<i>capbas</i>	0.49	0.50	0	1
Number of observations	6930			
Number of groups	1155			
Observations per group	6			

Source: Authors' calculation in Stata 11.2.

Table A.2: Cross-correlation table

	<i>nim</i>	<i>st_ir</i>	<i>spread</i>	<i>gdp</i>	<i>infl</i>	<i>unem</i>	<i>lta</i>
<i>nim</i>	1.00 -						
<i>st_ir</i>	0.03 (0.00)	1.00 -					
<i>spread</i>	-0.05 (0.00)	0.06 (0.00)	1.00 -				
<i>gdp</i>	0.14 (0.00)	-0.01 (0.51)	-0.59 (0.00)	1.00 -			
<i>infl</i>	0.11 (0.00)	0.47 (0.00)	0.31 (0.00)	-0.22 (0.00)	1.00 -		
<i>unem</i>	-0.19 (0.00)	-0.10 (0.00)	0.55 (0.00)	-0.46 (0.00)	-0.06 (0.00)	1.00 -	
<i>lta</i>	-0.13 (0.00)	0.08 (0.00)	-0.20 (0.00)	0.22 (0.00)	-0.00 (0.86)	-0.13 (0.00)	1.00 -
<i>llr_gl</i>	-0.02 (0.19)	-0.06 (0.00)	0.24 (0.00)	-0.22 (0.00)	-0.21 (0.00)	0.48 (0.00)	-0.13 (0.00)
<i>eq_ta</i>	0.35 (0.00)	-0.03 (0.01)	-0.01 (0.47)	0.06 (0.00)	0.01 (0.28)	-0.07 (0.00)	-0.32 (0.00)
<i>cir</i>	-0.11 (0.00)	0.01 (0.43)	0.02 (0.14)	-0.00 (0.70)	0.06 (0.00)	-0.05 (0.00)	-0.08 (0.00)
<i>nl_ta</i>	0.23 (0.00)	0.09 (0.00)	0.02 (0.11)	0.05 (0.00)	0.03 (0.01)	-0.11 (0.00)	-0.06 (0.00)
<i>nl_dstf</i>	0.01 (0.64)	0.13 (0.00)	0.08 (0.00)	-0.12 (0.00)	0.04 (0.00)	0.04 (0.00)	0.01 (0.29)
<i>la_dstf</i>	-0.21 (0.00)	0.02 (0.04)	-0.07 (0.00)	-0.04 (0.00)	0.01 (0.21)	0.00 (0.87)	0.20 (0.00)
<i>bhhc</i>	0.13 (0.00)	-0.01 (0.33)	-0.11 (0.00)	0.18 (0.00)	0.06 (0.00)	-0.21 (0.00)	0.10 (0.00)
<i>coop</i>	-0.21 (0.00)	-0.07 (0.00)	0.31 (0.00)	-0.46 (0.00)	-0.08 (0.00)	0.41 (0.00)	-0.43 (0.00)
<i>rem</i>	-0.17 (0.00)	0.04 (0.00)	-0.13 (0.00)	0.06 (0.00)	-0.01 (0.54)	-0.11 (0.00)	0.10 (0.00)
<i>savings</i>	-0.05 (0.00)	-0.01 (0.67)	-0.03 (0.01)	-0.02 (0.19)	-0.02 (0.08)	0.01 (0.50)	0.05 (0.00)
<i>large</i>	-0.16 (0.00)	0.05 (0.00)	-0.04 (0.00)	0.05 (0.00)	-0.02 (0.12)	0.09 (0.00)	0.75 (0.00)
<i>small</i>	-0.10 (0.00)	-0.07 (0.00)	0.29 (0.00)	-0.39 (0.00)	-0.08 (0.00)	0.35 (0.00)	-0.62 (0.00)
<i>negrate</i>	-0.21 (0.00)	-0.43 (0.00)	-0.24 (0.00)	0.06 (0.00)	-0.51 (0.00)	0.24 (0.00)	-0.09 (0.00)
<i>capbas</i>	0.38 (0.00)	-0.05 (0.00)	-0.24 (0.00)	0.43 (0.00)	0.17 (0.00)	-0.50 (0.00)	0.14 (0.00)
	<i>llr_gl</i>	<i>eq_ta</i>	<i>cir</i>	<i>nl_ta</i>	<i>nl_dstf</i>	<i>la_dstf</i>	<i>bhhc</i>
<i>llr_gl</i>	1.00 -						

<i>eq ta</i>	-0.01 (0.42)	1.00 -					
<i>cir</i>	0.01 (0.27)	0.02 (0.10)	1.00 -				
<i>nl ta</i>	-0.13 (0.00)	-0.02 (0.12)	-0.14 (0.00)	1.00 -			
<i>nl dstf</i>	-0.03 (0.01)	-0.02 (0.07)	-0.17 (0.00)	0.59 (0.00)	1.00 -		
<i>la dstf</i>	0.08 (0.00)	0.04 (0.00)	0.08 (0.00)	-0.50 (0.00)	0.01 (0.59)	1.00 -	
<i>bhhc</i>	-0.18 (0.00)	0.03 (0.02)	0.03 (0.01)	-0.02 (0.18)	-0.10 (0.00)	-0.06 (0.00)	1.00 -
<i>coop</i>	0.27 (0.00)	0.05 (0.00)	-0.01 (0.26)	-0.08 (0.00)	0.12 (0.00)	-0.02 (0.04)	-0.25 (0.00)
<i>rem</i>	-0.10 (0.00)	-0.17 (0.00)	-0.07 (0.00)	0.17 (0.00)	0.36 (0.00)	0.08 (0.00)	-0.09 (0.00)
<i>savings</i>	0.03 (0.00)	-0.04 (0.00)	0.02 (0.17)	0.10 (0.00)	0.02 (0.15)	-0.03 (0.01)	-0.12 (0.00)
<i>large</i>	-0.05 (0.00)	-0.22 (0.00)	-0.06 (0.00)	-0.12 (0.00)	0.06 (0.00)	0.23 (0.00)	0.00 (0.76)
<i>small</i>	0.26 (0.00)	0.19 (0.00)	0.05 (0.00)	-0.10 (0.00)	0.08 (0.00)	0.03 (0.01)	-0.22 (0.00)
<i>negrate</i>	0.31 (0.00)	-0.06 (0.00)	0.01 (0.41)	-0.10 (0.00)	0.01 (0.38)	0.08 (0.00)	-0.17 (0.00)
<i>capbas</i>	-0.43 (0.00)	0.16 (0.00)	-0.01 (0.30)	0.11 (0.00)	-0.21 (0.00)	-0.22 (0.00)	0.38 (0.00)
	<i>coop</i>	<i>rem</i>	<i>savings</i>	<i>large</i>	<i>small</i>	<i>negrate</i>	<i>capbas</i>
<i>coop</i>	1.00 -						
<i>rem</i>	-0.11 (0.00)	1.00 -					
<i>savings</i>	-0.14 (0.00)	-0.05 (0.00)	1.00 -				
<i>large</i>	-0.17 (0.00)	0.09 (0.00)	-0.03 (0.01)	1.00 -			
<i>small</i>	0.65 (0.00)	-0.03 (0.01)	-0.11 (0.00)	-0.22 (0.00)	1.00 -		
<i>negrate</i>	0.26 (0.00)	0.05 (0.00)	0.04 (0.00)	0.02 (0.14)	0.23 (0.00)	1.00 -	
<i>capbas</i>	-0.55 (0.00)	-0.13 (0.00)	-0.09 (0.00)	-0.06 (0.00)	-0.48 (0.00)	-0.43 (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	S-GMM	Pooled
	<i>NIM</i>	<i>NIM</i>	<i>NIM</i>
<i>NIM (first lag)</i>	0.238*** (0.0708)	0.846*** (0.0286)	0.941*** (0.0270)
<i>short-term rate</i>	0.162** (0.0793)	0.108*** (0.0325)	0.132** (0.0524)
<i>short-term rate squared</i>	-0.0259*** (0.00831)	-0.0223*** (0.00633)	-0.0258*** (0.00823)
<i>spread</i>	0.0366 (0.0229)	-0.00847 (0.0131)	-0.0163 (0.0139)
<i>spread squared</i>	-0.00196* (0.00104)	-0.000895 (0.000822)	-0.000514 (0.000710)
<i>GDP growth</i>	0.0196*** (0.00616)	0.0145*** (0.00518)	0.00934** (0.00425)
<i>inflation</i>	0.0674*** (0.0149)	0.0591*** (0.0112)	0.0513*** (0.0118)
<i>unemployment</i>	0.0188* (0.0113)	-0.00322 (0.00337)	0.000736 (0.00293)
<i>log (total assets)</i>	-0.229*** (0.0839)	-0.0108 (0.00926)	-0.00388 (0.00716)
<i>loan loss reserves/gross loans</i>	0.00309 (0.00676)	0.0128*** (0.00403)	0.00821** (0.00335)
<i>equity/total assets</i>	0.0232** (0.0105)	0.0128** (0.00551)	0.00984** (0.00447)
<i>cost/income ratio</i>	-0.00266*** (0.000706)	-0.00114** (0.000461)	-0.000547 (0.000601)
<i>net loans/total assets</i>	0.0141*** (0.00334)	0.00535*** (0.000920)	0.00337** * (0.00101)
<i>net loans/deposits & short-term funding</i>	-0.000711 (0.000586)	-0.0000578 (0.000301)	0.0000360 (0.000183)
<i>liquid assets/deposits & short-term funding</i>	0.000756 (0.00104)	-0.000244 (0.000507)	0.000376 (0.000377)
<i>bank holdings & holding companies dummy</i>	-	0.0285 (0.0225)	0.0382 (0.0287)
<i>cooperative banks dummy</i>	-	-0.106*** (0.0282)	-0.0758*** (0.0207)
<i>real estate & mortgage banks dummy</i>	-	-0.177*** (0.0565)	-0.0462 (0.0354)
<i>savings banks dummy</i>	-	-0.0608*** (0.0235)	-0.0425** (0.0191)
<i>large banks dummy</i>	-	0.0261 (0.0380)	0.0217 (0.0291)
<i>small banks dummy</i>	-	0.00194 (0.0315)	-0.00109 (0.0305)

<i>negative rate dummy</i>	-0.0339 (0.0366)	-0.00686 (0.0227)	0.0425* (0.0246)
<i>capital based market dummy</i>	-	0.0902** (0.0379)	0.00190 (0.0639)
<i>Constant</i>	4.426*** (1.442)	0.0216 (0.170)	-0.223* (0.124)
<i>Number of observations</i>	5775	5775	5775
<i>F/Wald statistic</i>	58.41***	26351.05***	2345.8***
<i>R-squared</i>	0.208	-	0.941

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 <i>NIM</i>	FE <i>NIM</i>	Pooled OLS <i>NIM</i>
<i>short-term rate</i>	-0.0698** (0.0321)	-0.0611* (0.0324)	-0.186** (0.0855)
<i>short-term rate squared</i>	-0.00763 (0.00510)	-0.00920* (0.00507)	0.0182 (0.0158)
<i>spread</i>	0.000270 (0.0158)	0.00962 (0.0160)	-0.191*** (0.0388)
<i>spread squared</i>	-0.000000132 (0.000878)	-0.000757 (0.000873)	0.0113*** (0.00252)
<i>GDP growth</i>	0.0100* (0.00584)	0.0107* (0.00581)	-0.000520 (0.0172)
<i>inflation</i>	0.105*** (0.00986)	0.0997*** (0.0101)	0.171*** (0.0248)
<i>unemployment</i>	0.0208** (0.00594)	0.0273*** (0.00620)	-0.0510*** (0.0100)
<i>log (total assets)</i>	-0.135*** (0.0275)	-0.127** (0.0319)	-0.160*** (0.0219)
<i>loan loss reserves/gross loans</i>	0.0188*** (0.00418)	0.0111** (0.00425)	0.120*** (0.00681)
<i>equity/total assets</i>	0.0236** (0.00370)	0.0139** (0.00384)	0.123*** (0.00515)
<i>cost/income ratio</i>	-0.00304*** (0.000352)	-0.00272*** (0.000351)	-0.00977*** (0.000860)
<i>net loans/total assets</i>	0.0249*** (0.00158)	0.0250*** (0.00165)	0.0233*** (0.00210)
<i>net loans/deposits & short-term funding</i>	-0.000660 (0.000518)	-0.000793 (0.000526)	0.000963 (0.000836)
<i>liquid assets/deposits & short-term funding</i>	0.00125 (0.000835)	0.00222** (0.000855)	-0.00584*** (0.00127)

<i>bank holdings & holding companies dummy</i>	-0.0821 (0.142)	-	-0.0168 (0.0601)
<i>cooperative banks dummy</i>	-0.851*** (0.169)	-	-0.748*** (0.0756)
<i>real estate & mortgage banks dummy</i>	-1.632*** (0.265)	-	-1.480*** (0.123)
<i>savings banks dummy</i>	-0.500*** (0.211)	-	-0.509*** (0.0900)
<i>large banks dummy</i>	-0.0938 (0.168)	-	0.310** (0.0967)
<i>small banks dummy</i>	0.248 (0.181)	-	-0.0373 (0.0910)
<i>negative rate dummy</i>	-0.158*** (0.0324)	-0.139*** (0.0326)	-0.494*** (0.0959)
<i>capital based market dummy</i>	1.193*** (0.136)	-	0.896*** (0.0741)
<i>Constant</i>	2.773*** (0.493)	2.971*** (0.547)	3.361*** (0.402)
<i>Number of observations</i>	6930	6930	6930
<i>F/Wald statistic</i>	1498.46***	69.02***	167.6***
<i>R-squared</i>	0.276	0.152	0.348
<i>Hausman test</i>	265.62***	-	-

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
United States of America	526
Total	1155

Source: Authors based on Orbis Bank Focus.

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