The sensitivity of banks' net interest margins to interest rate conditions in CESEE

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Since the global financial crisis, the relationship between monetary policy and banks' net interest margins (NIMs) has been investigated in many studies, not least in light of the low interest rate environment. However, to our knowledge, this is the first econometric study that explores this topic for the Central, Eastern and Southeastern European (CESEE) economies. Using bank-level data for 15 CESEE countries from 2006 to 2018, we assess the effect of the interest rate environment on banks' NIMs. Our policy rate variable takes into account both the domestic and the international interest rate environment (euro area, U.S.A. and Switzerland). To construct this variable, we use the shares of foreign and domestic currency loans in total bank loans extended to the domestic private sector as weights for the interbank rates of the different jurisdictions. Our results show that lower (weighted) interest rates lead to lower NIMs and that the effect is nonlinear, i.e. it becomes more pronounced as the level of interest rates falls. This finding is in line with the existing literature on other, more advanced economies. As net interest income (NII) is the key revenue component of banks, especially given the traditional lending and deposit-taking business model prevalent in the CESEE banking sectors, we conclude that both pressures on NIMs and the development of interest rates in the region and worldwide should be monitored closely.

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In many countries, the global financial crisis (GFC) was followed by a prolonged period of monetary easing and extremely accommodative monetary conditions. At the same time, bank profitability took a severe hit due to varying factors ranging from immediate direct consequences of the crisis on bank balance sheets (e.g. asset quality deterioration) to increased regulatory costs and a double-dip recession in Europe. Bank profitability is key for financial stability, as illustrated, for instance, by the concerns voiced by the European Banking Authority (EBA). In its regular risk assessments, the EBA has repeatedly named profitability as a key challenge for the banking sector of the European Economic Area. In the second quarter of 2019, it stated that "almost 50% of banks participating in the Risk Assessment Questionnaire suggest their current earnings do not cover their cost of equity." While both bank profitability and net interest margins in the Central, Eastern and Southeastern European (CESEE) economies continue to be above the EU average, the region is subject to historically low interest rates. Hence, it is worth paying attention to the effects low interest rates have on banking sector profitability in the region.

In this study, we only focus on one aspect of bank profitability, namely net interest margins (NIMs)[2], and therefore do not attempt to make a general statement

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[2] *In this study, net interest margins are defined as net interest income over average financial assets.*

about the impact the current accommodative monetary policy has on bank profitability. Instead, we take a closer look at one of the key revenue components, which in our view best reflects the sustainability of the traditional bank business model that is centered on maturity transformation and is prevalent in the CESEE region. Many studies on NIMs published since the GFC found that lower market and/or monetary policy rates have a negative effect on NIMs and that this negative effect increases as the interest rate level falls (e.g. Borio et al., 2015; Claessens et al., 2016; Egly et al., 2018). The relationship has thus been found to be concave. We are not aware of any papers studying this relationship econometrically for CESEE, which is most likely due to a lack of readily available data. With our paper, we try to fill this gap in the literature.

Methodologically, our paper loosely follows Borio et al. (2015), who study the influence of monetary policy on various components of bank profitability for 109 large international banks headquartered in 14 advanced economies for the period 1995–2012. The authors construct a measure for bank-specific monetary policy rates[3] which takes into account banks' exposure to different currencies and thus foreign monetary policy. We replicate this methodology as foreign monetary policy rates are important for most CESEE economies, given that the shares of foreign currency assets and liabilities are substantial in many countries of the region and some countries have fixed exchange rates pegged to the euro. Due to data limitations, our currency-weighted interest rate indicator is only country and not bank specific.

Our sample covers roughly 500 banks from 15 CESEE countries over the period 2006 to 2018. The countries examined in our analysis are Albania, Bosnia and Herzegovina, Bulgaria, the Czech Republic, Croatia, Hungary, Montenegro, North Macedonia, Poland, Romania, Russia, Serbia, Slovakia, Slovenia and Turkey. Despite the heterogeneity of the countries included in our sample, our results largely confirm the findings of the existing literature on other regions and countries, namely that NIMs are positively related to the level of interest rates and that the relationship is concave. We also partially confirm some findings regarding the interaction with business model characteristics but cannot find a significant effect of the term spread on NIMs.

The paper is structured as follows: section 1 provides an overview of the literature on the nexus of NIMs and the interest rate environment. Sections 2 and 3 explain the data and methodology used. Section 4 presents the results, section 5 discusses their robustness and section 6 concludes.

1 Literature review

Net interest income (NII) is the most important revenue component for banks. In our sample, both the average and the median share of NII in total operating income are around 70%, with limited variation across time for the full sample. In 2018, the lowest share was reported in Hungary, coming to about 50%.[4] NII is not only one of the key determinants of bank profitability, but it also most closely reflects the income that can be generated through traditional banking business centered on

[3] *Please note that, when we refer to monetary policy rates or the interest rate environment throughout the remainder of this study, these are defined as rates on the interbank markets. Therefore, our findings only reflect effects of unconventional monetary policy on interbank rate movements.*

[4] *Across countries, the evolution of the share of NII over the sample period was heterogeneous.*

maturity transformation. NII thus also best reflects the sustainability of this business model. As pointed out by Borio et al. (2015), the relationship between monetary policy and bank profitability was rarely a focus of research before the GFC. Since then, most of the empirical literature on the matter and the related issue of interest rate risk has centered on advanced economies and/or large banks. The relationship between monetary policy rates and NIMs is rather complex and is likely to vary across countries and banks; individual countries are characterized by differences in the monetary policy transmission mechanism, banks exhibit differences in the structure of their assets and liabilities and their market power (see for instance Scheiber et al., 2016). Further, both characteristics may change over time. These multiple sources of variation may result in differences in the relationship between monetary policy rates and NIMs.

Theoretically, the relationship between short-term interest rates and NIMs is ambiguous.[5] Given that banks' business models rely on maturity transformation, with predominantly long-term and often fixed-rate assets and short-term and variable-rate liabilities, one could assume a negative relationship in the short run. In other words, a decrease in policy rates could lead to an increase in the NIM in the short term. To be precise, a decline in the short-term policy rate should immediately lower funding costs, while interest income reacts more slowly. This would imply a higher term spread and thus higher NIMs (Ennis et al., 2016; Scheiber et al., 2016). However, as Borio et al. (2015) point out, the transmission from short-term to long-term rates can be quite swift and a large portion of the effect described above is likely to disappear when annual data are used. Yet, there are several channels which can explain why most studies tend to find that NIMs fall once interest rates decline: short-term funding largely takes the form of deposits and when interest rates fall, banks could be reluctant to lower the interest paid on deposits to the extent necessary to maintain their margins in fear of losing customers. In the recent low and negative interest rate environment, lowering deposit rates may even become legally or practically impossible. This means that a large portion of banks' short-term funding cost remains fixed at the zero lower bound or mildly above, while long-term rates charged on assets continue to fall. This compression of the term spread has negative effects on banks' returns on maturity transformation (Ennis et al., 2016; Scheiber et al., 2016).

Moreover, banks tend to price their deposits at a markdown on market rates depending on their market power. If a fall in interest rates yields a lower markdown or potentially even a markup, this will lower NIMs (Borio et al., 2015; Ennis et al., 2016).

These effects may become more pronounced as interest rates fall, leading to a nonlinear relationship between NIMs and market interest rates. Such a stronger reaction of banks' NIMs to low interest rates can arise either from the income or the expenditure side: at the zero lower bound, banks face practical and legal constraints in passing on lower market rates to customers. At the same time, interest rates on loans to customers continue to decline, which compresses margins. Even when the zero lower bound has not been hit, banks can become more reluctant to

[5] *The interested reader can consult Borio et al. (2015), who present an adapted version of the Monti-Klein model in the annex of their study to micro-found their empirical analysis. It shows how banks' NII could theoretically change with respect to interest rate and yield curve changes.*

lower deposit rates amid sinking market rates, while competitive pressures may induce them to lower loan rates, which again compresses margins.

As to the empirical literature, Busch and Memmel (2017) find for the German banking system that the relationship is initially negative and turns positive after around 1.5 years in line with the arguments above. Likewise, Alessandri and Nelson (2014) find differing short-term and long-term effects for U.K. banks, where the long-term effect is positive.

Most recent studies use annual data and find a positive relationship between market interest rates and NIMs. Molyneux et al. (2018) confirm this positive relationship, for OECD countries, also in the case of negative interest rates in the period 2012–2016. Boungou (2020) corroborates this finding for EU Member States over a similar period (2011–2017) and reports even stronger effects in countries with a negative interest rate policy.

Moreover, other studies find nonlinearity in the relationship, e.g. Kerbl and Sigmund (2016) for Austria, Busch and Memmel (2017) for Germany, and Genay and Podjasek (2014) as well as Egly et al. (2018) for the U.S.A. Borio et al. (2015) and Claessens et al. (2016) find qualitatively similar results for multi-country samples. Claessens et al. (2016) attribute the nonlinearity to a higher pass-through of short-term rates to interest income in the low interest rate environment. Banks need to pass on lower market interest rates to their customers, especially when the latter have other funding choices.

Borio and Gambacorta (2017) find empirical support for the markdown channel and conclude that, due to this channel, monetary policy easing becomes less effective in stimulating lending at low interest rate levels.

One study that stands in contrast to this literature is Scheiber et al. (2016), which examines bank profitability in Denmark, Sweden and Switzerland. The authors find that NII had not declined significantly since 2010, as interest expenditure had contracted at a faster pace than interest income. One explanation for this could be that Nordic banks are less exposed to the zero lower bound on deposit rates, given their uniquely low shares of deposits. Instead, they were able to benefit from the continued fall in funding costs for wholesale funding (Elliot et al., 2016).

Only a few studies focus on the relationship between NIMs and the interest rate environment for CESEE, and to our knowledge none uses econometric techniques to investigate this relationship. A distinct feature of the region is the heterogeneity of the countries with respect to their stage of EU or euro area integration and the related variety of monetary policy and exchange rate regimes. But these characteristics have changed not only across countries, but also over time. By the end of our observation period, two countries (Slovakia and Slovenia) had become euro area members, while others were inflation targeters (e.g. the Czech Republic, Hungary, Poland, but also Russia toward the end of the sample). In constructing our dataset and in our modeling setup, we took great care to consider all these differences and control for any effects that arise from these distinct features.

Apart from institutional differences, many of the countries in our analysis have substantial shares of foreign currency assets and/or liabilities, which are mostly denominated in euro but in some countries also in U.S. dollars or Swiss francs. This is why foreign monetary policy is even more important for CESEE banks (Égert and MacDonald, 2008). The Oesterreichische Nationalbank has published several descriptive studies on the profitability developments of Austrian banks' subsidiaries in CESEE. Ebner et al. (2016) split the sample into a pre- and a post-GFC period (2003–2008 and 2009–2015) and document a shift in the balance sheet of Austrian banks' CESEE subsidiaries.[6] On the asset side, sovereign bonds replaced loans to the real economy. On the liability side, deposits from nonbanks replaced deposits from credit institutions. These balance sheet changes were likely to contribute to pressures on spreads, with the latter falling by 78 basis points between the pre- and the post-crisis period. The authors attribute roughly 75% of this effect to the contracting spread between the average yield on interest-earning assets (IEAs) and the average cost of interest-bearing liabilities (IBLs) and the remainder to changes in the volumes of IEAs and IBLs. For the post-GFC period, Feldkircher and Sigmund (2017) find a positive effect from competition on profitability reflected by better capitalization, higher loan loss provisions and larger markups, with the effect being stronger for Austrian banks' subsidiaries in CESEE than for their parent banks.[7] Kavan and Martin (2015) show that, in the first years after the GFC, interest rate spreads in Croatia, Hungary and Romania increased due to asset yield losses being overcompensated by cheaper funding. After 2011, the fall in funding costs bottomed out, while asset yields continued to decrease, which compressed spreads.

2 Data

Our sample covers bank-level data for the following 15 CESEE countries: Albania, Bosnia and Herzegovina, Bulgaria, the Czech Republic, Croatia, Hungary, Montenegro, North Macedonia, Poland, Romania, Serbia, Russia, Slovakia, Slovenia and Turkey. Chart 1 shows the evolution of interest rates in the countries with a floating exchange rate.[8] A comparison of interest rates in the CESEE EU Member States (left panel) with the rates in the euro area, the U.S.A. and in Switzerland (middle panel) shows that there is still a positive rate differential. For our analysis, the evolution over time is more relevant, however. The chart clearly illustrates the strong reduction in interest rates over time and the historically low level of interest rates evident especially from 2014 onward. The Western Balkans (right panel) show similar developments. Russia and Turkey exhibit distinct conditions; following the marked currency depreciation during 2018, interest rates in Turkey became very elevated.

As outlined below, our main explanatory variable is a composite variable that consists of a weighted average of foreign and domestic interest rates. Chart 2 depicts the evolution of our proxy for monetary policy conditions. The strong decline to historically low levels in the aftermath of the crisis and especially following the double-dip recession is again more pronounced in the CESEE EU Member States and the Western Balkans, while developments are less clear cut in Russia and Turkey.

The dataset includes all banks operating on a consolidated level that are listed for our countries of interest on the S&P Global Market Intelligence platform. We use annual data, and the sample period ranges from 2006 to 2018, even though for

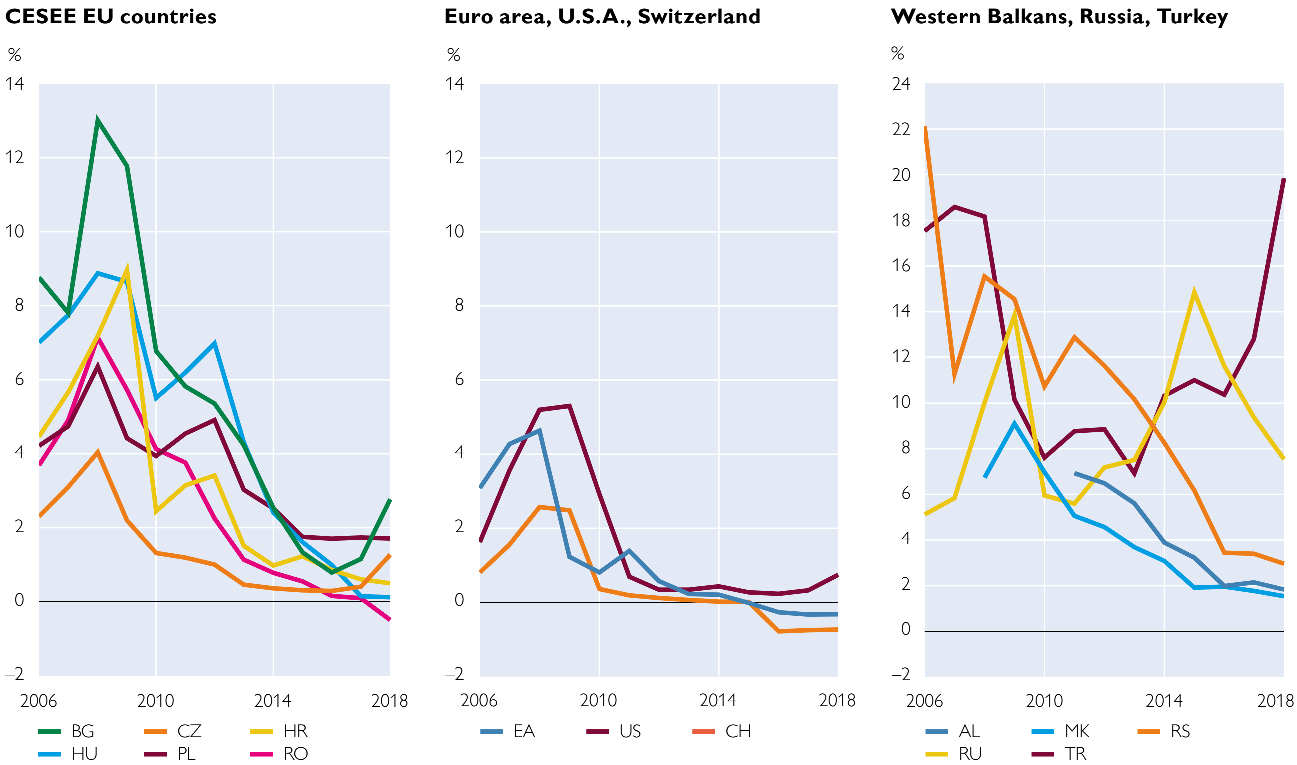
[6] *For the CESEE banking sector more generally, Lahnsteiner (2020; in this FEEI issue) confirms a material transformation of refinancing structures in CESEE banking sectors since the GFC, which is traceable to an increase in domestic deposits (and a shrinking credit stock in some cases).*

[7] *Analyzing the determinants of the NIM for Austrian banks over the period from 1998 to 2013, Gunter et al. (2013) also confirm a positive relationship between competition as measured by the Lerner index and the NIM.*

[8] *Interest rates in the countries in the sample that (unilaterally) adopted the euro closely follow the EURIBOR.*

Chart 1

Evolution of three-month interbank rates

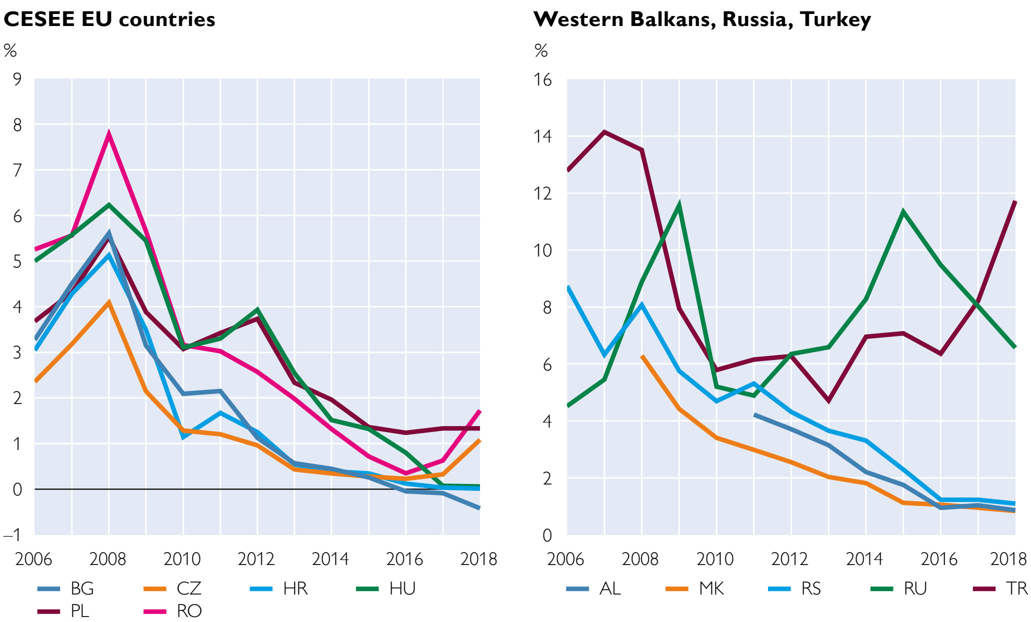


Source: Authors' calculations, national central banks.

Note: Rates for BA, ME, SI and SK are (largely) identical to the euro area (EA) rate and are thus not displayed.

Chart 2

Monetary policy conditions variable by country, 2006–2018



Source: Authors' calculations, national central banks.

Note: Rates for BA, ME, SI and SK are (largely) identical to the euro area (EA) rate and are thus not displayed.

Table 1

Mean of net interest margins in CESEE by country, 2006–2018

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Frequency
	%													
AL	.	.	.	.	.	3.7	3.6	3.2	3.4	3.5	3.3	3.1	3.4	109
BA	4.7	4.3	4.0	3.5	3.6	4.4	4.3	4.0	3.7	3.6	3.8	3.6	3.0	200
BG	6.4	6.1	5.6	5.2	4.6	3.2	2.9	3.1	3.3	3.6	3.8	3.8	3.7	182
CZ	2.5	2.7	2.9	2.9	2.9	2.4	2.1	2.1	2.2	2.0	1.8	1.7	1.9	207
HR	2.8	3.1	3.3	3.2	3.1	3.3	2.8	2.7	2.7	2.7	2.7	2.9	2.7	203
HU	4.1	3.8	3.1	3.5	3.8	3.5	3.7	3.3	3.2	2.8	2.8	2.2	2.1	214
ME	2.3	2.6	2.7	4.1	3.7	4.5	4.4	4.5	4.0	3.6	3.3	3.2	3.1	85
MK	5.2	4.4	4.0	4.5	4.2	4.5	3.9	4.0	4.2	4.1	4.1	4.0	3.8	128
PL	3.2	3.2	3.3	2.6	2.8	3.8	3.8	3.4	3.3	2.8	3.0	3.1	3.2	264
RO	4.5	3.8	4.3	4.2	4.5	4.3	3.6	3.4	3.4	3.2	3.1	2.8	3.0	207
RS	5.6	6.8	7.2	6.2	4.7	5.6	5.3	4.9	4.9	5.0	4.7	4.5	4.3	221
RU	8.3	6.8	6.5	5.4	5.1	5.7	5.7	5.7	5.6	5.3	5.5	5.5	5.1	1,897
SI	2.7	2.5	2.5	2.2	2.3	2.4	2.2	2.0	2.5	2.3	2.1	2.1	2.1	123
SK	.	.	2.6	2.8	3.2	4.6	4.6	4.6	4.6	4.7	4.4	3.6	2.5	124
TR	5.2	5.6	5.7	6.2	4.9	4.3	5.2	4.2	4.3	4.2	4.2	4.5	5.2	333
Frequency	65	78	100	104	108	489	505	514	517	516	512	522	467	4,497

Source: OeNB.

the years before 2011 markedly fewer banks are available in the said database. Up to end-2010, the number of banks per country varies between 1 (Montenegro, Serbia, Slovakia and Slovenia) and 23 (Russia). From 2011 onward, this number ranges from 10 (Montenegro) to more than 200 (Russia). To complement the bank-level data, we use macroeconomic data from different sources, mostly national central banks, but also Eurostat, Bloomberg and Macrobond.

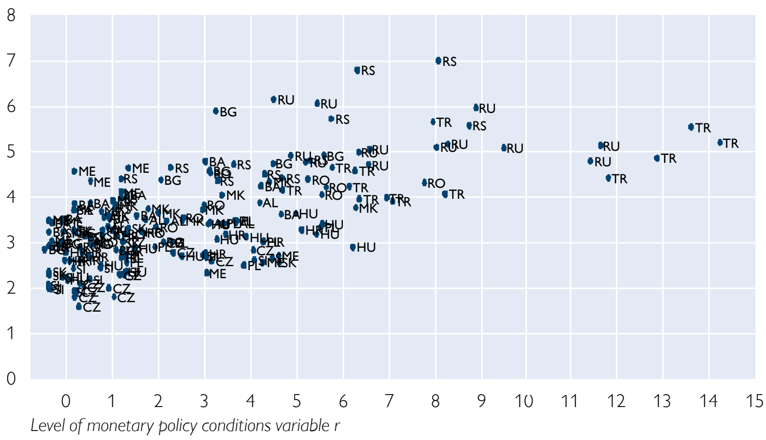
We exclude leasing and factoring companies as well as all credit institutions that reportedly do not hold deposits, as we assume that the latter have a "special" business model and are therefore not relevant for this study. In addition, we exclude banks that were put under restructuring or were liquidated after we had collected our data. The cleaned dataset comprises 4,497 observations, of which roughly 40% can be attributed to Russian banks. For the other countries, the total number of observations collected for the entire period ranges from 85 (Montenegro) to 333 (Turkey).

A cursory glance at our variable of interest shows that NIMs were trending downward over time (see table 1). When we exclude the pre-2011 period given the lower number of reporting banks, the sample NIM had fallen by roughly 70 basis points since 2011, namely to 4.7% (mean) and 4.1% (median) in 2018. When we exclude Russia and

Chart 3

Median of net interest margins and monetary policy conditions

Net interest margin – country median



Source: Authors' calculations.

Note: Median of net interest margin by country and year; monetary policy conditions reflect a weighted average of foreign and domestic monetary policy rates.

Turkey, which make up a large portion of the sample, the average NIM decreased by roughly 85 basis points to 3% and the median NIM by roughly 70 basis points to 2.8% between 2011 and 2018. T-tests confirm that the NIMs of the full sample and the sample excluding Russia and Turkey are statistically significantly lower in 2018 than in 2011.

Chart 3 plots the median NIM for each country in each year against our proxy for monetary policy conditions (i.e. the interest rate variable, see the next section for a description of this indicator). At lower interest rate levels, NIMs tend to be lower as well, and this positive relationship seems to be concave.[9] This would be in line with the literature.

3 Methodology

Using the model estimated by Borio et al. (2015) as a reference, we modified it to better fit our CESEE sample. Borio et al. (2015) theoretically base their estimations on a modified version of the Monti-Klein model for an oligopolistic banking market. It should be noted that this model is not uncontested, as several studies have found that one of its critical assumptions (cost-separation) does not hold (Elyasiani et al., 1995; Siebenbrunner and Sigmund, 2019). However, given the widespread practice in the literature of modeling bank profitability (components) in ways similar to that used in Borio et al. (2015), we choose this approach to better embed our study in the existing literature and leave more complicated modeling approaches for further research. Indexing individual banks with *i*, countries with *k* and years with *t*, we use the following model:

$$\begin{aligned} \mathrm{nim}_{i,k,t} = {} & \alpha_1\, \mathrm{nim}_{i,k,t-1} + \alpha_2\, \mathrm{nim}_{i,k,t-2} + \beta_1\, r_{k,t} + \beta_2\, r^2_{k,t} + \gamma_1\, \sigma_{k,t} + \varphi' C_{k,t} \\ & + \omega' X_{i,k,t} + \text{time dummies} + \mu_i + \varepsilon_{i,k,t} \end{aligned}$$

In this model, we take the NIM as the main dependent variable, which is defined as NII over average financial assets. The variable $r_{k,t}$ and its square stand for the interest rate variable akin to a weighted interest rate and are the explanatory variables of interest. Borio et al. (2015) construct their interest rate variable for each bank in their sample, using the asset and liability structure by currency as weights for the short-term money market rates of different jurisdictions. This approach seems also highly relevant for CESEE banks, which often hold high shares of foreign currency loans and deposits, and for the CESEE countries, which are largely small, open economies that considerably depend on the euro area in economic terms. However, a currency breakdown by bank is not available for most CESEE banks. Instead, we use country-wide data on the currency breakdown of loans to the private sector and construct a weighted monetary policy rate variable that varies by country, but not by bank. For instance, in Croatia the three-month EURIBOR receives a weight of 57% in the construction of $r_{k,\,2018}$ given that the reported share of loans denominated in euro was 57% in 2018. The use of short-term market rates for this purpose is standard in the literature.[10]

[9] *This relationship also holds when we exclude Russia and Turkey, the two countries with the highest NIMs and interest rates.*

[10] *For Bosnia and Herzegovina, we used the EURIBOR for local currency exposures for lack of a suitable market rate. For some countries in the region, local interbank markets are rather small and illiquid – for Bulgaria and Croatia, we tried our specification with a deposit-based reference rate as robustness check and found that our baseline results are mostly unchanged.*

To capture the nonlinearity in the relationship which is suggested by chart 1 and also noted in other studies, we include the square of $r_{k,t}$ in the equation. Unlike Borio et al. (2015), we do not include the term spread in the baseline, given that long-term yields are not available for several countries in our sample. We add the absolute value of the coefficient of variation of the national three-month interbank rate ($\sigma_{k,t}$) to capture perceived uncertainty about financial conditions in a given country.

The vector C includes various macroeconomic control variables. We use the growth rate of nominal GDP[11]. In addition, we include the ratio of total loans to GDP as a measure of financial development. Reflecting higher costs of financial intermediation and less efficiency, NIMs in emerging economies are often higher than in advanced economies. As the financial development progresses in emerging markets, NIMs tend to decline (see Schwaiger and Liebeg, 2007). We thus use the financial development proxy to capture this effect.

In addition, we control for several bank characteristics and the bank-fixed effect μ_i. We use many of the control variables as Borio et al. (2015), namely the logarithm of bank size, the equity-to-total assets ratio, the cost-to-income ratio and the liquidity-to-total assets ratio (for summary statistics, see table A1 in the annex). We rely on the literature on the bank-lending channel, according to which these control variables only have an impact on the supply of loans as they affect banks' ability to withstand shocks and influence banks' lending decisions (see Borio et al., 2015, for a detailed justification of the choice of controls).

We include two lags of the dependent variable in our model. The lags reflect the persistence of NIMs attributable to banks' efforts to stabilize this important profitability component and to the fact that current NIMs reflect past choices regarding asset and liability volumes and pricing. Including a lag of the dependent variable also helps with potential endogeneity if the state of the banking sector influences monetary policy. However, given that our monetary policy rate indicator also includes foreign monetary policy rates, we do not think that endogeneity is a major issue in our model.

We try different estimation methods for our dynamic panel data model and choose the difference Generalized Methods of Moments (GMM) estimation following Arellano and Bond (1991) as our baseline. We use Windmeijer-corrected robust standard errors and forward orthogonal deviations (FODs) to minimize the loss of data in our unbalanced panel. We collapse the instrument set and limit the lag length for the instrument to avoid instrument proliferation (Roodman, 2009a). Borio et al. (2015) estimate their model using a system GMM with instruments suggested by Blundell and Bond (1998). For our sample, we are skeptical of the additional moment conditions and sensitivity of the system GMM estimator to instrument set choices and therefore choose to estimate via difference GMM. In a system GMM estimation comparable to our difference GMM baseline, the coefficients of our main variable of interest are roughly equal (see annex 2 for a detailed discussion of the choice of estimator).

[11] *In an earlier version, we also included the stock market indices of the countries in our sample where available, following Borio et al. (2015). The coefficient turned out to be insignificant and the results remained unchanged, which may be related to the small size of the stock market in many CESEE countries.*

4 Results

Our baseline specification is presented in the first column of table 2 (see annex 2 for details on the choice of the econometric specification). We find that our results are qualitatively similar to Borio et al. (2015), i.e. most of the coefficients have the same sign and significance[12]. We conclude that NIMs are highly persistent and that the level of interest rates has a positive and nonlinear relationship with the level of the NIM. Our results are therefore very much in line with the broader literature on banks' NIMs and monetary policy.

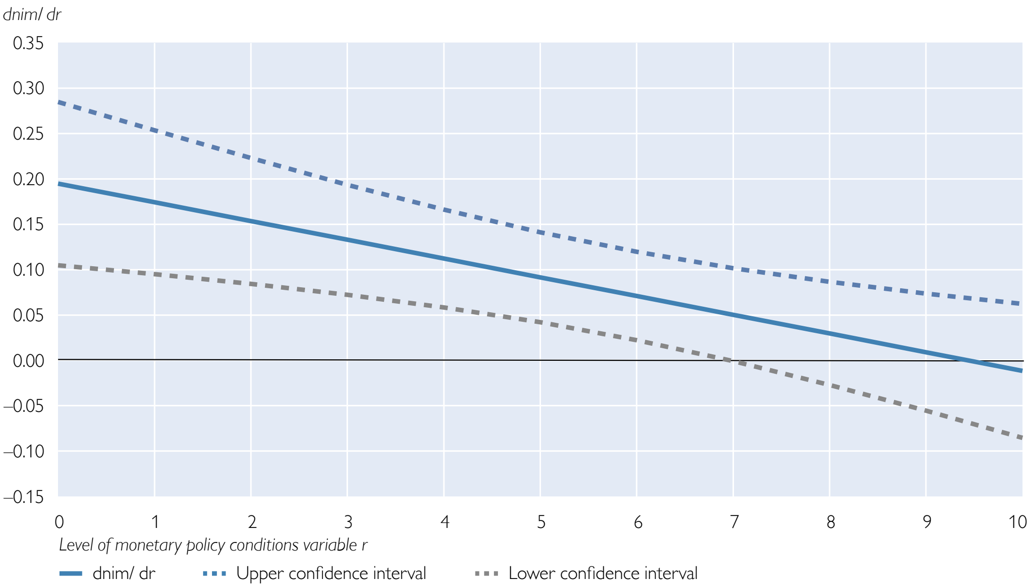
The coefficients of our monetary policy rate variable and its square term ($r_{k,t}$ and $r^2_{k,t}$) are 0.19 and –0.01, respectively, and calculating $\frac{\delta nim}{\delta r}$ serves to illustrate how the effect of monetary policy rates on net interest margins changes with the level of r.

As chart 4 shows, a decrease of r from 1 to 0 lowers NIMs by 0.19 basis points, while a decrease from 6 to 5 only leads to a reduction of NIMs by 0.09 basis points. It should be noted that because of the dynamic nature of the model, the coefficient shown is the short-term coefficient, while the long-term coefficient is higher given the positive coefficient of the lagged NIM variable.

While our coefficient of $r_{k,t}$ is less than half of that in Borio et al. (2015), it should be noted that the samples are quite different and that, unlike us, Borio et al. are able to construct a bank-specific $r_{k,t}$. Our results are quantitatively similar to Kerbl and Sigmund (2016), who find a coefficient of 0.15 for the effect which the EURIBOR has on NIMs in a static panel model of Austrian banks. Including a large number of small banks with traditional business models, their sample also resembles ours more closely. Our results would probably improve if we could construct a bank-specific and not just a country-specific monetary policy rate variable. Given

Chart 4

Marginal effects of monetary policy conditions on net interest margins



Source: Authors' calculations.

[12] *We replicate the specification in Borio et al. (2015) as closely as possible with our sample and report it in column 2 of table 1. This specification exhibits second-order serial autocorrelation.*

Table 2

Results – regression output

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Baseline	Borio et al. (2015) specification[1]	Non-weighted r	EU dummy[2]	Monetary policy regime[2]	Size dummy[2]	Loan share[2]	Deposit share[2]	Interest income share[2]
Dummy interactions with r	no			default = non-EU	default = non-inflation targeting	default = below country median	default = below sample median		
L.nim	**0.65** ***	**0.70** ***	**0.64** ***	**0.66** ***	**0.67** ***	**0.65** ***	**0.64** ***	**0.61** **	**0.53** *
L2.nim	−0.05		−0.06	−0.05	−0.05	−0.06	−0.05	−0.05	−0.05
r (default)	**0.19** ***	**0.14** ***		**0.21** ***	**0.16** **	**0.18** **	0.10	**0.17** ***	0.09
r (alternative)				**0.25** ***	**0.20** ***	**0.20** ***	**0.28** ***	**0.21** ***	**0.20** ***
r^2 (default)	**−0.01** **	**−0.01** *		**−0.01** **	**−0.01** *	−0.00	−0.00	**−0.01** *	−0.01
r^2 (alternative)				**−0.02** *	−0.01	**−0.01** **	**−0.02** ***	**−0.01** **	−0.01
Term spread (weighted)		0.00							
Term spread (weighted)^2		−0.01							
Local interbank rate			**0.07** **						
Local interbank rate^2			−0.00						
3-month EURIBOR			0.04						
3-month LIBOR			−0.02						
Coefficient of variation of local interbank rates	0.03	0.01	0.04	0.02	0.00	0.05	0.04	0.03	0.00
ngdp_growth	−0.00	0.00	−0.00	−0.00	−0.01	−0.01	−0.01	−0.00	−0.01
fin_dev	**−0.01** ***		**−0.01** ***	**−0.01** ***	**−0.01** ***	**−0.02** ***	**−0.02** ***	**−0.01** ***	**−0.01** ***
Size	**−0.40** ***		**−0.39** ***	**−0.40** ***	**−0.41** ***		**−0.43** ***	**−0.40** ***	**−0.47** ***
equity_ratio	0.01		0.01	0.01	0.01	0.02	0.01	0.01	0.01
Liquidity	**−0.02** ***		**−0.02** ***	**−0.02** ***	**−0.02** ***	**−0.02** ***	**−0.01** *	**−0.01** **	**−0.01** **
cir	**−0.01** ***		**−0.01** ***	**−0.01** ***	**−0.01** ***	**−0.01** ***	**−0.01** ***	**−0.01** ***	**−0.01** ***
L.size		**−0.07** **							
L.equity_ratio		**0.01** *							
L.liquidity		**−0.01** ***							
L.cir		**0.00** *							
Constant		**2.28** **							
Time dummies	included	excluded	included	included	included	included	included	included	included
Groups	512	461	512	512	512	512	511	512	512
Observations	2,699	3,148	2,699	2,699	2,699	2,694	2,698	2,697	2,696
Hansen p value	0.39	0.22	0.39	0.39	0.28	0.41	0.42	0.37	0.41
AR(3)[1]	0.59	0.051	0.57	0.59	0.59	0.75	0.56	0.68	0.69

Source: Authors' estimations.

[1] *Borio et al. (2015) estimate with a system GMM estimator and first difference transformation. The AR(3) line shows AR(2) for this specification as there is only one lag of the nim in the model.*
[2] *Columns (4) to (9) use interactions of a dummy variable with r and r2, where the dummy values are reported as "default" and "alternative".*

*Note: Significant results are marked in bold; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, estimated with Arellano-Bond two-step estimator by using the forward orthogonal deviations option, the collapse option and lag restrictions. Windmeijer-corrected standard errors.*

that the results are likely to be sensitive to our weighting mechanism, we also report estimations without weights.

Column 3 in table 2 shows that the effect of domestic interbank rates on NIMs is also significant, but weaker than with our weighted monetary policy rate variable. Yet, the coefficient of the square of domestic rates and, moreover, the coefficients of foreign interbank rates are insignificant. This seems somewhat puzzling given the evidence on monetary spillovers from the euro area to CESEE (see e.g. Feldkircher et al., 2016). Possibly, the EURIBOR has exhibited too little variation since quantitative easing started in the euro area, and a better measure would reflect unconventional measures. Our interpretation is that while our modeling of the interest rate environment may not be perfect given data limitations, including foreign monetary policy rates via country weights is nonetheless a strong improvement compared with alternatives such as those in column 3.

Regarding the control variables, the coefficient of the financial development variable is significant and negative across all specifications, which indicates what is suggested by the literature, namely that higher financial deepening is correlated with lower NIMs. The coefficients for the bank characteristics size, liquidity and cost-to-income ratio are also significant across most specifications, while the equity ratio is not significant in our baseline specification[13]. The results suggest that size is negatively correlated with the level of the NIM, which corresponds to most findings of the literature, as larger banks tend to be less focused on the traditional lending and deposit-taking business than smaller banks and have lower NIMs. Column 6 of table 2 reports the coefficients for the interaction of $r_{k,t}$ with size, namely whether banks are below (default) or above (alternative) their country median. The results show that the coefficients do not vary strongly between the two categories. This means that our results differ both from the studies that find that small banks are more affected (Kerbl and Sigmund, 2016; Genay and Podjasek, 2014) and from those finding that small banks are less affected by changes in market interest rates (e.g. Covas et al., 2015, for the U.S.A.).

Table 2 also reports additional interactions. We find that the coefficient of $r_{k,t}$ is somewhat higher for EU countries compared with non-EU countries, while it seems to be roughly the same for countries following an inflation-targeting[14] regime versus those with other monetary policy regimes. This suggests that choosing an inflation-targeting regime – and hence adopting a flexible exchange rate – does not exert significant influence on the relationship in our sample. Because monetary policy transmission depends on the monetary policy regime, we want to include this factor especially in light of the variety of regimes evident in our sample.

The final three columns of table 2 report the results for interactions with several business model characteristics by using dummies for values below (default) and above (alternative) the sample median. The results for the share of loans in total assets and the share of net interest income in total operating income tie in with the existing literature. In other words, the effects of the interest rate variable on NIMs are large and signficant for banks with above-median shares of loans in total assets and shares of net interest income in total operating income – i.e. banks

[13] *This is probably due to outliers as the coefficient becomes significant during our robustness check with outlier correction. As other coefficients remain unchanged, we do not apply a more rigorous outlier correction in the baseline.*

[14] *This refers to Albania, the Czech Republic, Hungary, Poland, Romania, Serbia and Turkey (de jure) in our sample. Russia switched to inflation targeting mid-sample and was therefore classified as other.*

with a traditional lending-oriented business model. This finding corroborates the argument in Claessens et al. (2016) of a stronger income pass-through at lower interest rates. The coefficients become weakly significant or insignificant for the below-median banks. This is in line with the idea that banks with a traditional lending business model are particularly vulnerable to changes in the interst rate environment. Interestingly, for the share of deposits in total assets, the results are similar for both groups. However, it should be noted that the median deposit share is rather high in our sample and well above the euro area median. Hence, banks with a very high deposit share also dominate in our "below-median" subsample, which might explain why we cannot find a differential effect with respect to this variable.

5 Robustness checks

We test our baseline specification to several modifications of the model and sample, and our main coefficients of interest prove to be very resilient. Table 3 shows that the coefficients of our main variables are robust to several changes that seem particularly important for our specification. In a first step, we add the term spread to the model. It is interesting to note that the term spread has a negative sign when included in our model but is insignificant (see column 2). This runs counter to many other studies, including Borio et al. (2015), which find that the term spread and NIMs are positively related. Column 3 presents the estimation conducted only for the CESEE EU countries, where the term spread does have a positive and significant coefficient. As soon as Russia or Turkey are included, the relationship breaks down. The term spread variable has a fairly high volatility and standard deviation for these two countries, which is likely to be related to the substantial shocks (e.g. concerning oil prices, sanctions, currency depreciation) that have also had an impact on the long end of the yield curve. This could be a possible explanation why the relationship does not hold for these countries. Moreover, it should be noted that, within our sample, roughly one-third of the term spread observations is negative, which implies an inverted yield curve. If we run the regression only for observations where our (weighted) yield curve is not inverted, the coefficient of the term spread becomes positive (around 0.36), while the coefficient of $r_{k,t}$ remains unchanged and both square terms become insignificant (not shown in table 3). Note that, in the adapted Monti-Klein model described in Borio et al. (2015), the relationship of NII and the yield curve could a priori be concave or convex, depending on the structural parameters of the model (in particular competition and hedging costs).

We also replace the NIM with an alternative variable for NIMs used in Ebner et al. (2016), which only minimally changes our coefficients of interest (column 4). The remaining columns of table 3 show that our results are also robust to the exclusion of very small (mostly Russian) banks in the sample as well as all Russian banks. Column 7 presents the estimation only for the CESEE EU countries. Restricting the sample to post-2010 – and hence to a period of historically low interest rates – leads to a mild increase in the coefficient of $r_{k,t}$, which corroborates our finding of nonlinearity in the relationship.

In addition to the variations shown in table 3, we conduct some further robustness checks.[15] We, for instance, omit insignificant control variables and include further controls (e.g. house price growth and business model variables), omit all

[15] *Results are available from the authors on request.*

Table 3

Robustness checks – regression output

	(1)	(3)	(4)	(2)	(5)	(6)	(7)	(8)
	Baseline	Term spread plus r	Term spread plus r (EU countries only)	Alternative variable[1] instead of NIM	Excluding small banks[2]	Excluding Russia[3]	EU only	Only post-2010 observations
L.nim	**0.65** ***	**0.69** ***	**0.60** ***		**0.64** ***	**0.59** ***	**0.58** ***	**0.61** **
L2.nim	−0.05	−0.04			−0.02	**−0.09** **		−0.07
L.spread				**0.73** ***				
r	**0.19** ***	**0.19** **	**0.19** *	**0.16** ***	**0.15** ***	**0.16** **	**0.18** **	**0.25** ***
r^2	**−0.01** **	**−0.01** **	0.01	**−0.01** ***	**−0.01** ***	−0.00	−0.00	**−0.01** ***
Term spread		−0.07	**0.27** *					
Term spread^2		0.03	−0.05					
Coefficient of variation of local interbank rates	0.03	0.03	−0.02	0.02	0.03	0.00	−0.02	−0.00
ngdp_growth	−0.00	0.00	0.00	−0.01	−0.01	**−0.03** ***	−0.00	0.00
fin_dev	**−0.01** ***	**−0.01** ***	−0.01	**−0.02** ***	**−0.01** ***	**−0.01** ***	**−0.01** *	**−0.02** ***
Size	**−0.40** ***	**−0.41** ***	0.04	**−0.49** ***	**−0.19** *	**−0.19** *	0.04	**−0.43** ***
equity_ratio	0.01	0.01	0.05	**−0.02** *	**0.04** *	0.03	0.05	0.01
Liquidity	**−0.02** ***	**−0.02** ***	−0.01	**−0.02** ***	**−0.01** ***	**−0.01** ***	**−0.01** *	**−0.02** ***
cir	**−0.01** ***	**−0.01** ***	**−0.01** *	**−0.01** ***	**−0.01** ***	**−0.01** **	**−0.01** *	**−0.01** ***
Groups	512	426	162	523	288	270	162	512
Observations	2,699	2,248	1,101	3,211	1,688	1,338	1,101	2,471
Hansen p value	0.39	0.42	0.26	0.73	0.46	0.31	0.23	0.32
AR(1) p value	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00
AR(3)[3,4]	0.59	0.57	0.72	0.311	0.14	0.54	0.772	0.65

Source: Authors' estimations.

[1] *The spread variable is calculated according to an ECB methodology. For details, see Ebner et al. (2016).*
[2] *The national market share is smaller than 0.3%.*
[3] *For column (6), a third lag is included to eliminate autocorrelation and AR(4) is reported instead of AR(3).*
[4] *For columnns (2) and (7), AR(2) is reported as only 1 lag is used.*

*Note: Significant results are marked in bold; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, estimated with Arellano-Bond two-step estimator by using the forward orthogonal deviations option, the collapse option and lag restrictions. Windmeijer-corrected standard errors.*

subsidiaries whose parent companies are also included in the dataset as well as clean the bank-specific variables for outliers.[16] In analogy to Borio et al. (2015), our results are robust to replacing the contemporaneous bank-specific control variables with the lagged ones. We find that our results are not driven by any individual country. We also interact both the interest rate variable and its square with region dummies (EU, Russia, Turkey and the Western Balkans), and the

[16] *To this end, we use a data-driven approach, running the regression only with observations excluding outliers and subsequently only inside the interquartile range.*

interaction term shows the expected sign and is significant for all regions.[17] Future research could zero in on differences between individual countries. A very crude inspection via interaction terms with country dummies suggests differences with respect to the significance and magnitude of the effect for individual countries.[18]

6 Conclusions

Our paper closes an important gap in the literature as it is the first, to our knowledge, to econometrically estimate the sensitivity of banks' net interest margins to the interest rate environment in CESEE. It should be emphasized that the CESEE sample is quite diverse in terms of country size, level of economic and financial development, exchange rate and monetary regimes and the share of foreign currency assets and liabilities.

In our econometric setup, we control for all these factors. Our findings confirm that the relationship between NIMs and monetary policy rates is concave and that foreign monetary policy rates play an important role for CESEE banks. As a common feature, the CESEE financial sectors are largely bank centric and have a large share of foreign banks. Still, the simple fact that, compared with studies that focus on other countries and regions, we find similar results regarding many key features of the relationship between NIMs and interest rates is in itself interesting and nonobvious.

In this study, we do not attempt to evaluate the adequacy of monetary policy as a whole or even the impact on banks' profitability. However, in light of the fact that net interest income is the key revenue source of banks – and in particular of small, retail-oriented banks prevalent in CESEE, our results have policy implications. CESEE banks' traditional business model centered on maturity transformation is under pressure amid the current low interest rate environment, and it will be even more so if the accommodative monetary policy conditions prevail for a prolonged period. While monetary policy conditions may have positive effects on other profitability components such as provisions (see e.g. Borio et al., 2015), it is critical for banks' viability, and therefore for financial stability, that banks can sustainably generate sufficient income.

To summarize, our results suggest several things: first, the sensitivity of NIMs varies from bank to bank, depending on certain bank characteristics, and the sustainability of profits of particularly vulnerable banks should be monitored closely. Second, actions banks might take to mitigate the fall in NIMs (e.g. higher risk taking) should be further investigated in the literature (see e.g. Boungou, 2020). Finally, it should be noted that the CESEE countries have not hit the zero lower bound. Negative rates may exert additional pressure on banks' NIMs (see Kerbl and Sigmund, 2016; Molyneux et al., 2018; Boungou, 2020). On the other hand, a tightening in monetary policy could alleviate the income pressure faced by banks. In the presence of a nonlinear relationship, which our results confirm, the effects are likely to weaken at higher interest rate levels. In our sample, we have

[17] *For Russia, the interaction term is only significant when small banks are excluded.*

[18] *Within our econometric setup, a thorough inspection of individual countries is hampered by the lack of sufficient data at the country level. The results from the interaction between the monetary policy variable and country dummies mentioned here should be taken with a grain of salt as reliable conclusions for individual countries would necessitate a differentiated econometric specification for each country (i.e. choice of lag length for the dependent variable, choice of instruments, etc. – see columns 6 and 7 of table 2 for examples of multi-country subsample specifications), which is not feasible given the small sample sizes at the country level.*

observed some spikes in interest rates related to crisis situations (e.g. the global financial crisis, but also events in Turkey and Russia). In cases of extremely high interest rates (resulting from crisis events), the relationship could even turn negative again, as crisis-related factors may dampen NIMs. Hence, the impact of the future development of interest rates on NIMs should be monitored.

Moreover, the literature suggests that the relationship between NIMs and interest rates may also be affected by the degree of competition in the banking sector (see e.g. Elekdag et al., 2019).[19] Further research could therefore investigate the nexus between market structure, monetary policy and bank profitability.

References

Alessandri, P. and B. Nelson. 2014. Simple banking: profitability and the yield curve. In: Banca d'Italia Temi di discussione (Economic working papers) 945.

Arellano, M. and S. Bond. 1991. Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. In: Review of Economic Studies 58(2). 277–297.

Baltagi, B. H. 2013. Econometric analysis of panel data. Chichester: John Wiley & Sons, Inc.

Blundell, R. and S. Bond. 1998. Initial conditions and moment restrictions in dynamic panel data models. In: Journal of Econometrics 87. 115–143.

Borio, C. and L. Gambacorta. 2017. Monetary policy and bank lending in a low interest rate environment: diminishing effectiveness? BIS Working Papers 612.

Borio, C., L. Gambacorta and B. Hofmann. 2015. The influence of monetary policy on bank profitability. BIS Working Papers 514.

Boungou, W. 2020. Negative interest rates policy and banks' risk-taking: Empirical evidence. In: Economics Letters 186. 108760.

Busch, R. and C. Memmel. 2017. Banks' net interest margin and the level of interest rates. In: Credit and Capital Markets 50(3). 363–392.

Claessens, S., N. Coleman and M. Donnelly. 2016. "Low-for-Long" Interest Rates and Net Interest Margins of Banks in Advanced Foreign Economies. In: IFDP Notes. April 11.

Covas, F. B., M. Rezende and C. M. Vojtech. 2015. Why Are Net Interest Margins of Large Banks So Compressed? In: FEDS Notes. October 5.

EBA. 2019. Profitability challenges the sector, asset quality still improving but requires constant monitoring. EBA Press Release. July 4.

Ebner, G., E. Endlich, A. Greiner, M. Gruber, G. Hobl, S. Kavan, M. Ohms, V. Redak, A. Schober-Rhomberg, P. Stockert, D. Widhalm and T. Wittenberger. 2016. The profitability of Austrian banking subsidiaries in CESEE: driving forces, current challenges and opportunities. In: Financial Stability Report 32. Vienna: OeNB. 64–79.

Égert, B. and R. MacDonald. 2008. Monetary Transmission Mechanism in Central and Eastern Europe: Surveying the Surveyable. OECD Economics Department Working Papers 654.

Egly, P. V., D. W. Johnk and A. V. Mollick. 2018. Bank Net Interest Margins, the Yield Curve, and the 2007–2009 Financial Crisis. In: Review of Financial Economics 36(1). 12–32.

Elekdag, S., S. Malik and S. Mitra. 2019. Breaking the Bank? A Probabilistic Assessment of Euro Area Bank Profitability. IMF Working Paper WP/19/254.

Elliot, J., H. Hoyle and A. Jobst. 2016. Impact of Low and Negative Rates on Banks. In: IMF Global Financial Stability Report April 2016. 44–46.

[19] *We would like to thank the referee for this interesting suggestion for further research.*

Elyasiani, E., K. J. Kopecky and D. van Hoose. 1995. Costs of Adjustment, Portfolio Separation, and the Dynamic Behavior of Bank Loans and Deposits. In: Journal of Money, Credit and Banking 27(4). 955–974.

Ennis, H. M., H. Fessenden and J. R. Walter. 2016. Do Net Interest Margins and Interest Rates Move Together? In: Richmond Fed Economic Brief 1–6.

Feldkircher, M., F. Huber and I. Moder. 2016. Modeling the evolution of monetary policy rules in CESEE. In: Focus on European Economic Integration Q1/16. Vienna: OeNB. 8–27.

Feldkircher, M. and M. Sigmund. 2017. Comparing market power at home and abroad: evidence from Austrian banks and their subsidiaries in CESEE. In: Focus on European Economic Integration Q3/17. Vienna: OeNB. 59–77.

Genay, H. and R. Podjasek. 2014. What Is the Impact of a Low Interest Rate Environment on Bank Profitability? Chicago Fed Letter. July.

Gunter, U., G. Krenn and M. Sigmund. 2013. Macroeconomic, market and bank-specific determinants of the net interest margin in Austria. In: Financial Stability Report 25. Vienna: OeNB. 87–101.

Hayakawa, K. 2009. First Difference or Forward Orthogonal Deviation – Which Transformation Should be Used in Dynamic Panel Data Models? A Simulation Study. In: Economics Bulletin 29(3). 2008–2017.

Hoffmann, P., B. Klaus and S. Langfield. 2018. The distribution of interest rate risk in the euro area. In: ECB Financial Stability Review May 2018. 177–186.

Kavan, S. and F. Martin. 2015. The profitability of Austrian banks' subsidiaries in Croatia, Hungary and Romania and how the financial crisis affected their business model. In: Financial Stability Report 29. Vienna: OeNB. 58–71.

Keele, L. and N. Kelly. 2006. Dynamic Models for Dynamic Theories: The Ins and Outs of Lagged Dependent Variables. In: Political Analysis 14(2). 186–205.

Kerbl, S. and M. Sigmund. 2016. From low to negative rates: an asymmetric dilemma. In: Financial Stability Report 32. Vienna: OeNB. 120–137.

Lahnsteiner, M. 2020. The refinancing of CESEE banking sectors: What has changed since the global financial crisis? In: Focus on European Economic Integration Q1/20. Vienna: OeNB.

Molyneux, P., A. Reghezza and R. Xie. 2018. Bank Profits and Margins in a World of Negative Rates. Bangor Business School Working Paper BBSWP/18/01.

Nickell, S. 1981. Biases in dynamic models with fixed effects. In: Econometrica 49. 1417–1426.

Roodman, D. 2009a. A Note on the Theme of Too Many Instruments. In: Oxford Bulletin of Economics and Statistics 71(1). 135–158.

Roodman, D. 2009b. How to do xtabond2: An introduction to difference and system GMM in Stata. In: The Stata Journal 9(1). 86–136.

Scheiber, T., M. Silgoner and C. Stern. 2016. The development of bank profitability in Denmark, Sweden and Switzerland during a period of ultra-low and negative interest rates. In: Focus on European Economic Integration Q3/16. Vienna: OeNB. 8–28.

Schwaiger, M. and D. Liebeg. 2007. Determinants of Bank Interest Margins in Central and Eastern Europe. In: Financial Stability Report 14. Vienna: OeNB. 68–84.

Siebenbrunner, C. and M. Sigmund. 2019. Simultaneity of Interbank Market Rates – Theory and Methodological Implications. https://ssrn.com/abstract=3082784

Annex

Annex 1: Summary statistics

Table A1

Summary statistics by bank size

	Mean			Median			Standard deviation		
	small	large	total	small	large	total	small	large	total
nim	4.7	4.1	4.4	4.1	3.7	3.8	3.2	2.9	3.1
Size	17.7	21.6	19.7	17.7	21.6	19.4	2.1	2.2	2.9
equity_ratio	18.1	12.4	15.2	13.8	11.4	12.2	15.5	8.8	13.0
Liquidity	38.9	34.1	36.5	34.8	30.8	32.4	20.7	16.3	18.8
cir	76.5	57.9	67.2	72.7	55.1	62.5	32.8	22.5	29.6

Source: Authors' calculations.

Note: "Small" refers to banks below and "large" to banks above a country's median bank size.

Annex 2: Choice of estimation method

Many econometric papers have analyzed the potential biases resulting from including or omitting lagged dependent variables under various conditions. We follow Keele and Kelly (2006), who argue that the choice should be motivated by considerations about the true data generation process. Since banks' past choices regarding the volume and pricing of assets and liabilities affect current NIMs, we consider it vital to include a lag of the dependent variable into our model to capture this process. Banks put a lot of effort into stabilizing their NIMs, which should make the latter even more persistent. This modeling choice implies that estimating the equation via Pooled Ordinary Least Squares (POLS) leads to biased and inconsistent estimates as the lag is correlated with the fixed effect μ_i. This gives rise to a dynamic panel bias (see Nickell, 1981). Removing the fixed effect with a within transformation introduces a different bias, however, which shrinks as the size of T increases. As Roodman (2009b) points out, the true lag coefficient should lie between the POLS and fixed effects estimates. As can be seen in table A2, the coefficients for the first lag resulting from the Arellano-Bond (AB) (columns 3 and 4) and Blundell-Bond (BB) (columns 5 and 6) estimations fulfill this condition.

The estimation method following Arellano and Bond (1991) uses the orthogonality condition between lagged values of the dependent variable and the error term to create an instrument matrix using lags of the dependent variable. Blundell and Bond (1998), among others, proposed extra moment conditions – however, the use of AB versus BB estimators is somewhat contested. For instance, Baltagi (2013) points out that, with small T and persistent series, the use of the extra moment conditions discussed by Blundell and Bond (1998) is indicated as it increases precision and reduces the finite sample bias of the GMM estimator. However, Roodman (2009a) points out that the use of extra moment conditions relies on the nontrivial assumption akin to a mild stationarity restriction on the dependent variable, which is particularly contentious for persistent series.

Columns 3 to 6 report selected results of the AB and BB specifications. All use the two-step option and the same choices of the instrument set, namely the collapse option and a restriction on the lags used to avoid instrument proliferation (see Roodman, 2009a; Baltagi, 2013). Windmeijer-corrected robust standard errors are used. Columns 3 and 5 are estimated using forward orthogonal deviations

Table A2

Choice of estimation method – regression output

	(1) POLS	(2) Fixed effects	(3) Arellano-Bond (fod[1])	(4) Arellano-Bond (fd[1])	(5) Blundell-Bond (fod[1])	(6) Blundell-Bond (fd[1])
L.nim	**0.77** ***	**0.42** ***	**0.65** ***	**0.64** ***	**0.61** ***	**0.56** ***
L2.nim	0.07	–0.07	–0.05	**–0.08** *	–0.08	**–0.10** *
r	**0.09** **	**0.17** ***	**0.19** ***	**0.38** ***	**0.22** ***	**0.29** ***
r^2	–0.00	**–0.01** **	**–0.01** **	**–0.02** ***	**–0.01** **	**–0.02** ***
Coefficient of variation of local interbank rates	0.05	0.04	0.03	0.02	0.07	**0.08** *
ngdp_growth	–0.00	0.00	–0.00	–0.01	0.00	0.00
fin_dev	–0.00	**–0.02** ***	**–0.01** ***	**–0.04** ***	**–0.01** ***	**–0.01** ***
Size	**–0.07** ***	**–0.44** ***	**–0.40** ***	**–0.47** *	**–0.16** ***	**–0.19** ***
equity_ratio	**0.01** **	0.02	0.01	0.01	**0.03** ***	**0.03** ***
Liquidity	**–0.01** ***	**–0.02** ***	**–0.02** ***	**–0.02** *	**–0.02** ***	**–0.03** ***
cir	**–0.01** ***	**–0.01** ***	**–0.01** ***	**–0.01** ***	**–0.01** ***	**–0.01** ***
Constant	**2.70** ***	**13.14** ***			**6.14** ***	**7.20** ***
Groups		526	512	511	526	526
Observations	3,225	3,225	2,699	2,667	3,225	3,225
Hansen p value			0.39	0.84	0.66	0.73
AR(3)			0.59	0.65	0.82	0.98

Source: Authors' estimations.

[1] *fod = forward orthogonal deviations option, fd = first difference option.*

*Note: Significant results are marked in bold; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.*

(FODs), whereas columns 4 and 6 are estimated using first differences (FDs). As pointed out by Roodman (2009b) and Hayakawa (2009), FOD is preferred for unbalanced panels and/or panels with many gaps, as FD magnifies these gaps. With FOD, the average of all future available observations of a variable is used instead of subtracting previous observations from current ones. Therefore, we prefer FOD to FD in our case even though FOD consistently results in a lower coefficient of our main variable of interest. We are therefore choosing the "more conservative" estimate.

Whether AB or BB should be preferred is generally not clear a priori, as discussed above. In our case, we are skeptical of the extra moment conditions and of the enhanced sensitivity of the BB estimators to the choice of lags. Moreover, the coefficients of column 3 and 5 obtained using the same estimation options are very similar, which reassures us since our choice does not have a material impact on the main result. We therefore decide to use the AB estimator as a baseline. The results of the Hansen test p values further support our choice, as the p values for columns 4 to 6 seem inflated, which is a cause for concern (Roodman, 2009b), while we find the p value for column 3 to be still sufficiently low. Estimations with only one lag of the dependent variable were subject to second-order autocorrelation, which made us introduce an additional lag. All estimations include a second lag and show no third-order serial autocorrelation. The Sargan test has been shown to never reject the null when T is too large for a given N and is thus not reported in this context (see Roodman, 2009a; Baltagi, 2013).