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The impact of low interest rates on the bank profitability

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Abstract: The recent negative interest rate policy implemented by the European Central Bank (ECB) has raised concerns about the impact of interest rates on bank profitability. Therefore, this paper aims to study the determinants of banking profitability in the European Union (EU) countries. Using annual macro-level data for the period 2008–2018, we examine the impact of banking sector, macroeconomic, and competition variables on the aggregate profitability of the banking sectors by using a panel data methodology. We find a positive relationship between short-term rates and negative relationship long-term rates. Hence, our findings indicate that monetary policy significantly influences bank profits in EU countries.

Keywords: bank profitability; low interest rate policy; European Union countries; banking sector variables; macroeconomic variables; competition; short-term interest rate; long-term interest rate; panel data.

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Biographical notes: Tomáš Fabian is a graduate of the Faculty of Economics, Technical University of Kosice. In his diploma thesis, he analyses interest rates and banking sectors in European Union countries.

Kristína Kočíšová, PhD, is an Associate Professor at the Faculty of Economics, Technical University of Kosice. Her research focuses on banking issues, diagnostics competition, the efficiency of the banking sector, and the efficiency of banks or bank branches in the national economy. The achieved results apply in teaching subjects banking, central banking, management of banking operations and selected models and analysis in banking.

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1 Introduction

Commercial banks can be defined as separate business entities competing and generating profits. Many factors influence banks' ability to make profits. Banks themselves influence and control some aspects. Others must be accepted, e.g., regulatory measures, a monetary policy implemented by the central bank, macroeconomic development or crisis impacts. Over the last decade, the economies of the European Union (EU) countries have faced several challenges. These were the global financial and economic crisis, the debt crisis, geopolitical tensions, etc. As a result of these crises, commercial banks have had to deal with an increasing volume of non-performing loans, reduced demand for new loans, or tightening regulatory measures in credit activity. The uncertainties and problems associated with the global economic crisis have thus forced the Euro system and the European Central Bank (ECB) to adopt some non-standard monetary policy instruments, i.e., implement the unconventional monetary policy. As mentioned by Kostelný (2014), the standard tools previously applied were not sufficient to address the problems that had arisen since the links in the transmission mechanism had been severely disrupted, resulting from the crisis that occurred in the past.

In addition to adopting non-standard measures, the ECB has launched a policy of low interest rates. In June 2014, the Governing Council of the ECB decided to reduce the interest rates on the deposit facility to a negative value of -0.1% . Since September 2019, these interest rates have fallen to -0.5% . Reducing the deposit facility rate below zero means that commercial banks are sanctioned if excess liquidity is deposited with the central bank. This measure aims to ensure that banks do not deposit liquidity in the central bank, but they put money into circulation, i.e., into the real economy, and stimulate euro area economic growth. In the pre-crisis period, commercial banks were not forced to use sterilisation operations through central banks as they benefited from more favourable interbank market conditions. However, the uncertainty caused by the global crisis and the excess liquidity in the system has resulted in greater use of these sterilisation operations. Therefore, as Scheiber et al. (2016) presented, the deposit facility rate currently affects money market rates and customer interest rates.

Interest rates on the main refinancing operations have also gradually declined (up to 0% since March 2016) to increase lending to euro area countries and thus relaunch their economic growth after the global crisis.

The impact of interest rate changes on banks' profitability has been a subject of numerous studies. However, various studies investigating the effect of interest rates on banks' profitability differ. Two main potential risks associated with lowering interest rates can be identified in terms of financial stability: pressure on bank interest income, followed by greater risk-taking by banks to compensate for lower interest income. The studies show that although a reduction in interest rates may decrease net interest income (NII), the impact on banks' overall profitability is not entirely clear. Banks can compensate the reduction of interest income by seeking an increase of non-interest revenue, or they can also benefit from the valuation of fixed-income securities, from an increase in operational efficiency, but also a reduction in the non-performing loans, as debt service in case of lower interest rates is less burdensome for borrowers. In addition, lower interest rates may result in the above-mentioned economic recovery in the form of higher demand for loans, which could ultimately also positively impact a banks' profitability.

Although the measures in the form of interest rate reductions were not primarily focused on the profitability of commercial banks, the conclusion is that it was ultimately affected by these measures. Therefore, it is important to examine the impact of the low interest rate environment on the profitability in the banking sectors of the EU countries. We examined the profitability of the banking sectors of the 27 EU countries for the period 2008–2018. We carried out the analysis using annual data at the macro level, i.e., at the level of the banking sector.

2 Literature review

Several authors significantly contributed to clarifying the issue of bank profitability, not only theoretically but also in practice. Busch and Memmel (2015) examined how the interest rates affect the net interest margin while studying the decomposition of the net interest margin on its individual parts. English (2002) also dealt with the net interest margins of banks. Alessandri and Nelson (2015) showed that large banks are trying to reduce the yield curve risk by hedging against changes in interest margins. Paper presented by Rognlie (2016) or Brunnermeier and Koby (2018) focused on the effects of the unconventional monetary policy, i.e., lowering interest rates to below zero.

The impact of low/negative interest rates on large international banks was also examined by Jobst and Lin (2016) or Altavilla et al. (2018), and the profitability of major international banks was examined by Borio et al. (2017). Many studies focus on the effects of low interest rate policy in specific countries. For example, Scheiber et al. (2016) focused on Denmark, Switzerland, and Sweden. In drawing up the examined sample, they ensured that the selected banks in each country represented more than 50% of total assets in the banking sector (Denmark-75%, Sweden-85%, Switzerland-69%). The authors first analysed the overall profitability of the banks. Then they examined the various components that affected the amount of total profit/loss. The authors concluded that negative interest rates did not significantly drop in profitability or interest income. They also did not find any changes in the structure of banks' operating income in terms of offsetting interest income by other sources of income. According to the authors, the transmission of central bank interest rates to money market interest rates worked efficiently. Nevertheless, the interest rates at which banks lend to their customers did not decrease as quickly and to the same extent as those of central banks. Therefore, the difference between interest rates on loans and deposits remained stable, and banks could still benefit from this difference. Another conclusion is that if negative interest rates are applied over a more extended period, commercial banks' room for manoeuvre may be limited, which may ultimately restrict banks' profitability. One solution could be increasing the volume of provided loans, but stricter regulatory requirements may restrict it. In the end, the authors noted that concerns related to negative interest rates were not met in the analysed countries. The banks' profitability was not significantly affected, and no 'rush to cash' effect was observed.

Borio et al. (2017) aimed to examine the effects of monetary policy on banks' profitability, with up to 109 major international banks between 1995 and 2012. The authors concluded that there is a positive correlation between the interest rates and the slope of the yield curve on the one hand and the return on assets (ROA) indicator on the other, i.e., higher interest rates and a steeper yield curve should support the profitability of banks. It is the result of two opposing effects. On the one hand, higher short-term

interest rates and a steeper yield curve increase NII by increasing banks' interest margin. But on the other hand, higher interest rates increase loan provisions as the cost of debt service and the probability of loan default increases. In turn, non-interest income decreases due to a negative impact on securities valuation. However, according to these authors, the positive effect of interest rates and the yield curve slope on NII ultimately exceeds the negative impact on net non-interest income.

Klacso and Rychtárik (2016) examined the impact of low interest rates on the banking sectors of the EU and euro area countries based on the consolidated bank data processed by the ECB. In the analysis, the authors used the main balance sheet items of banking sectors and various indicators characterising banks' ability to generate interest income. The authors note that an environment of easing monetary policy is a significant challenge for banks in the euro area. They consider this due to falling interest rates and the associated falling interest margins, putting pressure on NII. Their analysis confirmed a strong correlation between NII and loans. Thus, the combination of falling interest margins and weak lending activity creates a very challenging environment for banks' profitability. In addition, however, the authors state that this effect could not be generalised for all EU countries. Traditional banking sectors, including the Slovak one, are more sensitive to declining NII.

In a sample of 3385 banks from 47 countries worldwide, Claessens et al. (2018) examined the impact of low interest rates on banks' net interest margin and profitability between 2005 and 2013. The authors broke down countries according to the average yield on 3-month (3M) government bonds into the low-interest rate and high-interest rate countries (if the average yield on 3M government bonds was below 1.25%, it was an environment of low interest rates and vice versa). While only Japan and Switzerland met the condition of a low interest rate environment in 2005, the low interest rate environment was already registered in 21 countries (including Slovakia) in 2013. The authors pointed out that the low level of interest rates affected the net interest margin as follows:

- 1 The interest rates reduction reduced the net interest margin as interest costs fell more slowly than interest income.
- 2 The negative effect was much more significant if interest rates were low.
- 3 The longer the rates were low, the effect on the net interest margin was more pessimistic.

They showed that low interest rates significantly impact banks' net interest margins than the higher ones. The authors also found that banks with dominating short-term items on the balance sheet were more affected than banks with items with long-term maturities. According to them, the banks mitigated profitability by reducing costs and generating higher non-interest income. However, such measures take time, and their immediate effects are limited. Therefore, it is difficult for banks to maintain profitability at the desired level, especially if the low interest rate persists. The authors also reminded us of possible adverse effects on the transmission mechanism of monetary policy. Low interest rates weaken banks' capitalisation and lending capacity so that the credit channel can be distorted. A decrease in interest rates can be a less effective tool to stimulate economic activity.

Urbschat (2018) aimed to analyse the impact of the low interest rate policy and the ECB's quantitative easing program on the German banks. The author examined data for

2003–2016 on a sample of 1600 banks. The results showed that the German banking sector performed relatively well in the early years of this unconventional policy of the ECB. German banks benefited from lower refinancing costs or lower losses on non-performing loans in this period. The author also noted that banks were only slightly affected by low interest rates and quantitative easing policy. In addition, no more significant risk-taking was observed in the form of excessive credit growth or easing of lending rules. On the other hand, the author negatively assessed that capital gains from holding assets were not significant in the German banks, given the conservative accounting rules. These revenues were significant only for larger banks with a significant trading portfolio. He also did not confirm the hypothesis that banks offset lower interest income by increasing fees and commissions. Although several banks in the German banking sector have increased fees and commissions, having no significant impact on their profitability.

Boto-García et al. (2021) examined the main factors affecting banks' profitability in the Spanish banking sector between 1995 and 2016. The authors focus on the aggregate profitability of the banking sector. The results showed a positive relationship between the loans and ROA and gross domestic product (GDP) and ROA. In turn, the authors identified a negative relationship between the EURIBOR and ROA. Since EURIBOR is the reference rate for the fixation of interest rates on assets and liabilities, this rate's reduction (increase) increases (decreases) interest spreads. This negative relationship also showed that banks benefited from the possibility of a faster deposits interest rates reduction than in the case of the interest rates on loans. Therefore, the conclusion was that the low interest rate policy applied by the ECB had a positive impact on the profitability of the Spanish banks. Another conclusion is that the steeper slope of the yield curve was linked to a higher level of profitability in the banking sector. The impact of the CR5 was negative. This negative relationship can be justified by the fact that the process of bank mergers during the crisis was significant in the Spanish banking sector. The integration of banks with high non-performing loans in their balance sheets also decreased the profitability of those banks with which these banks were integrated.

Hanzlík and Teplý (2019) studied banks' profitability in the EU countries in an environment of low interest rates. They analysed the annual data from 629 banks operating in 24 EU member states during the years 2011–2016. The banks were divided into banking holdings, cooperative banks, mortgage banks, savings banks, large and small banks. A positive relationship has been identified between short-term interest rates and banks' net interest margin. There was also a positive relationship between the net interest margin and the market concentration. Significant differences in profitability were identified for the different types of banks examined in the work.

Some authors used data at the micro-level, focusing on a specific country, e.g., Boto-García et al. (2021) examined the Spanish banking sector, Urbschat (2018) examined the German banks, Bikker and Vervliet (2018) analysed the US banking sector, and many other authors focused on the banking sectors of specific countries. The microdata for individual banks was also used by the authors Hanzlík and Teplý (2019), examining banks operating in different banking sectors of the EU countries in their work. On the contrary, Klacso and Rychtárik (2016) used macro-level data in their work (i.e., for the entire EU banking sector).

Based on the results of the above work, we can say that the conclusions of these empirical studies are not clear. While Scheiber et al. (2016) and Urbschat (2018) stated that low interest rates did not have a significant negative impact on the profitability of

banks, Klacso and Rychtárik (2016) notes that an environment of easing monetary policy is a major challenge for banks in the euro area. Similarly, Bikker and Vervliet (2018) concluded that banks' performance in the US banking sector was weakened due to low interest rates. Claessens et al. (2018) also note that it is difficult for banks to maintain their profitability at the desired level, especially when the low interest rate environment lasts longer. We can therefore confirm that the examination of this issue is neither self-sufficient nor clear since the results of the empirical research mentioned above differ from one another.

3 Data and methodology

We applied a panel regression method to examine both individual and time variability of variables. Novák (2007) mentioned that the panel structure of the data thus allows us to analyse better hidden, unobservable, or random facts in the econometric, economic, sociological or other structure of relationships between units.

The panel regression method has also been used in many of the works presented in our literature review, e.g., Bikker and Vervliet (2018), Hanzlík and Teplý (2019), Urbschat (2018), Kerbl and Sigmund (2017), Gunter et al. (2013) and many others.

We generally use two models when working with panel data — the fixed effects model or the random-effects model. In practice, the Hausman test is used to test the suitability of a random/fixed-effect model. However, its result may be distorted if there is present a serial correlation or cross-sectional dependence in the model. That's why we gave the random and fixed effects model results due to the possible distortion of Hausman's test.

Additional statistical assumptions shall be verified when using the panel regression method. It involves testing the 'poolability', i.e., examining the appropriateness of using the panel structure of the data or the simple least-squares method ignoring the panel structure of the data. In the next step, we verified the time significance, individual or both effects. Finally, we also must verify the following statistical assumptions using the above diagnostic tests: cross-sectional dependence (Pesaran test), serial correlation (Breusch-Godfrey/Wooldridge test), stationarity (Maddala-Wu unit root test), and heteroscedasticity (Breusch-Pagan test). As mentioned by Želinský (2013), heteroskedasticity, serial correlation, and cross-sectional dependence are often present in econometric models, which may ultimately result in incorrect estimates of the significance of the regression factors. In this case, a robust variance-covariant matrix is estimated.

We analysed annual data for 27 EU Member States (including UK but excluding Estonia as information on long-term interest rates was not available) at the macro level between 2008 and 2018. Most of the data are available through the ECB Statistical Data Warehouse, Eurostat, or central bank databases of the analysed countries. The calculations were done using R software.

As already mentioned, the banking sector's profitability is influenced by many different factors. In empirical studies investigating bank profitability (e.g., Bikker and Vervliet (2018), Urbschat (2018), Boto-García et al. (2021)), explanatory variables are mainly divided into categories: variables characterising the banking sector, macroeconomic variables, the competition variables, and the interest rates. We have therefore included explanatory variables in this structure:

- variables characterising the banking sector: loans (LOA – share of loans to total assets), assets (ASS – the log value of total assets), capitalisation (CAP – the share of equity to total assets), the cost to income (CTI – operational efficiency)
- macroeconomic variable: GDP growth rate (GDP)
- the competition expressed indirectly via a concentration on the market: CR5 (concentration ratio – the share of five largest banks on total assets of the banking sector)
- interest rates: short-term interest rates (STR – EURIBOR 3M or alternative 3M interbank interest rates used in non-euro area EU countries), long-term interest rates (LTR – yield of 10-year government bonds).

The profitability of the banking sector was described using three indicators: return on assets (ROA), return on equity (ROE) and net interest income (NII).

For our study, the most critical variables are the interest rates, as we want to analyse their impact on the profitability of banking sectors. The econometric models can be written as follows:

$$\pi_{it} = c + \alpha X_{it}^{BS} + \beta X_{it}^{Makro} + \gamma X_{it}^C + \delta X_{it}^{IR} + \varepsilon_{it} \quad (1)$$

where π_{it} represents the profitability of the i th banking sector in the period t , X_{it}^{BS} represents the sum of the variables characterising the i th banking sector in the period t , X_{it}^{Makro} represents the macroeconomic variables of the i th banking sector in the period t , X_{it}^C expresses the concentration of the i th banking sector in the period t and the interest rates of the i th banking sector in the period t are characterised by the variable X_{it}^{IR} .

4 Results

We used panel regression to examine the impact of interest rates on banks' profitability in the EU banking sectors. After all the observations were included, the result was an unbalanced panel. We examined the impact of the eight explanatory variables chosen for three different explained variables, namely ROA, ROE and NII, which are among the basic ratios characterising the profitability of banking sectors. The results of the models are presented in Table 1 and Table 2. Table 3 then shows the results of the models, estimating only the impact of short-term and long-term interest rates on the profitability of the banking sectors without other variables. These models (Table 3) were designed to check robustness. Within them, we examined only the impact of interest rates on the ROA or ROE without the other control variables initially included in the baseline models.

Based on the pool test, the Chow test, we decided to work with the panel structure of the data and not to use the simple least-squares method. In diagnostic tests, we found that several statistical assumptions were not met within each model. Breusch-Godfrey/Wooldridge test demonstrated the presence of a serial correlation, the result of the Pesaran test showed a cross-sectional dependence and based on the p-value of the Maddala-Wu test, stationarity can be detected. Therefore, we give adjusted results after estimating the robust variance-covariance matrix. This was estimated using the Arellano method, which considers both heteroskedasticity and serial correlation. We present the

results of the fixed and random-effects model. We can note the significance of time and individual effects within the fixed-effects model.

Table 1 Results of the model for ROA and ROE as a dependent variable

	<i>Fixed effects (ROA)</i>		<i>Random effects (ROA)</i>		<i>Fixed effects (ROE)</i>		<i>Random effects (ROE)</i>	
Intercept			-1.0020 (1.9236)				-28.8337 (29.0023)	
LOA	-0.0156 (0.0114)		-0.0069 (0.0062)		-0.2482 (0.2527)		-0.1025 (0.1635)	
ASS	0.9180 (1.0470)		0.1749 (0.1822)		1.1049 (12.7465)		4.3472 (2.9646)	
CTI	-0.0083 (0.0018)	***	-0.0088 (0.0018)	***	-0.1609 (0.0238)	***	-0.1665 (0.0205)	***
CAP	0.0923 (0.0402)	*	0.1060 (0.0362)	**	1.1298 (0.7891)		1.2399 (0.7397)	.
STR	0.1456 (0.0569)	*	0.1668 (0.0548)	**	2.4174 (0.9825)	*	2.4070 (0.9031)	**
LTR	-0.2212 (0.0399)	***	-0.2319 (0.0301)	***	-3.3146 (0.6385)	***	-3.2531 (0.4580)	***
GDP	0.0614 (0.0245)	*	0.0571 (0.0236)	*	0.7417 (0.3749)	*	0.6868 (0.3229)	*
CR5	0.0029 (0.0124)		0.0064 (0.0043)		-0.0300 (0.1623)		0.1235 (0.0862)	
R^2	0.3785		0.4356		0.4101		0.4212	
R^2 corrig.	0.2966		0.4197		0.3324		0.4049	
Sample size	$N = 27, T = 7-11,$ $N = 293$		$N = 27, T = 7-11,$ $N = 293$		$N = 27, T = 7-11,$ $N = 293$		$N = 27, T = 7-11,$ $N = 293$	
Individual effects	1.598 (0.0366)				2.2747 (0.0006)			
Time effects	2.902 (0.0018)				1.6451 (0.0938)			
Cross-sectional dependence	11.284 (0.000)		11.907 (0.000)		9.5609 (0.000)		9.7147 (0.000)	
Serial correlation	16.5 (0.0209)		16.5 (0.0209)		42.729 (3.762e-07)		42.729 (3.762e-07)	
Heteroskedasticity	45.663 (2.755e-07)		45.663 (2.755e-07)		38.304 (6.615e-06)		38.304 (6.615e-06)	
Autocorrelation	1.6213 (0.0002)		1.6213 (0.0002)		1.2976 (1.4e-10)		1.2976 (1.4e-10)	

Source: Prepared by authors

Table 2 Results of the model for the NII as the dependent variable

	<i>Fixed effects (NII)</i>		<i>Random effects (NII)</i>	
Intercept			9.2430	***
			(1.8989)	
LOA	0.0028		0.0023	
	(0.0044)		(0.0045)	
ASS	-1.6005	***	-0.8455	***
	(0.2726)		(0.1791)	
CTI	-0.0009		-0.0010	
	(0.0007)		(0.0007)	
CAP	-0.0010		0.0172	
	(0.0160)		(0.0272)	
STR	0.0455	**	0.0498	**
	(0.0137)		(0.0155)	
LTR	-0.0095		-0.0030	
	(0.0105)		(0.0113)	
GDP	-0.0051		-0.0010	
	(0.0064)		(0.0070)	
CR5	-0.0062		-0.0068	
	(0.0057)		(0.0039)	
R^2	0.2847		0.3175	
R^2 corrig.	0.1904		0.2983	
Sample size	$N = 27, T = 7-11, N = 293$		$N = 27, T = 7-11, N = 293$	
Individual effects	51.029			
	(0.000)			
Time effects	2.772			
	(0.0028)			
Cross-sectional dependence	3.3962		2.6087	
	(0.0006)		(0.0090)	
Serial correlation	200.32		200.32	
	(0.000)		(0.000)	
Heteroskedasticity	75.124		75.124	
	(4.659e-13)		(4.659e-13)	
Autocorrelation	0.3601		0.3601	
	(0.000)		(0.000)	

Source: Prepared by authors

Table 3 ROA and ROE without control variables

	<i>Fixed effects (ROA)</i>		<i>Random effects (ROA)</i>		<i>Fixed effects (ROE)</i>		<i>Random effects (ROE)</i>	
Intercept			1.1110	***			13.9776	***
			(0.1196)				(1.2793)	
STR	0.1199	*	0.1406	**	2.0146	**	2.1041	**
	(0.0514)		(0.0506)		(0.7182)		(0.7195)	
LTR	-0.3101	***	-0.2965	***	-4.4821	***	-4.1796	***
	(0.0477)		(0.0417)		(0.7404)		(0.6914)	
R^2	0.2980		0.2969		0.3055		0.3023	
R^2 corrig.	0.2246		0.2922		0.2330		0.2976	
Sample size	$N = 27, T = 11,$ $N = 297$		$N = 27, T = 11,$ $N = 297$		$N = 27, T = 11,$ $N = 297$		$N = 27, T = 11,$ $N = 297$	
Individual effects	3.3601				3.0369			
	(3.1e-07)				(3.147e-06)			
Time effects	0.64289				0.57185			
	(0.7765)				(0.8365)			
Cross-sectional dependence	10.527		8.0637		10.393		8.4238	
	(0.000)		(7.401e-16)		(0.000)		(0.000)	
Serial correlation	33.788		33.788		52.525		52.525	
	(0.0003917)		(0.0003917)		(2.189e-07)		(2.189e-07)	
Heteroskedasticity	39.561		39.561		21.373		21.373	
	(2.568e-09)		(2.568e-09)		(2.285e-05)		(2.285e-05)	
Autocorrelation	1.4106		1.4106		1.2019		1.2019	
	(1.179e-07)		(1.179e-07)		(1.563e-12)		(1.563e-12)	

Source: Prepared by authors

Table 1 and Table 2 show the results of the models compiled for each of the variables (i.e., ROA, ROE and NII). The structure of the tables is the same. First, the quantitative impact of each explanatory variable is given, indicating statistical significance through the following codes: (***) at a probability level of 0.001; (**) at probability level 0.01; (*) at probability level 0.05 and (.) at probability level 0.1. It is followed by the value of the coefficient of determination (R^2) and the corrected coefficient of determination (R^2 corrig.) and an indication of the size of the sample. In addition, the tables also show the results of the diagnostic tests (test statistics and the corresponding p-values in brackets).

In the models compiled for ROA or ROE, respectively, we pointed to the positive and statistically significant impact of the following explanatory variables: short-term interest rates, capitalisation, and GDP. On the contrary, the following explanatory variables had a negative and statistically significant impact on the ROA or ROE: cost to income and long-term interest rates. Based on the results presented in Table 1, we can positively evaluate the fact that in the models compiled for both the ROA and ROE variables, the variables characterising interest rates, i.e., short-term and long-term interest rates, having

an impact on profitability is the main subject of our research, were statistically significant.

The impact of the cost to income variable reflecting operational efficiency was negative according to the theoretical expectations presented in the literature review. It means that reducing operating costs, of course, increases profitability and vice versa. This conclusion is in line with the analysis results by Claessens et al. (2018), who stated that banks are trying to promote their profitability by reducing operating costs. On the other hand, the impact of the variable capitalisation and GDP on banks' profitability was positive. The positive impact of capitalisation on profitability is in line with several empirical studies, e.g., Kok et al. (2015), Borio et al. (2017), or Gunter et al. (2013), who also confirmed that banks with higher capitalisation could generate higher profit. The positive impact of the GDP indicates that bank profitability is sensitive to the economic cycle. It means that in times of economic expansion, profitability may be positively affected, in turn in times of recession, i.e., negatively. This conclusion is also in line with empirical studies, namely Albertazzi and Gambacorta (2009) or Bikker and Hu (2002). In this context, we can express some concerns about future economic developments, as the crisis triggered by the current pandemic will have a significant negative economic impact on the euro area and the EU.

We also analysed the model compiled for the variable NII (Table 2). In this model, the impact of most explanatory variables was not statistically significant. However, as shown the Table 2, in this model, we have pointed to the positive and statistically significant impact of short-term interest rates, resulting in the pressure on interest income.

The impact of short-term interest rates on profitability expressed by the ROA or ROE variable was positive and statistically significant (see Table 1) and confirmed our expectations. Therefore, we can confirm that low interest rates put pressure on the banking sector's profitability. The model compiled for the variable NII has confirmed this positive impact of short-term interest rates (see Table 2). Our conclusion is in line with the results of many of the above-mentioned works, e.g., Bikker and Vervliet (2018), Borio et al. (2017), Hanzlík and Teplý (2019) and others. The ECB also emphasises the impact of falling interest rates, as it considers pressure on banks' profitability as one of the risks to financial stability.

Regarding long-term interest rates, the results of our models show a negative and statistically significant relationship between long-term interest rates and profitability expressed by ROA and ROE, see Table 1. Therefore, our result seems to be at odds with the theoretical assumptions and the results of some other studies. On the other hand, this conclusion can be justified by achieving a certain point where the steeper yield curve can already decrease profitability, as suggested by Borio et al. (2017). A similar result was also found by Hanzlík and Teplý (2019), who also found out the negative impact of the yield curve slope on the profitability of banks operating in the banking sectors of EU countries.

We can also suppose that during the period of decreasing interest rates, the bank started to reduce the share of loans on total assets and increase the investment into the securities with longer maturity. They wanted to replace the decrease in interest margin from loans and deposits by increasing the interest income from investments. Therefore, we can suppose that although the long-term interest rates also decreased, the higher volume of investments increased profitability. Then we also know that there is an inverse relationship between assets market prices and interest rates. Therefore, we can suppose that with a decrease in the long-term interest rate, the market prices of assets increased,

which could also be an opportunity for the bank to replace the decline in interest income by generating profit from securities.

As part of the robustness check, we estimated models for the variables ROA and ROE. We only left the explanatory variables characterising (short-term and long-term) interest rates. On the contrary, the other control variables (i.e., the variables describing the banking sector, the macroeconomic variables, and the concentration variables) included in the original models were excluded.

We estimated the fixed and random effects model for ROA and ROE explained variables. For both explained variables, the assembled model can be written as follows:

$$\pi_{it} = c + \alpha X_{it}^{IR} + \varepsilon_{it} \quad (2)$$

while π_{it} represents the profitability of the i th banking sector in period t , X_{it}^{IR} represents interest rates.

The results for the ROA and ROE compiled as part of the robustness check include Table 3.

The results presented in Table 3 show that also robustness models confirmed the positive and statistically significant impact of short-term interest rates on the explained variables ROA and ROE or the negative and statistically significant impact of long-term interest rates, which coincides with the effects of these explanatory variables estimated in the baseline models.

Based on the above findings and results, we can conclude that, following the outbreak of the global financial and economic crisis and the debt crisis, the ECB and other central banks within the EU generally proceeded to ease monetary policy in a historically unprecedented manner to accelerate the recovery of the economy after these crises. There was a decrease in the key ECB interest rates, followed by the short-term and long-term interest rates. Based on economic theory, low interest rates should increase demand for consumption and investment and ultimately stimulate economic growth.

Thus, while the ECB's intention to reduce interest rates is clear, the authors Klacso and Rychtárik (2016) note that historically low interest rates and their pressure on NII may pose a certain challenge to the banking sectors of the EU countries, as interest income is a quite important source of their income. The development of the average values of the ROA and ROE characterising the overall profitability achieved in the EU banking sectors indicate that, following the turbulent developments in the crisis and post-crisis periods, the average profitability of the European banking sectors has gradually increased steadily. Similar conclusions were found by Scheiber et al. (2016), who stated that negative interest rates did not lead to a significant drop in profitability or interest income of banks in the banking sectors of Switzerland, Sweden and Denmark. Urbschat (2018) notes that the German banking sector performed relatively well in the early years of the ECB's unconventional policy, while German banks benefited from lower refinancing costs or lower losses on non-performing loans during this period. Similarly, Genay and Podjasek (2014) suggest that low interest rates may ultimately be beneficial because of their positive impact on the economic cycle.

Of course, the results of our analysis cannot be generalised to all EU countries, as each country's banking sector has its characteristics. We can therefore expect that the impact of the low interest rate environment on the profitability of a particular banking sector will also depend on the importance of NII for banks in the banking sector. In some countries, the pressure of low interest rates on profitability is offset by higher loan volumes, increasing non-interest revenues, or increasing operational efficiency, which

may help overcome this challenge. For example, the authors of Borio et al. (2017) stated that the low interest rate environment encouraged banks to focus on activities generating revenue from fees and trading rather than activities oriented on interest income generation, which helps the interest margin decline compensation. This statement is confirmed by the conclusions of other authors, e.g., Genay and Podjasek (2014). However, in other countries, weaker loan demand, lower non-interest revenues, or lower operational efficiency may not sufficiently compensate for this pressure. The authors Klacso and Rychtárik (2016) note that this, together with a situation where banks do not have many options to reduce interest costs, may in the future be subject to certain restrictions for specific banking systems.

In the light of the arguments above, it would be appropriate to supplement our analysis with micro-level data, i.e., for commercial banks operating in individual EU banking sectors. However, such data is not freely available in free databases and would be very difficult to obtain.

There is great importance to the issue of banks' profitability in the euro area and the EU, as evidenced by the fact that the ECB ranks the profitability of banks under pressure from low interest rates among the main risks to the financial stability of the euro area. The ECB (2017) within the Annual Report states that the ECB's monetary policy measures may have had a negative impact on banks' profitability through two main channels:

- 1 The low interest rate environment puts pressure on banks' interest margins.
- 2 The negative deposit facility rate implies a direct charging of excess liquidity in the banking system.

Several positive factors have so far balanced these negative aspects. E.g., the positive effect of stable and broad-based economic expansion on banks' profitability. It is also in line with the results of our models, as we pointed to the positive impact of the macroeconomic variable GDP on banks' profitability (see Table 1).

The ECB (2017) shows that, due to the improvement in the economic outlook, the creditworthiness of borrowers has increased, and banks' cost of provisions has decreased. In addition, the profitability of banks was also positively affected by the increasing volume of loans due to the economic recovery and capital gains from rising asset prices. We analysed the share of loans in assets as one of the explanatory variables entering our models, as loans create a significant part of assets in all EU banking sectors. The average share of loans in total assets in the EU banking sectors was around 66%, representing 2/3 of total assets. The ECB's annual report also states that although downward rigidities characterise retail deposit rates, wholesale deposits, particularly non-residents, are often reimbursed at negative rates, which helps mitigate the dampening effect of low interest rates on NII.

In turn, the ECB's 2018 annual report shows that, despite generally improving profitability, banks remain under pressure caused by low interest rates, implying a need to adapt their business models. In the thematic assessment of profitability and business models realised by the ECB's banking supervision in 2018, there were significant differences between the banks. This assessment pointed out that the banks' strategic management is an important factor in profitability. The conclusion mentioned above of the ECB's assessment, together with the statement by Hanzlík and Teplý (2019), confirms the appropriateness of complementing our analysis with microdata for banks

operating in individual banking sectors, which would allow us to examine this issue in more detail.

Kalman (2018) states that markets continue to expect a persistent environment of low interest rates. It is expected that the nature of the current low interest rate period called 'low for long' (this name is used in their work, e.g., by Claessens et al. (2018)) will deepen. The rates will be lower, and this situation will last even longer than initially expected (which implies the name "lower for longer"). Notwithstanding the impact of low interest rates on banks' profitability, it can be concluded that such an environment entails some risks to financial stability, particularly rising indebtedness, risk of price bubbles, or investing in increasingly risky assets to keep profitability at a set level.

5 Conclusion

Examining the impact of interest rates on the profitability of the EU banking sector is a problematic issue given the many factors affecting profitability. Furthermore, the complexity of the problem is affected by the fact that the economies of the EU countries were affected by the global crisis and the subsequent introduction of non-standard monetary policy instruments and measures during the analysed period. In addition, the banking sectors of the EU countries differ considerably. The complexity of this issue is also illustrated by the results of empirical work within the literature review, which are not consistent and often differ one from another.

Although the impact of non-standard instruments and measures or the reduction of key ECB interest rates after the crisis was not of major concern (as they were adopted to support economic expansion in euro area economies following the global crisis), we can certainly conclude that banks' profitability was ultimately affected by these measures. This is also confirmed by the fact that the pressure of low interest rates on the profitability of commercial banks is among the risk factors for the financial stability of the euro area identified by the ECB in its annual reports.

Our study aimed to examine the impact of historically low interest rates introduced after the global crisis on banks' profitability in the EU banking sectors. For analysis, we used aggregated panel data for the EU banking sectors, looking at the period from 2008 (i.e., practically from the onset of the global crisis in Europe) to 2018.

We pointed to the statistically significant impact of short-term interest rates, long-term interest rates, and some other control variables on the profitability of banking sectors. The choice of variables was influenced by the studies presented in the literature review, in which a similar issue was examined. In general, in similar work, examining the profitability of banks or banking sectors, explanatory variables are divided into four categories – variables specifying banks/banking sectors, macroeconomic variables, variables characterising market concentration, and variables describing the interest rates themselves. That is why we have included explanatory variables in this structure in our models. The results of our analysis were then confronted with the results of the work presented in the literature review or the ECB's assessment.

We pointed to the positive and statistically significant impact of short-term interest rates (expressed by the EURIBOR 3M or alternative 3M interbank interest rates used in non-euro area EU countries), confirming the expected pressure of low interest rates on banks' profitability, namely interest income. This result coincides with many empirical studies we presented in the literature review. In line with our expectations, there was also

a statistically significant negative impact of the cost to income indicator on ROA or ROE. In addition, we identified a positive and statistically significant effect of the GDP, which is consistent with the statements made in the ECB's annual reports and the results of other studies. On the other hand, the impact of long-term interest rates on profitability was negative, contrary to some empirical works. However, this outcome coincides with Hanzlík and Teplý (2019), who examined banks' profitability in EU countries.

The negative impact of low interest rates on banks' profitability raises some policy issues. One is the possible negative effect on monetary policy transmission as the low interest rate decreases the banks' ability to lend. The low interest rate leads to lower deposits as investors prefer to invest their funds into another type of investment instrument. The lower deposits could mean lower loans. It can impede the bank lending channel and thus may make lowering interest rates a less effective tool to stimulate economic activity. Another critical issue is the effect of low interest rates on banks' capitalisation. The lower profitability can reduce the banks' ability to increase their capital, thus increasing their vulnerability to shocks and decline in market confidence and reducing their ability to support the real economy. Therefore, the lower effectiveness of the transmission mechanism as the lower capitalisation of banks can adversely affect economic activity and financial stability in the future. As the low interest rate environment is still actual, the question is how to compensate for the losses in interest income by decreasing operating expenses or other costs connected to banking activities. Another important issue is the effect of low interest rates on the level of debt, especially in the case of the household. The relatively long low interest rate environment led to the enormous growth in loans to households. But the question is, what will be with these loans in the future. Will be the households able to repay them at higher interest rates? Will they be able to repay them in a worse economic situation when they lose their jobs? As the risk of default on these loans will increase in the environment of increasing interest rates or the unstable geopolitical situation, some central banks started to react to this situation. They took actions to limit the level of provided loans or increase the quality of provided loans. Therefore, the decision about the interest rates is very important and can be adequately assessed by the policymakers, as the level and the duration during the rates do not change can significantly affect the banking sector's stability not only nowadays but also in the future.

Given the many differences in the banking sectors of EU countries, data at a micro level, i.e., data for individual banks operating in the banking sectors, could be subject to further research. This conclusion stems from some of the studies and the ECB's thematic profitability assessment, which found significant differences between the various banks and confirmed the high importance of the strategic management quality as a significant profitability factor.

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