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**Low Interest Rates and Banks' Interest Margins:
Does Deposit Market Concentration Matter? ***

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Low Interest Rates and Banks' Interest Margins: Does Deposit Market Concentration Matter? *

Nimrod Segev, Sigal Ribon, Michael Kahn, and Jakob de Haan

Abstract

Using a sample of 7,919 banks from 30 OECD countries over 1995–2019, we examine the impact of low interest rates on banks' net interest margins. Our results confirm a positive relationship between interest rates and interest margins, which is stronger in a low interest rate environment. In more concentrated markets, however, interest margins are less sensitive to the level of interest rates as income and expense interest rate sensitivities closely match. But our results also suggest that the effect of market concentration on the link between interest rates and interest margins is weaker when interest rates approach zero.

JEL-codes: E43; E52; G21

Keywords: bank profitability; net interest margin; low interest rates; market concentration

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ריביות נמוכות ומירווח הריבית של הבנקים: האם הם תלויים במידת התחרות

נמרוד שגב, סיגל ריבון, מיקי קהן ויעקב דה-האן

תקציר

המחקר בוחן באמצעות מדגם של 7,919 בנקים מ-30 מדינות OECD לשנים 1995-2019, את ההשפעה של ריביות נמוכות על מירווחי הריבית נטו של הבנקים. מהתוצאות עולה שקיים קשר חיובי בין רמת הריבית לבין מירווחי הריבית של הבנקים והוא חזק יותר בסביבה של ריביות נמוכות. עוד נמצא שבמדינות בהן מערכת הבנקאות ריכוזית יותר מירווחי הריבית פחות רגישים לרמת הריבית כיון שההשפעה שלה על ההכנסות מריבית וההוצאות על ריבית דומה. עם זאת, התוצאות מצביעות על כך שההשפעה של מידת הריכוזיות של מערכת הבנקאות על הקשר בין הריביות למירווחי הריבית נחלשת ככל שהריבית מתקרבת לאפס.

1. Introduction

Interest rates in many OECD countries have been low for quite some time. Low interest rates may stimulate economies, which, in turn, will improve banks' balance sheets by reducing non-performing loans. However, low interest rates may also erode banks' net interest margins. A bank's net interest margin (NIM) reflects the difference between interest income generated on loans provided and interest paid out to lenders (notably on deposits), both relative to the amount of their (interest-earning) assets. As pointed out by Borio et al. (2017), bank deposits are typically priced as a markdown on market rates. However, this markdown is compressed when market interest rates are very low because interest rates on deposits cannot fall significantly below zero. As interest rates on loans follow market rates, low interest rates are expected to reduce banks' NIMs.

The impact of low interest rates on bank interest rate margins and profitability is highly policy relevant. If low interest rates result in a decline in profits, this can erode bank capital positions through a reduction in retained earnings. In turn, this can further limit credit growth, thus hampering monetary policy transmission (Brunnermeier and Koby, 2018). Eroded capital positions may also raise financial instability concerns, especially since banks in several countries have been struggling since the global financial crisis with historically high levels of non-performing loans (Molyneux et al., 2019).

Using a sample of 7,919 banks from 30 OECD countries for the 1995–2019 period, this paper examines the impact of low interest rates on banks' net interest margins.¹ We are not the first to raise this issue. Several recent papers using international samples report a positive but non-linear relationship between interest rates and banks' interest margins; low interest rates have a significantly greater impact on banks' net interest margins than high interest rates (Borio et al., 2017; Claessens et al., 2018).² We extend this literature in several directions.

Our first contribution is that we test whether deposit market concentration weakens the connection between interest rates and banks' net interest margins. The importance of market

¹ We focus on the impact of low interest rates on banks' interest margins and not on banks' return on assets (ROA). The effects of low interest rates on bank profitability are less obvious, even if interest margins were to decline (Claessens et al., 2018). Banks may benefit (at least in the short run) from low interest rates through valuation gains on fixed-income securities they hold. Furthermore, lower interest rates may also spur the economy, increasing the profitability from new lending and the provision of other financial services. Banks may also offset the decline in the NIM by increasing non-interest income such as from fees and other charges.

² Some recent papers focus on the impact of negative interest rates on banks' interest margins; see, for example, Molyneux et al. (2019) and Lopez et al. (2020). Both studies report that negative interest rates reduced banks' net interest margins. Still, Lopez et al. (2020) conclude that bank profitability as a whole has, thus far, been unaffected by negative nominal interest rates, because banks were able to compensate declining net interest margins.

concentration for the relationship between interest rates and bank performance has been brought up by Drechsler et al. (2021). These authors argue that "deposit franchise gives banks market power over retail deposits, which allows them to borrow at rates that are both low and insensitive to market interest rates. ... while running a deposit franchise incurs high operating costs (branches, salaries, marketing, technology), these costs are also insensitive to interest rates. Thus, even though deposits are short-term, funding via a deposit franchise resembles funding with long-term fixed-rate debt." Using deposit concentration to proxy market power, Drechsler et al. (2021) present evidence suggesting that – due to market power – banks' net interest margins in the United States have been highly insensitive to interest rates over the past six decades. This is also true in the cross-section: banks that have a stronger deposit franchise hold more long-term assets. To the best of our knowledge, the impact of market concentration on the relationship between interest rates and banks' net-interest margins has not been explored for other countries.

Our second contribution is to explore whether the impact of deposit market concentration on the relation between interest rates and banks' net interest margins changes in periods of low interest rates. Sá and Jorge (2019) argue that banks' market power over deposits is eroded as interest rates approach zero. The intuition is that market power over deposits is only relevant when the interest rate is sufficiently higher than zero. Indeed, in the framework of Drechsler et al. (2021), the stability of net-interest margins is driven in part by banks' ability to charge a markdown on deposit rates. However, if the markdown is compressed when interest rates are reduced to very low levels, the net-interest margin may also decrease. To the best of our knowledge, this issue has not been addressed in empirical research before.

Our estimates of a similar model to that proposed by Claessens et al. (2018) confirm a positive relationship between interest rates and banks margins, which is stronger in a low interest rate environment. Consistent with Drechsler et al. (2021), we show that net-interest margins of banks which raise deposits in more concentrated markets are less sensitive to interest rate fluctuations. Our results suggest that the ability of banks operating in concentrated markets to evade the effect of lower interest rates on their net-interest margins results from a smaller impact of low interest rates on the income side and a larger decline of the sensitivity of the expenses side. We also find that in a low interest rate environment, the relationship between interest rates and banks' net-interest margins is positive and significant in both more and less concentrated markets. However, our results also suggest that the effect of market concentration on the link between interest rates and interest margins is weaker when interest rates approach zero. This provides empirical support for Sá and Jorge's (2019) argument.

The remainder of the paper is structured as follows. Section 2 discusses related studies explaining in more detail how our paper is related to previous research; this section also introduces the hypotheses tested. Section 3 describes our data and methodology, while section 4 presents the main results. Section 5 offers sensitivity analyses. Section 6 concludes.

2. Related studies and hypotheses

This paper is related to the large and growing literature investigating the impact of low and negative interest rates on banks' interest rate margins and profitability.³ Bank deposits are typically priced as a markdown on policy-driven market rates. This markdown is compressed when policy rates are reduced to very low or negative levels for several reasons. First, negative deposit rates provide customers an incentive to switch to paper currency (Claessens et al., 2018). In practice, until recently, negative interest rates on bank deposits have been rare and applied mainly to large corporate deposits (Lopez et al., 2020). Second, low or negative rates may lead to reductions in deposits, which is a relatively cheap source of funding for banks (Sääskilahti, 2018). Third, banks may fear losing clients when they lower rates too much. These clients are important in other ways than just funding. Banks may, for example, derive value from cross-selling products like consumer credit and mortgage to their depositors (Claessens et al., 2018). While interest rates on deposits face a floor as interest rates decline, banks often have to pass on lower rates on the asset-side of their balance sheet, for instance, due to contractual repricing terms, or for competitive reasons (borrowers may have other financing choices, e.g., from corporate bond markets or other banks). This asymmetry in pass-through on the asset and liabilities side of banks' balance sheets under low (or negative) interest rates will reduce banks' net interest income (Borio et al., 2017).

Several recent studies examine how low (or negative) interest rates affect (components of) bank profitability (Borio et al., 2017; Altavilla et al., 2018; Claessens et al., 2018; Bikker and Vervliet, 2018; Sääskilahti, 2018; Cruz-García et al., 2019; Molyneux et al., 2019; and Lopez et al., 2020).⁴ Most papers report a positive and non-linear relationship between market rates

³ In his seminal paper, English (2002) studied the link between interest rate risk and bank interest margins in ten industrialized countries reporting that a steep yield curve raises interest margins. Similarly, Alessandri and Nelson (2015) established a positive relationship between the level and the slope of the yield curve and bank profitability in the United Kingdom. There is an extensive literature on other determinants of bank profitability and interest margins (see, for example, Kasman et al., 2010; López-Espinosa et al., 2011; Entrop et al., 2015; Andrievskaya and Semenova, 2016; Birchwood et al., 2017).

⁴ Other recent studies examine the influence of low and negative rates on bank lending supply and risk-taking (see, for example, Borio and Gambacorta, 2017; Heider et al., 2019; Basten and Mariathasan, 2020; Boungou, 2020; Molyneux et al., 2020).

and banks' NIMs. The study in this line of literature that is closest to ours is Claessens et al. (2018). These authors report that low interest rates have a significantly greater impact on bank net interest margins than high interest rates. The impact is greater on interest income margins than on interest expense margins. We estimate a model which is similar to the one used by Claessens et al. (2018). We also use their cut-off level of 1.25% to define a low interest rate environment.⁵ Whereas the final sample of Claessens et al. (2018) contains 3,385 banks from 47 countries for 2005–2013, our sample consists of 7,919 banks from a more homogeneous sample of 30 OECD countries during the 1995–2019 period. Most importantly, we examine whether the relationship between interest rates and banks' interest margins is conditional on deposit market concentration.

This choice is motivated by a recent paper by Drechsler et al. (2021).⁶ These authors show that due to market power over deposits, banks' net interest margins in the United States have been highly insensitive to interest rates over the past six decades.⁷ The mechanism works as follows: Deposit market power allows banks to borrow at rates that are both low (markdown) and relatively insensitive to short-term market rates so that banks' interest expenses are relatively insensitive to interest rates. Banks hedge against interest rate fluctuations by holding more long-term fixed-rate assets. The result is that banks' net interest rate margins in more concentrated deposit markets are insensitive to the short-term rate. In other words, banks' market power over deposits results in limited pass-through of market rates to deposit rates so that deposits effectively behave like long-term fixed-rate liabilities. This leads to our first hypothesis:

Hypothesis I (H1): In more concentrated deposit markets, net interest margins are less sensitive to short-term rates.

⁵ We also consider national thresholds based on the 25th percentile of the distribution of short-term local interest rates to identify low interest rate periods. The advantage of using a distribution-based threshold versus a standard threshold for all countries is that it allows to account for cross country differences in interest rate levels. However, the main reasons why low interest rates may affect banks' NIMs differently apply if interest rates are close to the effective lower bound and not just historically low. As will be explained in more detail in section 3, using a uniform threshold implies that some countries are never in a low interest rate environment and this will help identification.

⁶ Earlier studies reporting that more concentrated markets exhibit greater price rigidity include Hannan and Berger (1991) and Neumark and Sharpe (1992).

⁷ In contrast, Bikker and Vervliet (2017) find that low interest rates compress banks' net interest margins using data of 3,582 US banks from 2001 to 2015.

To the best of our knowledge, H1 has not been tested for non-US banks.⁸ Drechsler et al. (2021) separate the net interest margin of US banks into its two components, interest income and interest expense (both scaled by assets), and compare their interest rate sensitivities. They find that both banks' interest income and interest expenses have a low sensitivity to the short rate. We examine whether this also holds in our sample of banks from 30 OECD countries.⁹

In a recent theoretical paper, Sá and Jorge (2019) argue that banks' market power over deposits is eroded as interest rates approach zero. In the framework of Drechsler et al. (2021), NIM's stability is driven by banks' ability to charge a markdown on deposit prices. However, if the markdown is compressed when the policy rate is reduced to very low levels, the NIM may also be affected by the low rate. This leads to our second testable hypothesis:

Hypothesis II (H2): The effect of market concentration on the link between interest rates and interest margins is weaker in a low interest rate environment.

To the best of our knowledge H2 has not been tested empirically.¹⁰

3. Data and Empirical Methodology

3.1 Methodology

Our baseline model is a variant of the specification used in Claessens et al. (2018):

$$y_{i,t} = \alpha_i + \alpha_t + \beta_1 y_{i,t-1} + \beta_2 r_{i,t} + \beta_3 Spread_{i,t} + \beta_4 Low_{i,t} + \beta_5 r_{i,t} * Low_{i,t} + \beta_6 Spread_{i,t} * Low_{i,t} + \gamma_1 Z_{i,t} + \gamma_2 X_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

where $y_{i,t}$ is the net interest margin (NIM), the interest income margin (IIM), or the interest expense margin (IEM) of bank i at year t . $r_{i,t}$ is the 3-month interest rate¹¹; $Spread_{i,t}$ is the spread between the 10-year rate and the 3-month rate; $Low_{i,t}$ is a dummy equal to 1 if bank i 's country in a specific year t is in a "low-rate environment". Following Claessens et al. (2018), in our

⁸ There is related research investigating the impact of bank concentration on bank performance. For example, studies have examined how bank concentration affects the connection between monetary policy and bank lending (Olivero et al., 2011; Adams and Amel, 2011; Drechsler et al., 2017), bank earnings volatility (de Haan and Poghosyan, 2012), bank profitability (Mirzaei et al., 2013) and financial stability (Beck et al., 2006; Jiménez et al., 2013; IJtsma et al., 2017).

⁹ We do not include US banks for two reasons. First, they would dominate our sample. Second, the conditioning impact of deposit concentration in the relationship between (low) interest rates and banks' NIMs has been investigated already by Drechsler et al. (2021).

¹⁰ A related paper is by Wang et al. (2020) who show that bank market power interacts with capital regulation to reverse the effect of US monetary policy when the federal funds rate is very low. Specifically, they estimate that, when the federal funds rate is below 0.9%, further cuts in the policy rate can be contractionary.

¹¹ Note that interest rates used are annual averages, while all bank-level data that relate to flows, are measured at the end of the year.

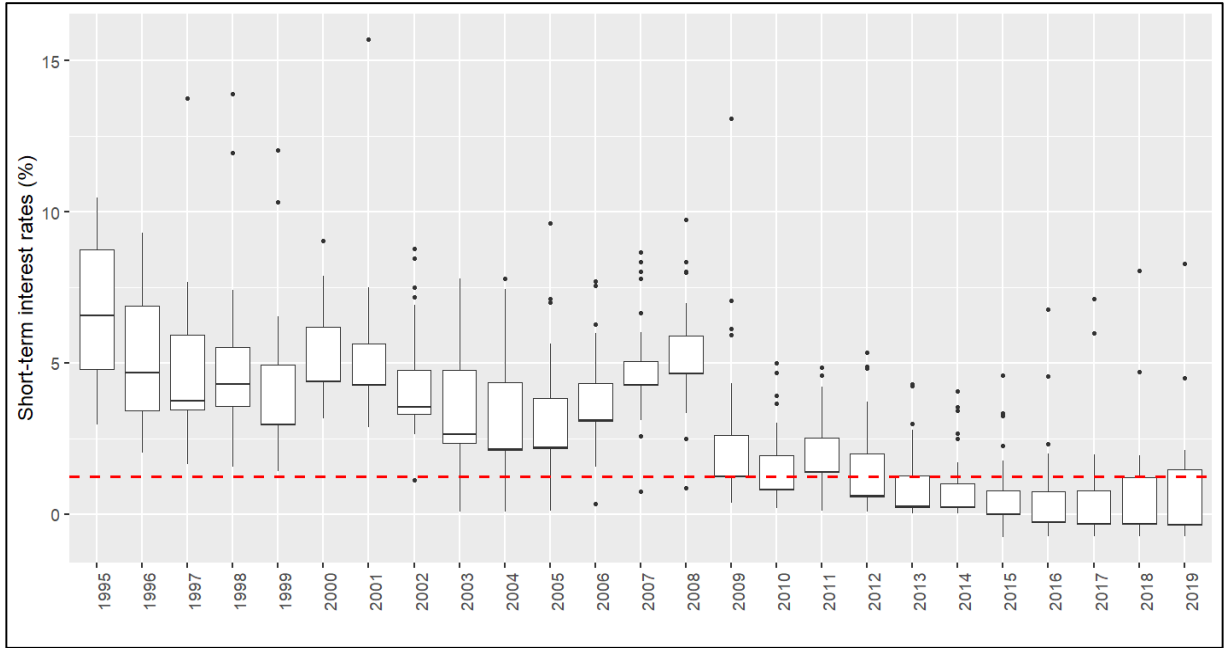
baseline specification, we consider a country in a low interest environment when its 3-month interest rate is below 1.25%. In the sensitivity analysis, we also experiment with a threshold of 0.5% and a national-based threshold. $X_{i,t-1}$ are bank-level controls that include deposits over total liabilities, the liquidity ratio, total equity capital over total assets, and total securities over total assets, all lagged one period. $Z_{i,t}$ are macroeconomic controls, i.e., real GDP growth and CPI inflation in bank i 's country. α_i and α_t are bank and time fixed effects, respectively, and $\epsilon_{i,t}$ is an error term. We use robust standard errors clustered by bank.

Our modeling approach implies that, in essence, we are estimating a diff-in-diff model with countries that never fall below 1.25% (Mexico, Colombia, New Zealand, Australia, Poland, and Korea; see Table A2 in the Online Appendix) acting as a control group (Molyneux et al., 2019). The control group becomes slightly larger if the threshold used is 0.5.

Figure 1 shows a box plot of short-term interest rates for the countries in our sample. The figure illustrates that although there is a decline in interest rates over time, there is a lot of cross-country variation.

Figure 1: Short-term interest rates, boxplot, by year

The figure presents for every year in the sample period a boxplot of short-term interest rate for all countries in the sample, showing the minimum, the maximum, the sample median, and the first and third quartiles. The dots show outliers not included in the whiskers. The red dashed line is the threshold used (1.25%), following Claessens et al. 2018 to define the low interest rate environment.



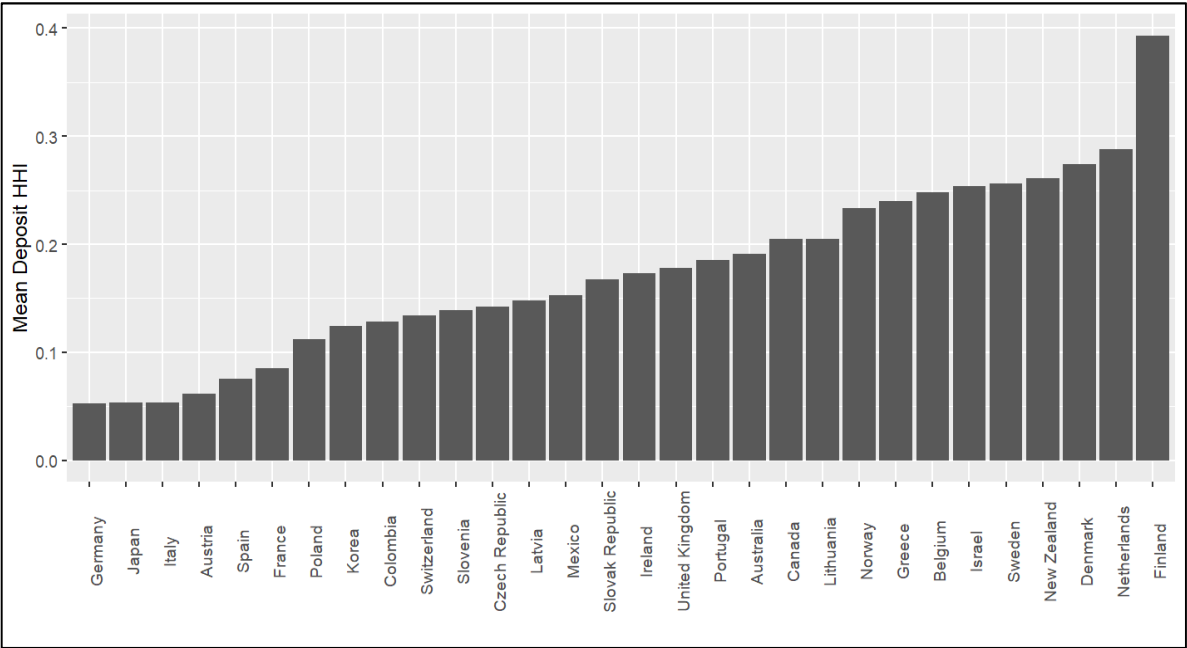
Although this may not fully address the endogeneity in monetary policy, the specification includes countries' economic growth and inflation, thereby controlling for general economic

conditions. In addition, the time fixed effects controls for any commonality across countries, such as the impact of the global financial crisis and policy makers' attempts to contain the crisis (through reducing interest rates). The time fixed effects also control for common regulatory changes that may have affected banks' performance (Claessens et al., 2018). In section 5, we discuss this potential endogeneity in more detail.

To investigate the role of the concentration of the deposit market structure on the connection between low interest rates and bank interest rate margins, we need a proxy for banks' market power in the deposit market. In line with several previous papers (Berger et al., 2000; Jiménez et al., 2013; Drechsler et al., 2017; 2021 and Acharya et al., 2020), we use the Herfindahl-Hirschman Index (HHI) for bank deposits (using data from Fitch connect) for this purpose. Figure 2 shows the average HHI for the countries in our sample, illustrating that concentration in the deposit markets varies a lot in our sample. To distinguish between more and less concentrated markets, we split our sample as follows: We define a banking sector as less concentrated for every year in which its HHI for bank deposits is in the first quartile of the distribution across all countries for the given year, and more concentrated otherwise. In the sensitivity analysis, we check the robustness of our findings for other cut-off points to define concentrated markets and use a triple-interaction model.

Figure 2: Deposit Concentration, HHI index by country, 1995-2019 average

The figure shows the mean-deposit-based HHI in every country in the sample.



3.2 Data and sample construction

We use bank-level data from Fitch connect (Solutions) for the 1995-2019 period. Our sample includes all OECD countries, excluding Chile, Estonia, Hungary, Iceland, Luxembourg, and Turkey, due to missing interest rate data and insufficient observations. We also exclude the USA to avoid any biases that may result from an over-representation of American banks in the sample.¹² We only keep commercial banks, cooperative banks, savings banks, and bank holding companies. To avoid concerns regarding banks that operate in more than one country, we employ unconsolidated balance sheet information only. We drop observations if the total assets or the capital assets ratio are negative and if deposits are greater than total liabilities. The resulting bank balance sheet variables have been winsorized at the 1% and 99% level to avoid outliers. Our final sample includes 7,919 banks over 1995-2019, resulting in 95,964 bank-year observations.

Interest rates are from the OECD database. Data for GDP growth and inflation come from the IMF's International Financial Statistics (IFS). Table 1 presents a description of all variables used and their sources, while Table 2 shows descriptive statistics.

Table 1: Data description and source		
Name:	Description:	Source:
Net Interest margin	Net interest income as a percentage of earning assets	Fitch Connect
Interest income margin	Interest income expressed as a percentage of average earning assets	Fitch Connect
Interest expense margin	Interest expense expressed as a percentage of average interest-bearing liabilities.	Fitch Connect
Deposits over liabilities	Deposits and short-term funding to total liabilities ratio	Fitch Connect
Equity over assets	Equity to total assets ratio	Fitch Connect
Securities over assets	Other earning assets (all return bearing assets other than loans) over total assets	Fitch Connect
Liquidity ratio	Liquid assets to deposits and short-term funding ratio	Fitch Connect
Short-term interest rate	Three-month money market rates, annual average	OECD national accounts database
Spread	Difference between the short-term rate and the 10-year government bond rate	OECD national accounts database
GDP growth	Percent change of annual average of gross domestic product, constant prices (National currency)	IMF International Financial Statistics
Inflation	Percent change of annual average consumer prices	IMF International Financial Statistics

¹² Excluding the U.S. also distinguishes this paper from the evidence presented in Drechsler et al. (2021) which is based on US banks only.

Table 2: Descriptive Statistics

This table presents the descriptive statistics for the main variables used in the analysis. See Table 1 for descriptions of all variables. The sample period is 1995 - 2019. The sample is an unbalanced panel that includes 7,919 banks with a total of 95,964 bank-year observations. Mean, median, and standard deviation of each variable are given. The table also provides a breakdown by high and low deposit HHI. In every year, a banking sector is considered as Low concentration if its deposit-based HHI is in the first quartile of the countries distribution.

	All (95,964 obs.)			Low Concentration (76,819 obs.)			High Concentration (19,145 obs.)		
	Mean	Median	Std. dev.	Mean	Median	Std. dev.	Mean	Median	Std. dev.
Net Interest margin	2.47	2.34	1.28	2.46	2.40	1.12	2.50	2.02	1.81
Interest income margin	4.42	4.20	2.44	4.34	4.23	2.24	4.74	4.08	3.11
Interest expense margin	2.09	1.82	1.76	2.01	1.81	1.66	2.41	1.86	2.07
Short rate	1.90	1.39	2.01	1.84	1.23	1.91	2.13	1.70	2.37
Spread	1.23	1.03	1.08	1.24	1.11	0.96	1.21	0.96	1.47
HHI	0.10	0.06	0.09	0.06	0.05	0.02	0.24	0.23	0.10
CR3	0.42	0.37	0.16	0.35	0.34	0.08	0.68	0.68	0.12
Deposits over liabilities	89.54	95.39	14.33	90.36	95.91	13.63	86.27	92.13	16.43
Equity over assets	9.30	7.41	8.23	8.92	7.13	7.78	10.81	8.69	9.68
Securities over assets	36.22	33.82	20.11	37.69	35.29	18.54	30.30	22.62	24.57
Liquidity Ratio	27.73	16.76	37.56	26.80	16.87	35.57	31.45	16.27	44.48
GDP growth	1.49	1.66	2.00	1.32	1.53	1.91	2.19	2.31	2.19

Correlation Matrix

	Net Interest margin	Interest income margin	Interest expense margin	Short rate	Spread	HHI	CR3	Deposits over liabilities	Equity over assets	Securities over assets	Liquidity Ratio	GDP growth	Inflation
Net Interest margin	1												
Interest income margin	0.76	1											
Interest expense margin	0.30	0.80	1										
Short rate	0.37	0.72	0.77	1									
Spread	0.10	0.09	0.05	-0.14	1								
HHI	-0.03	0.02	0.06	0.07	-0.06	1							
CR3	0	0.07	0.11	0.12	-0.01	0.92	1						
Deposits over liabilities	-0.04	-0.13	-0.24	-0.15	-0.11	-0.11	-0.10	1					
Equity over assets	0.20	0.05	0.04	-0.03	0.03	0.07	0.07	-0.28	1				
Securities over assets	-0.23	-0.19	-0.05	0.01	0	-0.13	-0.12	0.06	0.19	1			
Liquidity Ratio	-0.08	-0.05	0.08	0.06	0	0.04	0.04	-0.42	0.50	0.45	1		
GDP growth	0.07	0.10	0.10	0.19	-0.25	0.14	0.14	0.03	0.04	-0.01	0.05	1	
Inflation	0.26	0.37	0.34	0.46	0.05	0.01	0.05	-0.15	0.10	-0.03	0.07	0.24	1

The average (median) NIM in our sample amounts to 2.47 (2.34). These numbers are fairly similar to those reported by Claessens et al. (2018) for their sample (mean = 2.76; median = 2.36). The median of the NIMs in more and less concentrated markets differ (2.02 and 2.40, respectively) in contrast to their means which are about 2.50 for both markets. The variability of NIMs in more concentrated markets is higher than NIMs in less concentrated markets (the standard deviations amount to 1.81 and 1.12, respectively) which is due to the larger number of observations in the low concentrated sample.

The medians of the interest income margins in both subsamples differ much more than the medians of the interest expense margins. The median income margin in less concentrated markets is 4.23, while in more concentrated markets it amounts to 4.08. The standard deviations of both margins are higher in the sample of more concentrated markets than in the sample of less concentrated markets.

4. Results

4.1 Impact of deposit concentration

Table 3 presents the first estimation results for equation (1) for our entire sample. Columns (1)-(3) show the outcomes of three different specifications for the NIM. In the first column, we do not include the low interest environment dummy. In the second and third columns, this dummy is included and interacted with the short-term interest rate (column 2) and the short-term interest rate and the spread (column 3). The results are consistent with the findings of previous studies: there is a positive relationship between short-term interest rates and banks' NIMs. Also, the low interest rate environment amplifies the connection between the short-term rate and banks' net interest margins.

We also examine the relationship between the short-term interest rate and the two components of NIM, namely the interest income margin (IIM) and the interest expense margin (IEM). Here we consider the same models as for the NIM: in the first specification we do not include the dummy for the low interest rate environment, while in the second and third specification this dummy is included and interacted with the interest rate variables.

Claessens et al. (2018) find that the effects of interest rates are generally larger on the interest income margin than they are on the interest expense margin. In contrast, we do not find strong differences between the impact of the short-term interest rate on both components of the NIM (the coefficients of the short-term interest rate in columns (4) and (7) are pretty close). Our results suggest that in the low interest rate environment, the pass-through between the

interest rates and the interest expenses becomes weaker, possibly because of banks' inability or unwillingness to drop deposit rates below zero. The sensitivity of the IIM to interest rates, on the other hand, is not significantly impacted by the low interest rate environment. The coefficients of the interaction between the low interest environment dummy and the short-term interest rate are insignificant (columns (5) and (6) in Table 3).

We find a negative relation between banks' net interest margin and the slope of the yield curve, reflecting a larger positive reaction of expenses than of income to the spread. While not the focus of this paper, this negative relationship may seem counterintuitive since one would expect the slope to reflect the difference between long-term and short-term rates. However, as noted by Borio et al. (2017), the slope of the yield curve may also have quantity effects which could affect the demand for bank loans (mostly fixed-rate loans). If the demand for loans is more elastic than the supply of deposits, a steeper yield curve may negatively impact banks' net interest margins. Additionally, a steeper yield curve may affect banks' long-term liabilities, such as long-term unsecured bonds. Indeed, Claessens et al. (2018) also find that the spread coefficient is negative when including time fixed effects.¹³

Whereas Claessens et al. (2018) find a non-significant coefficient of the deposits over liabilities variable, we find a significant positive coefficient in the models for the net interest margin suggesting that banks that rely more on deposits have a higher NIM. This effect on the NIM is driven by the impact on the IEM; the coefficients of the deposits over liabilities variable are not significant in the models for IIM.

Our results also suggest that better capitalized banks have higher NIMs, while banks with higher securities to assets ratios, i.e., banks that are less engaged in lending, have lower NIMs. Both findings are consistent with the results of Claessens et al. (2018). While the liquidity ratio is not related to NIM, it turns out significant in the models for IEM and IIM. Apparently, these effects cancel out, so the liquidity ratio coefficient is not significant in the models for NIM.

Finally, the coefficients on GDP growth and inflation are significantly positive in the models for the net interest margin, suggesting that strong economic activity enhances banks' interest margins. Whereas the coefficient of GDP growth is negative and statistically significant in the models for IEM and IIM, the coefficient of inflation switches sign: it is positive in the models for IIM and negative in the models for IEM.

¹³ Table A.1 in the online Appendix shows the results of the estimation without time fixed effects. As in Claessens et al. (2018), the coefficient of the spread is positive when time fixed effects are excluded.

Table 3: Low interest rate environment and interest margins

The table presents the results for estimating Eq. (1) for the full sample (1995-2019). Low is a dummy that takes the value of one when the 3-month interest rate is equal to or below 1.25%. Robust standard errors clustered by banks are shown in parentheses. *p<0.1; **p<0.05; ***p<0.01.

	<i>Dependent variable:</i>								
	NIM			IIM			IEM		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lagged dependent variable	0.5679*** (0.0142)	0.5658*** (0.0142)	0.5647*** (0.0142)	0.4737*** (0.0162)	0.4721*** (0.0163)	0.4722*** (0.0163)	0.4996*** (0.0120)	0.5001*** (0.0120)	0.4992*** (0.0121)
3-Month rate	0.0173*** (0.0046)	0.0143*** (0.0054)	0.0292*** (0.0060)	0.3485*** (0.0121)	0.3529*** (0.0131)	0.3588*** (0.0136)	0.3447*** (0.0086)	0.3519*** (0.0093)	0.3431*** (0.0094)
Low		-0.0750*** (0.0160)	0.0355 (0.0222)		-0.0120 (0.0244)	0.0326 (0.0323)		0.0936*** (0.0166)	0.0244 (0.0233)
Spread	-0.0201*** (0.0046)	-0.0256*** (0.0047)	0.0089 (0.0065)	0.0352*** (0.0071)	0.0319*** (0.0072)	0.0459*** (0.0109)	0.0609*** (0.0063)	0.0654*** (0.0065)	0.0438*** (0.0088)
Deposits over liabilities (t-1)	0.0030*** (0.0005)	0.0033*** (0.0005)	0.0034*** (0.0005)	0.0005 (0.0008)	0.0006 (0.0009)	0.0006 (0.0009)	-0.0058*** (0.0008)	-0.0062*** (0.0008)	-0.0062*** (0.0008)
Equity over assets (t-1)	0.0103*** (0.0015)	0.0106*** (0.0015)	0.0104*** (0.0015)	0.0029 (0.0022)	0.0029 (0.0022)	0.0028 (0.0022)	-0.0009 (0.0021)	-0.0012 (0.0021)	-0.0011 (0.0021)
Securities over assets (t-1)	-0.0048*** (0.0005)	-0.0050*** (0.0005)	-0.0050*** (0.0005)	-0.0108*** (0.0008)	-0.0109*** (0.0008)	-0.0109*** (0.0008)	-0.0030*** (0.0006)	-0.0029*** (0.0006)	-0.0029*** (0.0006)
Liquidity (t-1)	0.0002 (0.0003)	0.0002 (0.0003)	0.0002 (0.0003)	-0.0005 (0.0004)	-0.0005 (0.0004)	-0.0006 (0.0004)	-0.0008** (0.0004)	-0.0008* (0.0004)	-0.0008* (0.0004)
GDP growth	0.0095*** (0.0024)	0.0113*** (0.0024)	0.0111*** (0.0024)	-0.0179*** (0.0040)	-0.0157*** (0.0040)	-0.0158*** (0.0040)	-0.0349*** (0.0033)	-0.0353*** (0.0033)	-0.0352*** (0.0033)
Inflation	0.0290*** (0.0034)	0.0231*** (0.0035)	0.0179*** (0.0036)	0.0178*** (0.0051)	0.0138*** (0.0052)	0.0117** (0.0055)	-0.0155*** (0.0037)	-0.0109*** (0.0036)	-0.0076** (0.0037)
3-Month rate * Low		0.1250*** (0.0140)	0.1235*** (0.0141)		0.0947*** (0.0239)	0.0939*** (0.0239)		-0.0869*** (0.0138)	-0.0857*** (0.0139)
Spread * Low			-0.0571*** (0.0073)			-0.0231** (0.0103)			0.0358*** (0.0083)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	95,964	95,964	95,964	95,964	95,964	95,964	95,964	95,964	95,964
R ²	0.8914	0.8917	0.8919	0.9248	0.9248	0.9248	0.9168	0.9169	0.9169
Adjusted R ²	0.8816	0.8819	0.8821	0.9180	0.9180	0.9180	0.9093	0.9093	0.9094

Table 4 shows the results when we split the sample according to countries' level of concentration in the deposit market. There is a positive relationship between interest rates and banks' net interest margin in countries with low-concentrated markets but no significant relation in countries with more concentrated markets. Also, for both the interest income and the interest expense margins, the coefficients of the interest rate for concentrated markets are lower than those estimated for less concentrated markets. Note that while the coefficients are smaller, there is a highly significant positive relationship between interest rates and banks' net interest income and expense margins in both countries with more and countries with less concentrated markets.

The insignificance of interest rates on the NIM in concentrated markets arises from the close co-movement of the interest income and the interest expense margins. Regarding the impact of the low interest rate environment, as in the baseline results, the proximity to the effective lower bound (ELB) strengthens the relation between interest rates and bank net margins in both more and less concentrated markets, which works mainly because of the weaker adjustment of the interest expenses. Interestingly, banks' margins in highly concentrated markets are also positively affected by market rates in a low interest rate environment. That is, the hedging mechanism described by Drechsler et al. (2021) is weaker when interest rates are in the neighborhood of the ELB, possibly because banks are less able to utilize their market power over deposits when those approach zero.

Looking more closely at our results, we conclude that although banks in concentrated markets cannot fully hedge interest rate changes in a low interest rate environment, their ability to shield against these changes is better than that of banks in less concentrated markets. Our results, therefore, provide support for hypothesis H1. This result reflects a weaker sensitivity of banks' interest income in more concentrated markets to a reduction in interest rates than that in less concentrated markets. This is in line with the finding of Drechsler et al. (2021) that banks in concentrated markets tend to hold fixed-income assets. On the other hand, somewhat surprisingly, the ability of banks in more concentrated deposit markets to reduce expenses in a low interest rate environment is smaller than that of banks in less concentrated markets. This may reflect the stickiness of deposit rates relative to the price of other forms of funding.

The coefficient of the spread is positive and significant for the low-concentration markets and negative and significant for the high-concentration markets. The positive connection between the spread and banks' NIM in the low-concentration market is mainly driven by a negative connection with the interest expense margin (all else equal, a larger slope is associated with lower interest expenses). On the other hand, for the high-concentration markets, the negative connection is mostly driven by the negative impact on the interest income margin. These results fit well with the argument of Drechsler et al. (2021) that banks with more deposit market power (a higher deposit franchise) hedge against interest rate risk by offering more long-term fixed rates assets. Recall that the quantity effect is likely to be stronger for banks offering more fixed-rate loans. That is, a steeper yield curve will induce a stronger drop in the demand for loans for those banks. The positive relation between the spread and interest expenses in low deposit concentrated markets is also not surprising because banks in those markets are likely to have more alternative funding sources, including long-term debt. Overall the low interest rate environment reduces the differences between markets with low and high deposit concentration

as it reduces the positive relation between the spread and banks' NIM in the former and increases it in the latter. This, again, suggests that banks' ability to use their deposit market power diminishes in a low interest rate environment. So, our results also support hypothesis H2.

Table 4: Impact of Deposit Concentration

This table presents the results of estimating Eq. (1), splitting the sample by the deposit concentration level. Time period is 1995-2019. Low is a dummy that takes the value of one when the 3-month interest rate is equal to or below 1.25%. Every year, a banking sector is considered Low concentration if its deposit-based HHI is in the first quartile of the countries distribution. Robust standard errors clustered by banks are shown in parentheses. *p<0.1; **p<0.05; ***p<0.01.						
	<i>Dependent variable:</i>					
	NIM	IIM	IEM	NIM	IIM	IEM
	Low HHI			High HHI		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged dependent variable	0.5405*** (0.0179)	0.4443*** (0.0212)	0.5113*** (0.0166)	0.5566*** (0.0255)	0.4834*** (0.0321)	0.4466*** (0.0192)
3-Month rate	0.0673*** (0.0063)	0.4450*** (0.0137)	0.3727*** (0.0097)	-0.0124 (0.0119)	0.2846*** (0.0264)	0.3497*** (0.0206)
Spread	0.0423*** (0.0089)	0.1462*** (0.0143)	0.1278*** (0.0100)	-0.0212** (0.0108)	-0.0160 (0.0173)	0.0240 (0.0146)
Low	0.3006*** (0.0256)	0.2265*** (0.0416)	0.0066 (0.0305)	-0.1852*** (0.0426)	0.0706 (0.0610)	0.2899*** (0.0351)
Deposits over liabilities (t-1)	0.0042*** (0.0006)	0.0011 (0.0010)	-0.0056*** (0.0009)	0.0011 (0.0010)	-0.0006 (0.0017)	-0.0068*** (0.0017)
Equity over assets (t-1)	0.0093*** (0.0019)	0.0035 (0.0030)	0.0009 (0.0026)	0.0135*** (0.0033)	0.0021 (0.0035)	-0.0025 (0.0035)
Securities over assets (t-1)	-0.0050*** (0.0006)	-0.0095*** (0.0009)	-0.0015** (0.0007)	-0.0057*** (0.0010)	-0.0137*** (0.0018)	-0.0054*** (0.0011)
Liquidity (t-1)	0.0001 (0.0003)	-0.0011** (0.0005)	-0.0015*** (0.0005)	-0.00005 (0.0004)	-0.0001 (0.0006)	0.0009 (0.0008)
GDP growth	0.0042 (0.0027)	-0.0266*** (0.0040)	-0.0348*** (0.0032)	0.0109** (0.0045)	-0.0016 (0.0069)	-0.0227*** (0.0057)
Inflation	0.0051 (0.0034)	-0.0281*** (0.0052)	-0.0327*** (0.0036)	0.0300*** (0.0068)	0.0420*** (0.0098)	0.0049 (0.0069)
3-Month rate * Low	0.1008*** (0.0181)	0.1202*** (0.0401)	-0.1220*** (0.0243)	0.0965*** (0.0250)	-0.1659*** (0.0458)	-0.3248*** (0.0204)
Spread * Low	-0.1507*** (0.0080)	-0.1418*** (0.0128)	-0.0115 (0.0088)	0.0284** (0.0124)	0.0539*** (0.0164)	0.0208* (0.0126)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	76,819	76,819	76,819	19,145	19,145	19,145
R ²	0.8802	0.9245	0.9237	0.9223	0.9384	0.9166
Adjusted R ²	0.8691	0.9174	0.9166	0.9103	0.9288	0.9036

4.2 The effect of "low for long"

Next, we examine whether the length of the low interest period matters for the connection between short-term rates and banks' net interest margins. Previous studies suggest that the duration of the low interest rate environment may impact banks' sensitivity to short-term rates in a number of ways (Borio et al., 2017; Altavilla et al., 2018; Claessens et al., 2018). On the one hand, in the short run, fixed rate assets may delay the full impact of repricing due to falling rates. Therefore, banks' NIM may be fully impacted by a low interest rate environment only if it persists for a few years. On the other hand, in the longer run, banks may try to offset the impact of low rates on NIMs by shifting away from cash and safe assets, investing more in securities, increasing lending, changing their funding structure to be less deposit dependent and even expanding internationally.

We test the duration of the low interest rate environment by replacing the *Low* dummy by a variable indicating the number of consecutive years the country has been in a low interest rate environment (*Lowlength*). Since banks may try to offset the impact of the low rate if it persists we allow for non-linearities by also including *Lowlength* in quadratic form, in line with the specification used by Lopez et al. (2020).

$$y_{i,t} = \alpha_i + \alpha_i + \beta_1 y_{i,t-1} + \beta_2 r_{i,t} + \beta_3 Spread_{i,t} + \beta_4 Lowlength_{i,t} + \beta_5 r_{i,t} \quad (2)$$

$$* Lowlength_{i,t} + \beta_6 Spread_{i,t} * Lowlength_{i,t} + \beta_7 r_{i,t} * Lowlength_{i,t}^2 + \beta_8$$

$$Spread_{i,t} * Lowlength_{i,t}^2 + \gamma_1 Z_{i,t} + \gamma_2 X_{i,t-1} + \varepsilon_{i,t}$$

The results for the estimation of Eq. (2) are presented in Table 5. Figure 3 plots the fitted values of $(\beta_2 + \beta_5 * Lowlength_{i,t} + \beta_7 * Lowlength_{i,t}^2)$ along with a 90% confidence band for banks in markets with high or low deposit concentration. Consistent with the results of Claessens et al. (2018), we find that the amplifying impact that low interest rates have on the relationship between interest rates and banks' NIM depends on the number of years the bank is in a low interest rate environment. Interestingly, we also find that the impact is non-linear (interaction with quadratic *Lowlength* negative and significant), suggesting the impact peaks after about 4 and 6 years for more and less concentrated markets, respectively, and then starts to decline. That is, the sensitivity of banks' NIM to interest rates is strongest after 4 consecutive years of a low-rate environment. The decline in impact, manifested in the negative coefficient of the quadratic term, might be due to banks adjusting their funding sources to the new environment by shifting away from deposits as the main source of funding, which is consistent with our previous findings.

Interestingly, when we differentiate between more and less concentrated markets, we find in both cases a significant linear relationship between NIM and *Lowlength*. However, the pattern of the relationship is different, with banks in less concentrated markets being more sensitive to the length of the period with low interest rates, while banks in more concentrated markets are only marginally affected by long periods of low rates.

Figure 3: Duration of low-rate environment

The figure plots the fitted values of $(\beta_2 + \beta_5 * Lowlength_{i,t} + \beta_7 * Lowlength_{i,t}^2)$ from estimating Eq. (2) for different number of consecutive years in a low interest rate environment. In every year, a banking sector is considered as low concentration if its deposit-based HHI is in the first quartile of the countries distribution.

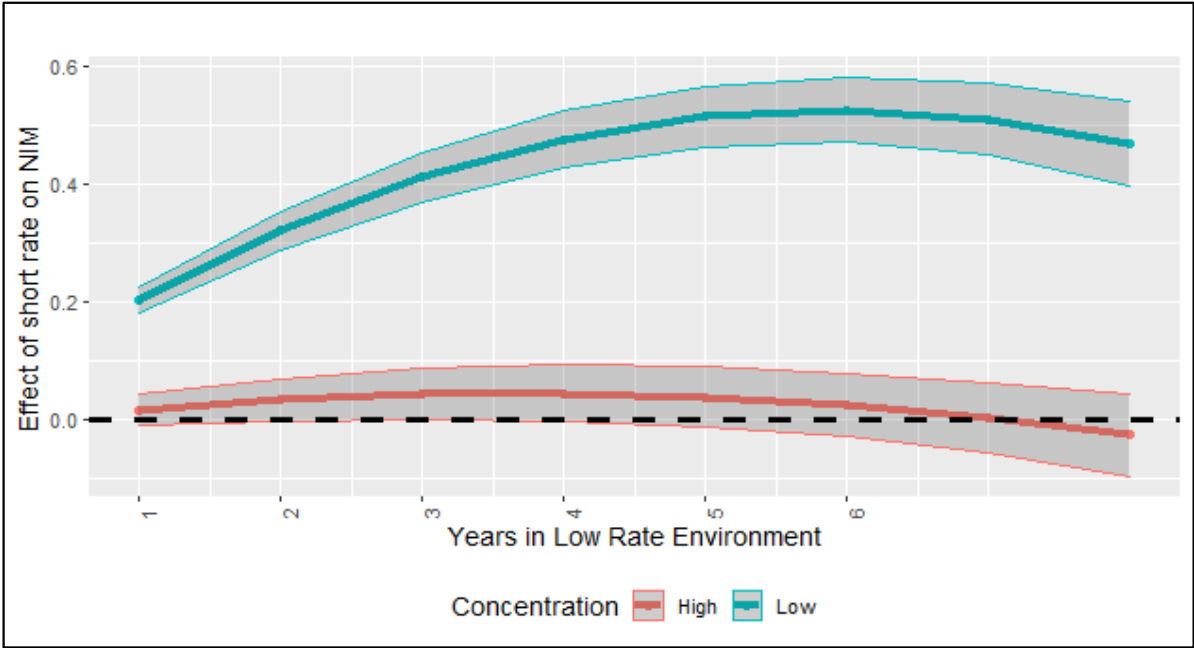


Table 5: Impact of low for long

The table presents the results for estimating Eq. (2). Time period is 1995-2019. *Lowlength* is the number of consecutive years that the country's 3-month interest rate is equal to or below 1.25%. Every year, a banking sector is considered Low concentration if its deposit-based HHI is in the first quartile of the countries distribution. Robust standard errors clustered by banks are shown in parentheses. *p<0.1; **p<0.05; ***p<0.01.

	<i>Dependent variable:</i>								
	NIM	IIM	IEM	NIM	IIM	IEM	NIM	IIM	IEM
	All			Low HHI			High HHI		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lagged dependent variable	0.5628*** (0.0142)	0.4716*** (0.0165)	0.4960*** (0.0124)	0.5383*** (0.0180)	0.4424*** (0.0209)	0.5074*** (0.0166)	0.5554*** (0.0256)	0.4810*** (0.0323)	0.4436*** (0.0194)
3-Month rate	0.0295*** (0.0059)	0.3451*** (0.0127)	0.3337*** (0.0091)	0.0582*** (0.0060)	0.4340*** (0.0124)	0.3794*** (0.0092)	-0.0098 (0.0114)	0.2816*** (0.0260)	0.3426*** (0.0203)
Spread	-0.0084 (0.0051)	0.0208** (0.0085)	0.0353*** (0.0070)	-0.0284*** (0.0067)	0.0562*** (0.0100)	0.1014*** (0.0074)	-0.0183** (0.0093)	-0.0158 (0.0153)	0.0180 (0.0134)
Lowlength	-0.0229*** (0.0047)	-0.0369*** (0.0076)	-0.0150*** (0.0044)	-0.0417*** (0.0048)	-0.0929*** (0.0082)	-0.0593*** (0.0060)	-0.0624*** (0.0141)	-0.0189 (0.0191)	0.0459*** (0.0137)
Lowlength ²	0.0007*** (0.0002)	0.0022*** (0.0003)	0.0012*** (0.0002)	0.0005** (0.0002)	0.0027*** (0.0004)	0.0017*** (0.0003)	0.0032** (0.0016)	0.0002 (0.0022)	-0.0026 (0.0016)
Deposits over liabilities (t-1)	0.0033*** (0.0005)	0.0007 (0.0009)	-0.0061*** (0.0008)	0.0036*** (0.0007)	0.0003 (0.0011)	-0.0061*** (0.0010)	0.0011 (0.0010)	-0.0004 (0.0017)	-0.0065*** (0.0017)
Equity over assets (t-1)	0.0105*** (0.0016)	0.0034 (0.0022)	-0.0005 (0.0021)	0.0094*** (0.0019)	0.0041 (0.0031)	0.0015 (0.0027)	0.0134*** (0.0034)	0.0022 (0.0035)	-0.0024 (0.0036)
Securities over assets (t-1)	-0.0050*** (0.0005)	-0.0111*** (0.0008)	-0.0031*** (0.0006)	-0.0049*** (0.0006)	-0.0097*** (0.0009)	-0.0017** (0.0007)	-0.0059*** (0.0010)	-0.0143*** (0.0019)	-0.0056*** (0.0011)
Liquidity (t-1)	0.0002 (0.0003)	-0.0005 (0.0004)	-0.0008* (0.0004)	0.0001 (0.0003)	-0.0011** (0.0005)	-0.0015*** (0.0005)	-0.00002 (0.0004)	0.00003 (0.0006)	0.0010 (0.0008)
GDP growth	0.0109*** (0.0025)	-0.0180*** (0.0040)	-0.0371*** (0.0033)	0.0004 (0.0029)	-0.0355*** (0.0044)	-0.0421*** (0.0035)	0.0116** (0.0046)	0.0029 (0.0070)	-0.0188*** (0.0057)
Inflation	0.0201*** (0.0037)	0.0174*** (0.0056)	-0.0039 (0.0039)	0.0187*** (0.0037)	-0.0030 (0.0055)	-0.0284*** (0.0037)	0.0286*** (0.0068)	0.0383*** (0.0100)	0.0022 (0.0071)
3-Month rate * Lowlength	0.0859*** (0.0064)	0.0671*** (0.0109)	-0.0410*** (0.0059)	0.1575*** (0.0107)	0.1542*** (0.0152)	-0.0200** (0.0089)	0.0292** (0.0114)	-0.0517*** (0.0173)	-0.1086*** (0.0095)
3-Month rate * Lowlength ²	-0.0082*** (0.0007)	-0.0067*** (0.0011)	0.0033*** (0.0006)	-0.0133*** (0.0014)	-0.0101*** (0.0019)	0.0043*** (0.0011)	-0.0039** (0.0015)	0.0004 (0.0023)	0.0067*** (0.0013)
Spread * Lowlength	-0.0242*** (0.0029)	0.0016 (0.0044)	0.0292*** (0.0037)	-0.0394*** (0.0037)	-0.0245*** (0.0059)	0.0042 (0.0040)	0.0090 (0.0070)	0.0359*** (0.0095)	0.0287*** (0.0084)
Spread * Lowlength ²	0.0029*** (0.0003)	0.0012** (0.0005)	-0.0020*** (0.0004)	0.0044*** (0.0004)	0.0042*** (0.0007)	0.0009** (0.0004)	-0.0001 (0.0012)	-0.0058*** (0.0016)	-0.0058*** (0.0012)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	95,964	95,964	95,964	76,819	76,819	76,819	19,145	19,145	19,145
R ²	0.8920	0.9249	0.9170	0.8800	0.9246	0.9238	0.9224	0.9384	0.9163
Adjusted R ²	0.8822	0.9181	0.9095	0.8688	0.9175	0.9167	0.9104	0.9288	0.9032

5. Sensitivity analyses

5.1 Dependence on deposit funding

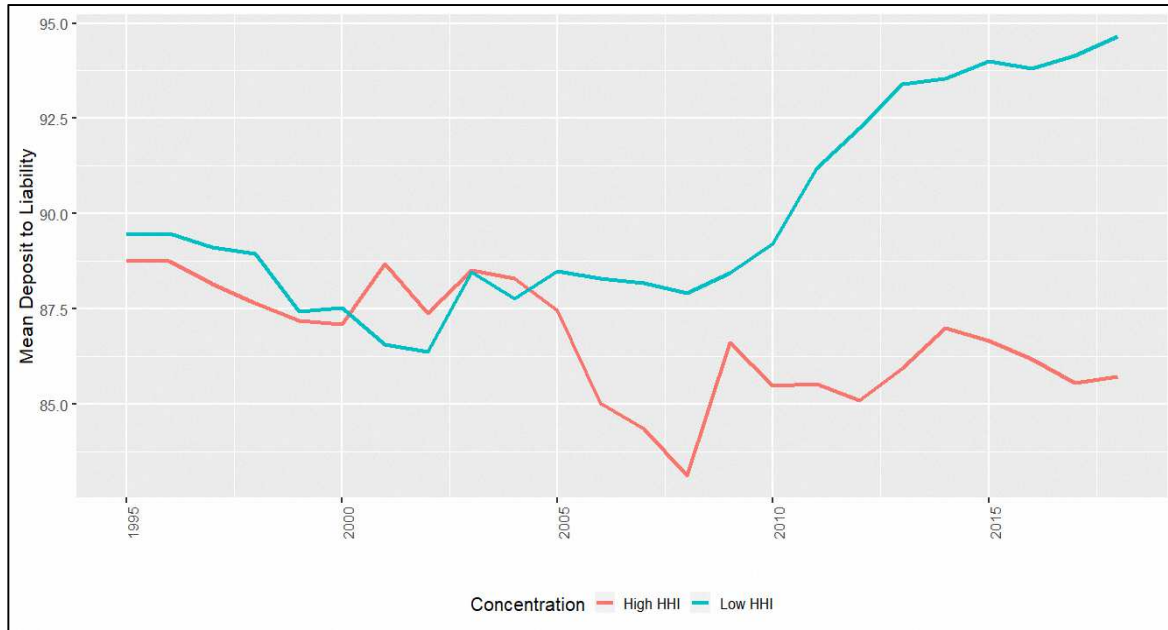
A potential concern about our findings is that the effect of the concentration in deposit markets reflects differences across banks in their dependence on deposit funding. Some banks are more dependent on deposits for their funding than others and this may increase the extent to which the interest margins are affected by low interest rates. Indeed, Lopez et al. (2020) find that banks that rely less on deposits do better under low/negative rates. So, our results may be driven by banks' reliance on deposits in countries with more deposit concentrated markets. However, the cross correlation between the deposits-to-liabilities ratio and the deposit HHI over the full sample is -0.11 as shown in the lower part of Table 2.¹⁴ One possible reason for this (low) negative correlation is that banks with more deposit market power may have alternative funding sources which are less expensive (Craig and Dinger, 2013). As also shown in Table 2, the mean and the median of the ratio of deposits to liabilities in more concentrated markets is lower than that in less concentrated markets.

We also look at the development over time of the share of deposit funding in both concentrated and less concentrated markets. Figure 4 shows that since the onset of the GFC, banks in more deposit concentrated markets have decreased their funding dependency while banks in less concentrated markets have increased it considerably.

¹⁴ The correlation is close to zero for the period between 1995-2009, and negative at about -0.2 between 2010-2018.

Figure 4: Deposit Dependency, by HHI concentration, 1995-2019 average

The figure shows the mean deposits to liabilities ratio of banks in low and high deposit-based HHI markets. In every year, a banking sector is considered as low concentration if its deposit-based HHI is in the first quartile of the countries distribution.



We, therefore, test whether the level of deposit funding dependence affects the impact of market rates and the low interest rate environment differently in more and less deposit concentrated markets. As shown in Table 6, the effect of short-term and low interest rates on NIM in concentrated and less concentrated markets is similar to that in our base model (Table 4); the interaction between the deposit ratio and the money market rate is negative and significant only in the low-concentrated markets. Consistent with our earlier findings, this implies that in more deposit concentrated markets the net interest margins of even less deposit-dependent banks are not very responsive to changes in the market rate.

Table 6: Deposit reliance

The table presents the results for estimating Eq. (1) with an additional interaction with the deposits-to-liabilities ratio (DEP) and Low. Time period is 1995-2019. Low is a dummy that takes the value of one when the 3-month interest rate is equal to or below 1.25%. Every year, a banking sector is considered Low concentration if its deposit-based HHI is in the first quartile of the countries distribution. Robust standard errors clustered by banks are shown in parentheses. *p<0.1; **p<0.05; ***p<0.01.

	<i>Dependent variable:</i>					
	NIM	IIM	IEM	NIM	IIM	IEM
	Low HHI			High HHI		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged dependent variable	0.5368*** (0.0180)	0.4444*** (0.0212)	0.5113*** (0.0165)	0.5561*** (0.0253)	0.4834*** (0.0321)	0.4448*** (0.0192)
3-Month rate	0.2246*** (0.0306)	0.6130*** (0.0477)	0.4096*** (0.0526)	-0.0373 (0.0447)	0.3456*** (0.0860)	0.5190*** (0.0608)
Spread	0.0587*** (0.0105)	0.1659*** (0.0166)	0.1330*** (0.0122)	-0.0222** (0.0108)	-0.0187 (0.0171)	0.0211 (0.0146)
Low	0.0918 (0.1224)	0.1724 (0.1689)	0.0946 (0.1744)	-0.0450 (0.1209)	0.5180** (0.2216)	0.8398*** (0.1757)
Deposits over liabilities (t-1)	0.0067*** (0.0013)	0.0047** (0.0019)	-0.0044** (0.0019)	0.0011 (0.0019)	0.0032 (0.0029)	0.0005 (0.0027)
Equity over assets (t-1)	0.0099*** (0.0019)	0.0039 (0.0030)	0.0010 (0.0026)	0.0132*** (0.0033)	0.0019 (0.0035)	-0.0023 (0.0035)
Securities over assets (t-1)	-0.0050*** (0.0006)	-0.0095*** (0.0009)	-0.0015** (0.0007)	-0.0057*** (0.0010)	-0.0137*** (0.0018)	-0.0052*** (0.0011)
Liquidity (t-1)	0.0003 (0.0003)	-0.0009* (0.0005)	-0.0015*** (0.0005)	-0.00002 (0.0004)	-0.00004 (0.0006)	0.0009 (0.0008)
GDP growth	0.0085*** (0.0028)	-0.0233*** (0.0040)	-0.0348*** (0.0032)	0.0110** (0.0045)	-0.0013 (0.0069)	-0.0225*** (0.0057)
Inflation	-0.0007 (0.0035)	-0.0336*** (0.0053)	-0.0334*** (0.0038)	0.0292*** (0.0068)	0.0417*** (0.0097)	0.0057 (0.0070)
3-Month rate * Low	0.1221*** (0.0194)	0.1331*** (0.0408)	-0.1241*** (0.0263)	0.0900*** (0.0244)	-0.1740*** (0.0434)	-0.3264*** (0.0217)
Spread * Low	-0.1241*** (0.0115)	-0.1252*** (0.0167)	-0.0148 (0.0148)	0.0301** (0.0126)	0.0584*** (0.0168)	0.0259** (0.0132)
DEP * Low	0.0017 (0.0011)	0.0002 (0.0016)	-0.0009 (0.0016)	-0.0016 (0.0014)	-0.0054** (0.0025)	-0.0067*** (0.0020)
DEP * 3-Month rate	-0.0016*** (0.0003)	-0.0017*** (0.0005)	-0.0004 (0.0005)	0.0003 (0.0005)	-0.0007 (0.0008)	-0.0019*** (0.0006)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	76,819	76,819	76,819	19,145	19,145	19,145
R ²	0.8812	0.9247	0.9237	0.9224	0.9384	0.9169
Adjusted R ²	0.8701	0.9176	0.9166	0.9103	0.9289	0.9040

5.2 Nickell bias

Another potential problem with our panel regressions, which include both the lagged dependent variable and fixed effects, is that it might be subject to the bias discussed by Nickell (1981). A common solution to the dynamic panel bias is applying the generalized method of moments (GMM) estimators. However, the dynamic panel GMM can generate too many instruments, which may over-fit endogenous variables and run a risk of a weak-instruments bias (Roodman 2009). Given that we estimate this model with a relatively long time series (25 years) and the Nickell bias induced by the presence of the lagged dependent variable decreases with T , our baseline estimation uses a fixed effects estimator. However, for robustness purposes, we also estimate two alternative versions of equation (1) which are not subject to the Nickell bias: one without the lagged dependent variable and another one without bank fixed effects. Results (presented in Tables A2 and A3 in the Online Appendix) are robust to these changes, except for the interaction between the short-term interest rate and the Low dummy for the low concentration sample, which becomes insignificant.

5.3 Different thresholds to define low interest rate environment

We show that the results are overall robust to using a national threshold and a different uniform threshold of 0.5 for defining the low-rate interest rate environment (results are shown in Table 7 and Table A5 in the Online Appendix, respectively). For the first, we take the 25th percentile of the distribution of short-term local interest rates to identify low interest rate periods. The advantage of using a distribution-based threshold versus a standard threshold for all countries is that it allows to account for cross country differences in interest rate levels. Table A4 in the Online Appendix shows for each country the number of years the country short-term rate was below the national threshold and below the 1.25 and 0.5 thresholds. As we can see, by design, when using the country-specific threshold each country is in a low-rate environment in part of the sample (a quarter of the county total sample years, by construction). Therefore, the analysis based on country specific low interest rate periods is equivalent to a staggered difference-in-difference which along with the time FE and bank-specific FE implies a within bank estimation of the impact of moving from a "normal" to a low interest rate environment. For the 1.25 threshold, on the other hand, some countries are never in a low interest rate environment (Australia, Colombia, Korea, Mexico, New Zealand and Poland) while others are there for most of the sample (Japan, Switzerland). In fact, several countries are exclusively in a low-rate environment after the onset of the GFC. Therefore, the 1.25 threshold is, to a large extent, a comparison between countries and between periods. The different results could, therefore, be

attributed to changes in regulatory and overall economic environment in a group of countries after the GFC, whereas in models based on the country specific threshold all countries have both low and normal interest environments in the years after the crisis which mitigates this potential bias.

Table 7: Robustness – Country Specific Threshold						
This table presents the results of estimating Eq. (1), splitting the sample by the deposit concentration level. Time period is 1995-2019. Low is a dummy that takes the value of one when the 3-month interest rate is in the first quartile of the country-by-country sample distribution. Every year, a banking sector is considered Low concentration if its deposit-based HHI is in the first quartile of the countries distribution. Robust standard errors clustered by banks are shown in parentheses. *p<0.1; **p<0.05; ***p<0.01.						
	<i>Dependent variable:</i>					
	NIM	IIM	IEM	NIM	IIM	IEM
	Low HHI			High HHI		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged dependent variable	0.5437*** (0.0178)	0.4446*** (0.0204)	0.5049*** (0.0161)	0.5576*** (0.0257)	0.4817*** (0.0321)	0.4459*** (0.0191)
3-Month rate	0.0171*** (0.0043)	0.4001*** (0.0125)	0.3814*** (0.0093)	-0.0012 (0.0112)	0.2876*** (0.0257)	0.3362*** (0.0200)
Spread	-0.0416*** (0.0058)	0.0404*** (0.0085)	0.0863*** (0.0070)	-0.0048 (0.0082)	0.0069 (0.0128)	0.0291*** (0.0107)
Low	0.0455*** (0.0122)	-0.0610*** (0.0196)	-0.0596*** (0.0123)	-0.1606*** (0.0530)	-0.1385* (0.0754)	0.0564 (0.0439)
Deposits over liabilities (t-1)	0.0045*** (0.0006)	0.0004 (0.0010)	-0.0071*** (0.0009)	0.0008 (0.0010)	-0.0002 (0.0016)	-0.0059*** (0.0017)
Equity over assets (t-1)	0.0095*** (0.0018)	0.0042 (0.0030)	0.0014 (0.0026)	0.0135*** (0.0033)	0.0021 (0.0035)	-0.0027 (0.0036)
Securities over assets (t-1)	-0.0048*** (0.0006)	-0.0097*** (0.0009)	-0.0019*** (0.0007)	-0.0056*** (0.0010)	-0.0141*** (0.0019)	-0.0057*** (0.0011)
Liquidity (t-1)	0.0002 (0.0003)	-0.0010** (0.0005)	-0.0016*** (0.0005)	-0.0001 (0.0004)	0.000004 (0.0006)	0.0010 (0.0008)
GDP growth	0.0049* (0.0026)	-0.0296*** (0.0040)	-0.0368*** (0.0032)	0.0110** (0.0045)	-0.0005 (0.0069)	-0.0211*** (0.0057)
Inflation	0.0265*** (0.0040)	0.0131** (0.0058)	-0.0116*** (0.0039)	0.0343*** (0.0069)	0.0365*** (0.0101)	-0.0068 (0.0071)
3-Month rate * Low	0.1165*** (0.0190)	0.1540*** (0.0284)	-0.0713*** (0.0205)	0.0465** (0.0202)	-0.0131 (0.0330)	-0.1125*** (0.0160)
Spread * Low	-0.0493*** (0.0075)	0.0490*** (0.0112)	0.1067*** (0.0085)	0.0167 (0.0125)	0.0057 (0.0177)	-0.0240* (0.0136)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	76,819	76,819	76,819	19,145	19,145	19,145
R ²	0.8793	0.9243	0.9239	0.9222	0.9382	0.9159
Adjusted R ²	0.8680	0.9172	0.9168	0.9101	0.9286	0.9028

5.4 Different samples

Next, we employ different starting years for our sample. Table 8 shows the estimates using 2010 as the first year of our sample period, which gives a sample without the Global Financial Crisis (GFC). Dropping the GFC makes the difference between low- and high-concentration markets more pronounced. The coefficient of the interaction term between the low interest rate dummy and the short-term interest rate is not significant in more concentrated markets, while it is significant in less concentrated markets.

Table 8: Robustness – Excluding GFC (2010-2019 sample)						
The table presents the results for estimating Eq. (1) starting the sample only after the GFC (2010-2019). Low is a dummy that takes the value of one when the 3-month interest rate is equal to or below 1.25%. Every year, a banking sector is considered Low concentration if its deposit-based HHI is in the first quartile of the countries distribution. Robust standard errors clustered by banks are shown in parentheses. *p<0.1; **p<0.05; ***p<0.01.						
	<i>Dependent variable:</i>					
	NIM	IIM	IEM	NIM	IIM	IEM
	Low HHI			High HHI		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged dependent variable	0.3670*** (0.0363)	0.3829*** (0.0410)	0.4743*** (0.0275)	0.4851*** (0.0390)	0.5048*** (0.0413)	0.3433*** (0.0456)
3-Month rate	0.1699*** (0.0385)	0.7508*** (0.0746)	0.5676*** (0.0432)	-0.0060 (0.0365)	0.3943*** (0.0470)	0.5518*** (0.0396)
Spread	0.1163*** (0.0123)	0.1537*** (0.0193)	0.0449*** (0.0100)	-0.0406*** (0.0124)	-0.0140 (0.0178)	0.0498** (0.0198)
Low	0.2280*** (0.0570)	0.3808*** (0.0999)	0.1392** (0.0606)	-0.1337** (0.0585)	-0.0075 (0.0731)	0.1241** (0.0491)
Deposits over liabilities (t-1)	0.0027*** (0.0009)	0.0052*** (0.0014)	-0.0024 (0.0016)	-0.0010 (0.0019)	-0.0037 (0.0025)	-0.0075*** (0.0026)
Equity over assets (t-1)	0.0038 (0.0033)	0.0027 (0.0047)	0.0101*** (0.0039)	0.0127** (0.0058)	0.0033 (0.0062)	0.0009 (0.0064)
Securities over assets (t-1)	-0.0084*** (0.0011)	-0.0126*** (0.0018)	-0.0015* (0.0008)	-0.0066*** (0.0017)	-0.0124*** (0.0027)	-0.0039*** (0.0013)
Liquidity (t-1)	-0.0001 (0.0004)	0.0014* (0.0007)	-0.0006 (0.0009)	-0.0006 (0.0007)	-0.0008 (0.0010)	0.0007 (0.0009)
GDP growth	0.0409*** (0.0043)	0.0637*** (0.0071)	0.0208*** (0.0047)	-0.0087* (0.0046)	-0.0180*** (0.0064)	-0.0247*** (0.0055)
Inflation	-0.0087** (0.0040)	-0.0115* (0.0066)	-0.0056 (0.0036)	0.0309*** (0.0102)	0.0389*** (0.0139)	0.0052 (0.0089)
3-Month rate * Low	0.1460*** (0.0442)	0.2515*** (0.0738)	0.0073 (0.0477)	0.0663* (0.0351)	-0.1605*** (0.0488)	-0.2760*** (0.0305)
Spread * Low	-0.0631*** (0.0098)	0.0009 (0.0147)	0.0749*** (0.0087)	0.0270** (0.0133)	0.0510*** (0.0176)	0.0310** (0.0128)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	34,169	34,169	34,169	10,423	10,423	10,423
R ²	0.8995	0.9033	0.8862	0.9430	0.9600	0.9285
Adjusted R ²	0.8842	0.8887	0.8690	0.9324	0.9526	0.9152

We also re-estimate our models, dropping banks that are or have become inactive over the sample period. Table 9 presents the estimation results. The results are slightly different from those in Table 4. For instance, the coefficient of the short-term interest rate is now insignificant in the NIM models for high and low-concentration markets. However, we still find that the coefficient of the interaction of the low interest-environment dummy and the short-term interest rate is twice as high in low-concentration markets than in high-concentration markets. Likewise, the coefficients in the models for IIM are slightly different but do not yield another pattern than in Table 4. The same holds for the models for the IIE.

Table 9: Robustness – Active banks						
The table presents the results for estimating Eq. (1) dropping from the sample banks that have become inactive over the sample period. Time period is 1995-2019. Low is a dummy that takes the value of one when the 3-month interest rate is equal to or below 1.25%. Every year, a banking sector is considered Low concentration if its deposit-based HHI is in the first quartile of the countries distribution. Robust standard errors clustered by banks are shown in parentheses. *p<0.1; **p<0.05; ***p<0.01.						
	<i>Dependent variable:</i>					
	NIM	IIM	IEM	NIM	IIM	IEM
	Low HHI			High HHI		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged dependent variable	0.5834*** (0.0199)	0.4908*** (0.0263)	0.5560*** (0.0189)	0.6249*** (0.0294)	0.5603*** (0.0407)	0.4574*** (0.0235)
3-Month rate	0.0514*** (0.0091)	0.3836*** (0.0201)	0.3226*** (0.0125)	-0.0074 (0.0157)	0.2733*** (0.0335)	0.3553*** (0.0291)
Spread	0.0247* (0.0127)	0.0994*** (0.0210)	0.0889*** (0.0121)	-0.0106 (0.0128)	-0.0063 (0.0207)	0.0307 (0.0190)
Low	0.2260*** (0.0355)	0.0737 (0.0562)	-0.0657* (0.0354)	-0.1834*** (0.0434)	0.0159 (0.0630)	0.2441*** (0.0378)
Deposits over liabilities (t-1)	0.0026*** (0.0007)	0.0004 (0.0013)	-0.0048*** (0.0011)	0.0003 (0.0011)	-0.0001 (0.0021)	-0.0074*** (0.0021)
Equity over assets (t-1)	0.0072*** (0.0020)	0.0058* (0.0034)	0.0023 (0.0026)	0.0056* (0.0029)	0.0023 (0.0037)	0.0069* (0.0039)
Securities over assets (t-1)	-0.0048*** (0.0006)	-0.0085*** (0.0011)	-0.0004 (0.0007)	-0.0053*** (0.0012)	-0.0115*** (0.0023)	-0.0039*** (0.0012)
Liquidity (t-1)	0.00001 (0.0003)	-0.0008 (0.0006)	-0.0019*** (0.0006)	-0.0006 (0.0004)	-0.0007 (0.0006)	0.0012* (0.0007)
GDP growth	0.0064** (0.0026)	-0.0244*** (0.0043)	-0.0335*** (0.0032)	0.0104** (0.0051)	0.0040 (0.0077)	-0.0169** (0.0066)
Inflation	-0.0027 (0.0031)	-0.0242*** (0.0052)	-0.0192*** (0.0036)	0.0273*** (0.0079)	0.0294*** (0.0111)	-0.0070 (0.0081)
3-Month rate * Low	0.1694*** (0.0203)	0.1991*** (0.0474)	-0.0913*** (0.0284)	0.0798** (0.0252)	-0.1371*** (0.0456)	-0.3050*** (0.0207)
Spread * Low	-0.1204*** (0.0109)	-0.0910*** (0.0171)	0.0090 (0.0110)	0.0332*** (0.0108)	0.0652*** (0.0175)	0.0288* (0.0161)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	52,224	52,224	52,224	13,007	13,007	13,007
R ²	0.8964	0.9341	0.9341	0.9317	0.9451	0.9155
Adjusted R ²	0.8890	0.9294	0.9294	0.9236	0.9385	0.9055

5.5 Different definitions of concentrated markets

We have redone our main model, using two alternative ways to define high and low concentrated markets. First, we take a uniform definition of low concentration markets. Under this definition, a banking sector is considered low concentration if its full sample deposit HHI mean is in the bottom quartile of the distribution. As can be seen in Figure 3, the countries concerned are Italy, Japan, Germany, Austria, France, Spain, Poland, and Korea. Table A6 in the Online Appendix shows that our results are robust to this alternative method for defining low concentration. Likewise, Table A7 shows that our main findings do not change if we employ the CR3 ratio to determine market concentration. To be more precise, in this table a banking sector is considered low concentration if, in a particular year, its deposit-based CR3 is in the first quartile of the distribution across all countries for the given year, and more concentrated otherwise.

5.6 Endogeneity of monetary policy

Finally, although we control for domestic macroeconomic conditions, and while time fixed effects control for common responses to global conditions, the possible endogeneity of monetary policy implies that our results should be carefully interpreted. In our panel set-up, it is hard to consider methods that have been suggested in the literature to deal with this problem. For instance, Jarociński and Karadi (2020) disentangle US monetary policy shocks from contemporaneous information shocks and use a Bayesian structural vector autoregression to assess their dynamic impact. Their data have been used in subsequent research (e.g. de Haan et al., 2021). Unfortunately, similar measures are not available for the countries in our sample. DellAricca et al. (2017) suggest various ways to deal with monetary policy endogeneity. One approach focuses on observations in U.S. states whose economic cycles exhibit a low correlation with the U.S. cycle, as economic conditions in these states are less likely to affect monetary policy. Inspired by this approach, we re-estimate our model for small countries in the European monetary union (Austria, Belgium, Finland, Ireland, the Netherlands, and Portugal).¹⁵ In view of their size, their weight in euro area inflation and economic growth is very small. In other words, ECB policy rates can be considered exogenous in these countries. Since these countries have the same short-term interest rate every year we cannot use time FE, so we add a

¹⁵ We start the sample in 2000, the second full year of the eurozone, because some of the controls are lagged one period and include only small countries that were in the eurozone from that period forward. We do not include Greece as that would imply that we could start our sample later. However, including Greece and using fewer years gives similar results (available on request)

time trend instead. We use a triple interaction with the deposit HHI and the deposit CR3 measures instead of the sample split since the small number of countries makes some of the sub-samples very small. Table 10 shows the results. Although there are some differences compared to the results reported in Table 4 the overall results hold. Specifically, we find a positive and significant relationship between banks' NIM and the short-term rate. The interaction between the short-term rate and the market concentration measures are negative and significant which suggests that in more concentrated markets banks' NIM is less responsive to the short-term rate, confirming Hypothesis H1. While the interaction between the short-term rate and the Low dummy is negative, the triple interaction with the concentration measure is positive and significant. A linear hypothesis test confirms that the sum of these interactions is positive and significant which confirms the amplifying impact of the low interest rate environment on the connection between the short-term interest rate and banks' NIM. Interestingly, in this specification, the amplifying impact of the low interest rate environment becomes even stronger for more concentrated markets.

Table 10. Robustness – Small Eurozone countries

This table presents the results of estimating Eq. (1), using triple interaction between the interest rate and the concentration ratio instead of the sample split. The sample starts at 2000 and includes only small countries that were in the eurozone from that period forward (Austria, Belgium, Finland, Ireland, Netherlands, and Portugal), except for Greece. Low is a dummy that takes the value of one when the 3-month interest rate is equal to or below 1.25%. Concentration is the deposit based HHI in columns (1)-(3), and deposit CR3 in columns (4)-(6). Dependent variables are the Net Interest Margin (NIM), Interest Income Margin (IIM) and Interest Expense Margin (IEM). Robust standard errors clustered by banks are shown in parentheses. *p<0.1; **p<0.05; ***p<0.01.

	<i>Dependent variable:</i>					
	<i>NIM</i>	<i>IIM</i>	<i>IEM</i>	<i>NIM</i>	<i>IIM</i>	<i>IEM</i>
	HHI			CR3		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged dependent variable	0.4123*** (0.0663)	0.3577*** (0.0588)	0.4116*** (0.0407)	0.4112*** (0.0663)	0.3626*** (0.0602)	0.4193*** (0.0420)
3-Month rate	0.1587*** (0.0351)	0.5323*** (0.0715)	0.3675*** (0.0683)	0.3013*** (0.0822)	0.5035*** (0.1317)	0.1657 (0.1223)
Spread	0.2140*** (0.0494)	0.1594 (0.1139)	-0.0883 (0.1121)	0.4182*** (0.1032)	0.1320 (0.2074)	-0.3409* (0.1991)
Low	0.4560*** (0.1388)	0.4279 (0.2734)	-0.2047 (0.2536)	1.0839*** (0.3430)	0.5811 (0.6009)	-0.6806 (0.5539)
Concentration	2.6829*** (0.7389)	1.1839 (1.5443)	-2.0193 (1.4802)	2.0495*** (0.6304)	0.6035 (1.0722)	-1.5716 (1.0185)
Deposits over liabilities (t-1)	0.0021 (0.0022)	-0.0035 (0.0029)	-0.0107*** (0.0037)	0.0022 (0.0022)	-0.0034 (0.0029)	-0.0106*** (0.0036)
Equity over assets (t-1)	0.0197*** (0.0061)	0.0048 (0.0052)	-0.0042 (0.0063)	0.0196*** (0.0061)	0.0045 (0.0052)	-0.0044 (0.0063)
Securities over assets (t-1)	-0.0035* (0.0018)	-0.0085*** (0.0023)	-0.0044*** (0.0017)	-0.0033* (0.0019)	-0.0086*** (0.0024)	-0.0046*** (0.0017)
Liquidity (t-1)	-0.0003 (0.0010)	0.0001 (0.0013)	0.0022 (0.0014)	-0.0002 (0.0010)	0.0003 (0.0013)	0.0023 (0.0014)
GDP growth	0.0072 (0.0055)	0.0010 (0.0102)	0.0023 (0.0071)	0.0039 (0.0055)	-0.0014 (0.0098)	0.0015 (0.0071)
Inflation	-0.0369*** (0.0084)	0.0020 (0.0146)	0.0301** (0.0149)	-0.0315*** (0.0091)	0.0074 (0.0153)	0.0309** (0.0151)
3-Month rate * Low	-0.1063* (0.0626)	0.0013 (0.1066)	0.0293 (0.0874)	-0.2997** (0.1234)	0.1184 (0.1851)	0.3527** (0.1430)
Spread * Low	-0.2172*** (0.0490)	-0.2114* (0.1108)	0.0875 (0.1116)	-0.4156*** (0.1020)	-0.2773 (0.1965)	0.2239 (0.1898)
3-Month rate * Concentration	-0.5838*** (0.1744)	-0.1291 (0.2805)	0.5937** (0.2742)	-0.3819*** (0.1315)	-0.0057 (0.1870)	0.4721*** (0.1742)
Spread * Concentration	-2.3904*** (0.6557)	-1.9361 (1.4308)	1.2522 (1.3826)	-1.5806*** (0.5407)	-0.7174 (0.9143)	1.1804 (0.8546)
Concentration * Low	-0.9649*** (0.2478)	-0.6521 (0.5519)	0.5203 (0.5215)	-0.5706*** (0.1532)	-0.1497 (0.2965)	0.5202* (0.2756)
3-Month rate * Low * Concentration	0.7765** (0.3801)	-0.9807 (0.6096)	-1.6832*** (0.6204)	0.5359** (0.2427)	-0.5443 (0.3322)	-1.1319*** (0.2936)
Spread * Low * Concentration	1.0295*** (0.2463)	1.3159** (0.5564)	-0.1050 (0.5418)	0.5714*** (0.1497)	0.4774* (0.2856)	-0.2206 (0.2641)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time trend	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,119	8,119	8,119	8,119	8,119	8,119
R ²	0.8416	0.9000	0.8957	0.8416	0.9000	0.8962
Adjusted R ²	0.8192	0.8859	0.8810	0.8192	0.8858	0.8815

6. Conclusions

Using a very large sample of banks from 30 OECD countries over 1995–2019, this paper examines the impact of low interest rates on banks' net interest margins. In line with the findings of most previous studies, our results suggest a positive relationship between interest rates and interest margins, which is stronger in a low interest rate environment. Most importantly, consistent with the view of Drechsler et al. (2021), we find that in more concentrated markets interest margins are less sensitive to the level of interest rates as income and expense interest rate sensitivities closely match. In addition, consistent with the view of Sá and Jorge (2019), our results also frequently suggest that the effect of market concentration on the link between interest rates and interest margins is weaker when interest rates approach zero.

These findings matter for policymakers. Several observers have expressed worries that banks' low net-interest margins due to the low-for-long policies of central banks may erode banks' capital bases, thereby hampering monetary policy transmission and creating a threat to financial stability. Our results imply that the impact of the low interest rate environment, due to accommodative monetary policy on banks' net interest margins may turn out to be stronger and more pronounced in less concentrated deposit markets and more moderate in concentrated markets. This is notably relevant for the European Central Bank as the concentration of the deposit markets in the countries in the euro area differs substantially. For instance, our findings imply that the ECB's low-for-long policy may cause more fragmentation in monetary policy transmission. Likewise, the low interest rate environment may not create the same risks to financial stability in all countries in the euro area.

Our analysis focuses on the impact of low interest rates. An interesting avenue for future research would be to examine whether our results also hold for negative-interest rate periods, once there are more observations with negative interest rates.

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Online Appendix

Table A.1: Baseline Results Without Time FE

The table presents the results for estimating Eq. (1) for the full sample (1995-2019) without time FE. Low is a dummy that takes the value of one when the 3-month interest rate is equal or below 1.25%. Robust standard errors clustered by banks are shown in parentheses. *p<0.1; **p<0.05; ***p<0.01.

	<i>Dependent variable:</i>								
	NIM			IIM			IEM		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lagged dependent variable	0.6029*** (0.0128)	0.5998*** (0.0128)	0.5885*** (0.0130)	0.5030*** (0.0120)	0.5038*** (0.0121)	0.4966*** (0.0125)	0.4832*** (0.0100)	0.4857*** (0.0100)	0.4880*** (0.0101)
3-Month rate	0.0815*** (0.0035)	0.0604*** (0.0039)	0.0765*** (0.0043)	0.4193*** (0.0104)	0.4247*** (0.0110)	0.4425*** (0.0120)	0.3491*** (0.0064)	0.3837*** (0.0069)	0.3777*** (0.0072)
Low		-0.1054*** (0.0108)	0.0542*** (0.0138)		0.0284* (0.0160)	0.1718*** (0.0216)		0.1742*** (0.0130)	0.1207*** (0.0157)
Spread	0.0607*** (0.0033)	0.0453*** (0.0033)	0.0865*** (0.0047)	0.1254*** (0.0078)	0.1304*** (0.0077)	0.1692*** (0.0105)	0.0572*** (0.0047)	0.0834*** (0.0048)	0.0694*** (0.0060)
Deposits over liabilities (t-1)	0.0028*** (0.0005)	0.0037*** (0.0005)	0.0037*** (0.0005)	0.0014* (0.0008)	0.0011 (0.0008)	0.0011 (0.0008)	-0.0047*** (0.0008)	-0.0063*** (0.0008)	-0.0063*** (0.0008)
Equity over assets (t-1)	0.0085*** (0.0015)	0.0092*** (0.0015)	0.0093*** (0.0015)	0.0022 (0.0022)	0.0020 (0.0022)	0.0019 (0.0022)	-0.0005 (0.0021)	-0.0015 (0.0021)	-0.0014 (0.0021)
Securities over assets (t-1)	-0.0041*** (0.0005)	-0.0042*** (0.0005)	-0.0045*** (0.0005)	-0.0100*** (0.0008)	-0.0099*** (0.0008)	-0.0102*** (0.0008)	-0.0030*** (0.0006)	-0.0029*** (0.0006)	-0.0028*** (0.0006)
Liquidity (t-1)	0.0006** (0.0003)	0.0006** (0.0003)	0.0004* (0.0003)	-0.0002 (0.0004)	-0.0002 (0.0004)	-0.0004 (0.0004)	-0.0011** (0.0004)	-0.0010** (0.0004)	-0.0010** (0.0004)
GDP growth	0.0142*** (0.0011)	0.0165*** (0.0012)	0.0172*** (0.0012)	0.0261*** (0.0019)	0.0249*** (0.0019)	0.0251*** (0.0020)	0.0085*** (0.0016)	0.0044*** (0.0016)	0.0044*** (0.0016)
Inflation	0.0039 (0.0025)	0.0006 (0.0025)	-0.0054** (0.0026)	-0.0124*** (0.0047)	-0.0112** (0.0047)	-0.0176*** (0.0051)	-0.0140*** (0.0030)	-0.0082*** (0.0030)	-0.0060** (0.0030)
3-Month rate * Low		0.0980*** (0.0079)	0.1459*** (0.0086)		-0.0366*** (0.0125)	0.0073 (0.0137)		-0.1708*** (0.0103)	-0.1866*** (0.0110)
Spread * Low			-0.0987*** (0.0060)			-0.0885*** (0.0091)			0.0328*** (0.0064)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	95,964	95,964	95,964	95,964	95,964	95,964	95,964	95,964	95,964
R ²	0.8890	0.8894	0.8904	0.9226	0.9226	0.9228	0.9132	0.9139	0.9140
Adjusted R ²	0.8790	0.8795	0.8805	0.9156	0.9156	0.9158	0.9054	0.9061	0.9062

Table A.2: No bank FE

This table presents the results of estimating Eq. (1) without bank FE, splitting the sample by the deposit concentration level. Time period is 1995-2019. Low is a dummy that takes the value of one when the 3-month interest rate is equal to or below 1.25%. Every year, a banking sector is considered Low concentration if its deposit-based HHI is in the first quartile of the countries distribution. Robust standard errors clustered by banks are shown in parentheses. *p<0.1; **p<0.05; ***p<0.01.

	<i>Dependent variable:</i>					
	NIM	IIM	IEM	NIM	IIM	IEM
	Low HHI			High HHI		
	(1)	(2)	(3)	(4)	(5)	(6)
	Lagged dependent variable	0.8524*** (0.0072)	0.7996*** (0.0117)	0.7957*** (0.0096)	0.8928*** (0.0080)	0.8489*** (0.0100)
3-Month rate	0.0624*** (0.0053)	0.2081*** (0.0117)	0.1405*** (0.0066)	-0.0001 (0.0084)	0.1478*** (0.0160)	0.2245*** (0.0138)
Spread	0.0947*** (0.0085)	0.1772*** (0.0143)	0.0709*** (0.0084)	0.0045 (0.0091)	-0.0006 (0.0141)	0.0105 (0.0111)
Low	0.1325*** (0.0189)	0.1532*** (0.0335)	0.0430* (0.0231)	-0.1664*** (0.0310)	-0.0594 (0.0450)	0.1053*** (0.0258)
Deposits over liabilities (t-1)	0.0013*** (0.0003)	0.0012** (0.0005)	-0.0018*** (0.0005)	0.0019*** (0.0005)	0.0007 (0.0008)	-0.0067*** (0.0007)
Equity over assets (t-1)	0.0062*** (0.0007)	0.0084*** (0.0012)	0.0035*** (0.0009)	0.0041*** (0.0013)	0.0076*** (0.0018)	0.0055*** (0.0013)
Securities over assets (t-1)	-0.0021*** (0.0002)	-0.0047*** (0.0004)	-0.0011*** (0.0003)	-0.0022*** (0.0004)	-0.0047*** (0.0007)	-0.0007 (0.0005)
Liquidity (t-1)	-0.0005*** (0.0002)	-0.0007** (0.0003)	-0.0003 (0.0003)	0.0002 (0.0003)	0.0001 (0.0005)	-0.0005 (0.0004)
GDP growth	-0.0040 (0.0025)	-0.0160*** (0.0042)	-0.0135*** (0.0027)	0.0074* (0.0039)	-0.0160*** (0.0053)	-0.0309*** (0.0051)
Inflation	0.0004 (0.0030)	-0.0398*** (0.0055)	-0.0486*** (0.0038)	0.0301*** (0.0057)	0.0665*** (0.0095)	0.0280*** (0.0077)
3-Month rate * Low	0.0191 (0.0145)	-0.1568*** (0.0272)	-0.1973*** (0.0171)	0.0655*** (0.0184)	-0.0436 (0.0278)	-0.1592*** (0.0163)
Spread * Low	-0.1123*** (0.0081)	-0.1827*** (0.0135)	-0.0752*** (0.0086)	0.0035 (0.0114)	0.0199 (0.0157)	0.0168 (0.0115)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	76,819	76,819	76,819	19,145	19,145	19,145
R ²	0.8420	0.8942	0.8936	0.8849	0.9007	0.8730
Adjusted R ²	0.8419	0.8942	0.8935	0.8847	0.9005	0.8727

Table A3: No lagged dependent variable

This table presents the results of estimating Eq. (1) without lagged dependent variable, splitting the sample by the deposit concentration level. Time period is 1995-2019. Low is a dummy that takes the value of one when the 3-month interest rate is equal to or below 1.25%. Every year, a banking sector is considered Low concentration if its deposit-based HHI is in the first quartile of the countries distribution. Robust standard errors clustered by banks are shown in parentheses. * $p<0.1$; ** $p<0.05$; *** $p<0.01$.

	<i>Dependent variable:</i>					
	NIM	IIM	IEM	NIM	IIM	IEM
	Low HHI			High HHI		
	(1)	(2)	(3)	(4)	(5)	(6)
3-Month rate	0.0970*** (0.0106)	0.6524*** (0.0132)	0.5988*** (0.0103)	0.0196 (0.0154)	0.4497*** (0.0303)	0.4782*** (0.0271)
Spread	-0.0440*** (0.0135)	0.0029 (0.0182)	0.0218* (0.0127)	-0.0013 (0.0148)	0.0136 (0.0273)	0.0321 (0.0225)
Low	0.3859*** (0.0434)	-0.0439 (0.0559)	-0.3901*** (0.0421)	-0.2790*** (0.0646)	0.0330 (0.0947)	0.3261*** (0.0573)
Deposits over liabilities (t-1)	0.0062*** (0.0010)	0.0019 (0.0015)	-0.0097*** (0.0014)	0.0023 (0.0017)	-0.0014 (0.0024)	-0.0128*** (0.0023)
Equity over assets (t-1)	0.0276*** (0.0028)	0.0092** (0.0042)	0.0019 (0.0042)	0.0360*** (0.0037)	0.0065 (0.0046)	-0.0063 (0.0049)
Securities over assets (t-1)	-0.0113*** (0.0008)	-0.0162*** (0.0013)	-0.0009 (0.0011)	-0.0150*** (0.0016)	-0.0254*** (0.0023)	-0.0075*** (0.0015)
Liquidity (t-1)	-0.0003 (0.0005)	-0.0017*** (0.0007)	-0.0021*** (0.0008)	-0.0005 (0.0006)	-0.0002 (0.0009)	0.0012 (0.0011)
GDP growth	0.0287*** (0.0034)	-0.0297*** (0.0050)	-0.0612*** (0.0043)	0.0219*** (0.0063)	-0.0028 (0.0099)	-0.0371*** (0.0076)
Inflation	0.0235*** (0.0046)	-0.0282*** (0.0066)	-0.0461*** (0.0051)	0.0250** (0.0099)	0.0157 (0.0131)	-0.0229*** (0.0086)
3-Month rate * Low	0.2861*** (0.0265)	0.6844*** (0.0401)	0.3410*** (0.0326)	0.2504*** (0.0480)	-0.1225 (0.0791)	-0.4254*** (0.0295)
Spread * Low	-0.1612*** (0.0114)	-0.0306** (0.0149)	0.1500*** (0.0104)	0.0254* (0.0142)	0.0445** (0.0224)	0.0272 (0.0175)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	76,819	76,819	76,819	19,145	19,145	19,145
R ²	0.8297	0.9037	0.8909	0.8830	0.9130	0.8872
Adjusted R ²	0.8137	0.8947	0.8807	0.8649	0.8995	0.8697

Table A4: Country Stats

This table reports for each country the number of banks, bank-year observations, and the years each country was below different thresholds for the low interest rate environment.

Country	Banks	Obs.	Years below national threshold	Years below 1.25	Years below 0.5
Australia	72	543	7	0	0
Austria	672	5,994	7	10	7
Belgium	106	1,076	7	10	7
Canada	39	319	7	9	0
Colombia	67	511	5	0	0
Czech Republic	35	393	5	7	5
Denmark	139	1,940	7	9	7
Finland	64	370	7	10	7
France	473	5,536	7	10	7
Germany	2,598	37,592	7	10	7
Greece	26	222	6	10	7
Ireland	33	258	7	10	7
Israel	12	164	6	7	5
Italy	922	12,032	7	10	7
Japan	703	9,749	6	17	14
Korea	109	784	5	0	0
Latvia	24	295	5	9	7
Lithuania	13	146	5	8	6
Mexico	73	375	5	0	0
Netherlands	54	310	7	10	7
New Zealand	22	195	7	0	0
Norway	184	2,171	7	3	0
Poland	181	1,118	5	0	0
Portugal	141	1,044	7	10	7
Slovak Republic	18	201	5	10	7
Slovenia	19	227	5	10	7
Spain	279	2,756	7	10	7
Sweden	123	1,410	7	9	7
Switzerland	536	6,525	7	15	13
United Kingdom	182	1,708	7	11	2

Table A5: Robustness – 0.5 threshold

This table presents the results of estimating Eq. (1), splitting the sample by the deposit concentration level. Time period is 1995-2019. Low is a dummy that takes the value of one when the 3-month interest rate is at or below 0.5%. Every year, a banking sector is considered Low concentration if its deposit-based HHI is in the first quartile of the countries distribution. Robust standard errors clustered by banks are shown in parentheses. *p<0.1; **p<0.05; ***p<0.01.

	<i>Dependent variable:</i>					
	NIM	IIM	IEM	NIM	IIM	IEM
	Low HHI			High HHI		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged dependent variable	0.5442*** (0.0178)	0.4411*** (0.0206)	0.5026*** (0.0162)	0.5559*** (0.0255)	0.4832*** (0.0322)	0.4475*** (0.0194)
3-Month rate	0.0086* (0.0047)	0.3893*** (0.0121)	0.3827*** (0.0093)	-0.0069 (0.0113)	0.3016*** (0.0261)	0.3616*** (0.0198)
Spread	-0.0492*** (0.0062)	0.0164* (0.0089)	0.0718*** (0.0071)	-0.0157* (0.0086)	0.0130 (0.0136)	0.0464*** (0.0112)
Low	-0.0536*** (0.0163)	-0.3222*** (0.0286)	-0.2176*** (0.0168)	-0.1925*** (0.0342)	0.1192** (0.0526)	0.3656*** (0.0321)
Deposits over liabilities (t-1)	0.0044*** (0.0007)	0.000001 (0.0011)	-0.0074*** (0.0009)	0.0012 (0.0010)	-0.0007 (0.0017)	-0.0069*** (0.0017)
Equity over assets (t-1)	0.0100*** (0.0019)	0.0052* (0.0030)	0.0018 (0.0027)	0.0134*** (0.0033)	0.0019 (0.0035)	-0.0026 (0.0035)
Securities over assets (t-1)	-0.0049*** (0.0006)	-0.0101*** (0.0009)	-0.0021*** (0.0007)	-0.0057*** (0.0010)	-0.0138*** (0.0018)	-0.0054*** (0.0011)
Liquidity (t-1)	0.0002 (0.0003)	-0.0011** (0.0005)	-0.0016*** (0.0005)	-0.00003 (0.0004)	-0.00003 (0.0006)	0.0009 (0.0008)
GDP growth	0.0066** (0.0027)	-0.0247*** (0.0040)	-0.0356*** (0.0033)	0.0112** (0.0045)	-0.0004 (0.0070)	-0.0214*** (0.0058)
Inflation	0.0261*** (0.0037)	0.0183*** (0.0051)	-0.0116*** (0.0036)	0.0290*** (0.0069)	0.0448*** (0.0100)	0.0087 (0.0071)
3-Month rate * Low	0.1616*** (0.0342)	0.2048*** (0.0640)	-0.1457*** (0.0374)	0.0635* (0.0339)	-0.0769 (0.0619)	-0.2258*** (0.0329)
Spread * Low	-0.0247*** (0.0073)	0.1115*** (0.0115)	0.1384*** (0.0085)	0.0421*** (0.0103)	0.0389*** (0.0147)	-0.0053 (0.0129)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	76,819	76,819	76,819	19,145	19,145	19,145
R ²	0.8791	0.9244	0.9241	0.9223	0.9383	0.9166
Adjusted R ²	0.8678	0.9174	0.9170	0.9103	0.9287	0.9036

Table A.6: Alternative concentration threshold (uniform)

This table presents the results of estimating Eq. (1), splitting the sample by the deposit concentration level. Time period is 1995-2019. Low is a dummy that takes the value of one when the 3-month interest rate is equal to or below 1.25%. A banking sector is considered Low concentration if its full sample deposit HHI mean is in the bottom quartile (bottom 8 countries) of the distribution. Robust standard errors clustered by banks are shown in parentheses. *p<0.1; **p<0.05; ***p<0.01.

	<i>Dependent variable:</i>					
	NIM	IIM	IEM	NIM	IIM	IEM
	Low HHI			High HHI		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged dependent variable	0.5544*** (0.0182)	0.4549*** (0.0213)	0.5115*** (0.0168)	0.5699*** (0.0240)	0.5091*** (0.0273)	0.4906*** (0.0179)
3-Month rate	0.0676*** (0.0070)	0.4500*** (0.0141)	0.3815*** (0.0106)	0.0160 (0.0109)	0.2787*** (0.0231)	0.3069*** (0.0180)
Spread	0.0520*** (0.0085)	0.1846*** (0.0127)	0.1627*** (0.0087)	-0.0042 (0.0093)	-0.0290* (0.0150)	-0.0148 (0.0141)
Low	0.3115*** (0.0289)	0.3303*** (0.0414)	0.0778*** (0.0246)	-0.1657*** (0.0347)	0.0505 (0.0509)	0.2590*** (0.0363)
Deposits over liabilities (t-1)	0.0037*** (0.0007)	0.0004 (0.0011)	-0.0058*** (0.0009)	0.0033*** (0.0009)	0.0013 (0.0015)	-0.0069*** (0.0014)
Equity over assets (t-1)	0.0094*** (0.0020)	0.0038 (0.0032)	0.0009 (0.0028)	0.0124*** (0.0025)	0.0036 (0.0030)	-0.0027 (0.0029)
Securities over assets (t-1)	-0.0046*** (0.0006)	-0.0091*** (0.0010)	-0.0019*** (0.0007)	-0.0060*** (0.0010)	-0.0136*** (0.0016)	-0.0043*** (0.0010)
Liquidity (t-1)	0.00001 (0.0004)	-0.0011** (0.0006)	-0.0012** (0.0005)	0.0001 (0.0004)	-0.00003 (0.0006)	0.0002 (0.0007)
GDP growth	0.0079*** (0.0030)	-0.0165*** (0.0040)	-0.0245*** (0.0029)	0.0212*** (0.0044)	-0.0059 (0.0065)	-0.0410*** (0.0060)
Inflation	0.0094*** (0.0030)	-0.0136*** (0.0048)	-0.0245*** (0.0032)	0.0178** (0.0071)	0.0185* (0.0097)	-0.0039 (0.0068)
3-Month rate * Low	0.1017*** (0.0199)	0.0249 (0.0426)	-0.1655*** (0.0259)	0.1230*** (0.0228)	-0.0410 (0.0399)	-0.2416*** (0.0220)
Spread * Low	-0.1389*** (0.0077)	-0.1505*** (0.0114)	-0.0295*** (0.0075)	0.0107 (0.0118)	0.0553*** (0.0161)	0.0450*** (0.0137)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75,561	75,561	75,561	20,403	20,403	20,403
R ²	0.8816	0.9248	0.9267	0.9096	0.9289	0.8975
Adjusted R ²	0.8715	0.9183	0.9205	0.8997	0.9211	0.8862

Table A.7: Alternative concentration measure (CR3)

This table presents the results of estimating Eq. (1), splitting the sample by the deposit concentration level. Time period is 1995-2019. Low is a dummy that takes the value of one when the 3-month interest rate is equal to or below 1.25%. Every year, a banking sector is considered Low concentration if its deposit-based CR3 is in the first quartile of the countries distribution. Robust standard errors clustered by banks are shown in parentheses. *p<0.1; **p<0.05; ***p<0.01.

	<i>Dependent variable:</i>					
	NIM	IIM	IEM	NIM	IIM	IEM
	Low CR3			High CR3		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged dependent variable	0.5415*** (0.0179)	0.4410*** (0.0219)	0.5054*** (0.0169)	0.5581*** (0.0257)	0.4756*** (0.0323)	0.4548*** (0.0178)
3-Month rate	0.0657*** (0.0061)	0.4441*** (0.0136)	0.3756*** (0.0097)	-0.0200* (0.0120)	0.2718*** (0.0262)	0.3368*** (0.0200)
Spread	0.0405*** (0.0085)	0.1439*** (0.0139)	0.1316*** (0.0098)	-0.0232** (0.0106)	-0.0194 (0.0168)	0.0223 (0.0142)
Low	0.2916*** (0.0260)	0.2126*** (0.0426)	0.0080 (0.0299)	-0.1830*** (0.0409)	0.1017* (0.0579)	0.3263*** (0.0335)
Deposits over liabilities (t-1)	0.0043*** (0.0006)	0.0014 (0.0010)	-0.0057*** (0.0009)	0.0013 (0.0010)	-0.0010 (0.0016)	-0.0071*** (0.0016)
Equity over assets (t-1)	0.0082*** (0.0018)	0.0018 (0.0030)	-0.0002 (0.0027)	0.0149*** (0.0033)	0.0045 (0.0033)	-0.0013 (0.0035)
Securities over assets (t-1)	-0.0050*** (0.0006)	-0.0096*** (0.0010)	-0.0017** (0.0007)	-0.0057*** (0.0010)	-0.0136*** (0.0018)	-0.0047*** (0.0010)
Liquidity (t-1)	0.0001 (0.0004)	-0.0011** (0.0005)	-0.0013** (0.0006)	-0.0002 (0.0004)	-0.0001 (0.0006)	0.0007 (0.0007)
GDP growth	0.0043 (0.0027)	-0.0268*** (0.0041)	-0.0340*** (0.0033)	0.0092** (0.0043)	-0.0062 (0.0067)	-0.0239*** (0.0055)
Inflation	0.0048 (0.0034)	-0.0284*** (0.0051)	-0.0302*** (0.0035)	0.0285*** (0.0068)	0.0398*** (0.0098)	0.0032 (0.0070)
3-Month rate * Low	0.1094*** (0.0186)	0.1384*** (0.0410)	-0.1184*** (0.0242)	0.1037*** (0.0241)	-0.1667*** (0.0438)	-0.3462*** (0.0201)
Spread * Low	-0.1499*** (0.0078)	-0.1411*** (0.0125)	-0.0104 (0.0087)	0.0262** (0.0121)	0.0488*** (0.0157)	0.0166 (0.0124)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75,549	75,549	75,549	20,415	20,415	20,415
R ²	0.8838	0.9279	0.9257	0.9179	0.9332	0.9137