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Abstract

This paper provides a retrospective assessment of the relationship between bank profitability and interest rates, focusing on the period when rates were very low or negative. To do this we use new confidential bank-level data covering about 1,500 banks operating in 10 banking systems, with most samples spanning the two decades up to the end of 2019. Our analysis confirms the empirical regularity that declining interest rates reduce banks' net interest margins. However, we find a smaller effect than in previous studies: on average across countries, a 100 basis point fall in short-term interest rates results in a 5 basis point decline in net interest margins in the short run. Notably, there are substantial cross-country differences, and, in some cases, the estimated effect is greater. Importantly, the effect of lower interest rates on net interest margins is larger than the effect on asset returns, suggesting that banks can shield overall profitability in the face of lower interest rates. For example, lower interest rates alleviate debt-servicing burdens and are associated with a fall in provisions set aside to cover losses on loans. There is therefore no one-size-fits-all result for the impact of low interest rates on overall profitability: in some jurisdictions banks maintained their level of profitability as the beneficial impact of lower rates on loan-loss provisions and other factors, including an increased focus on cost efficiencies and streamlining business models, materially offset the drag from lower interest margins.

JEL Classification Numbers: E52, F34, F36, G21

Keywords: interest rates, bank profitability, net interest margin, monetary policy

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1. Introduction

For much of the past decade, interest rates in many countries were at or near historically low levels. This raised questions about the consequences of low interest rates for bank profitability and implications for the transmission of monetary policy. While interest rates have risen more recently due to high inflation, this paper provides a retrospective assessment of the effect of low interest rates on bank profitability. The challenges and consequences of low rates may arise again at some point in the future, particularly given the neutral rate is estimated to have fallen significantly in advanced economies over the past few decades (Holston, Laubach and Williams 2017). This paper is unique in using proprietary bank-level data for 10 countries, with the effect of lower interest rates on bank profitability estimated by banking sector experts from each country.

This paper presents new insights on the *direct* impact of lower rates on bank profitability, after controlling for other factors that operate indirectly through monetary policy's independent impact on aggregate demand.[1] All else equal, lower interest rates are likely to directly impact bank profitability by eroding banks' net interest margins (NIMs). This is because most bank assets earn a rate of interest that varies to some extent with the policy rate. However, some bank liabilities, including equity and transaction deposits, pay no or little interest and banks may choose not to reprice transaction deposits in line with the policy rate. As a result, lower interest rates are likely to lower NIMs. Moreover, the impact on margins could be larger in low-rate environments, when rates are at or near their effective lower bounds. This is because of the higher share of deposits at low rates that banks choose not to reprice lower in line with lending rates. The impact on margins could also be larger if rates have been 'lower for longer' as interest rate hedges become less effective over time.[2]

While NIMs will tend to decline with interest rates, the overall direct impact on bank profitability is not obvious (CGFS 2018). Lower interest rates can decrease loan-loss provisions by reducing the cost of servicing debt and lowering default probabilities. Banks can also respond endogenously by increasing their non-interest income (for example, fee income) and reducing their costs of operating. Ultimately, teasing out the balance of these effects is an empirical question.

Quantifying the impact of lower rates on bank profitability and its components is relevant for policymakers. On the one hand, lower profits erode banks' ability to build capital buffers to absorb future losses. Lower capital can also weigh on lending (Gambacorta and Shin 2018), with reduced credit availability potentially weighing on economic activity. In a theoretical model, Brunnermeier and Koby (2018) propose a 'reversal rate' below which further reductions in the policy rate become contractionary under specific conditions.[3] This is because of the negative effects of lower profitability on bank capital and the associated contractionary effects on bank lending. On the other hand, if banks choose to protect their profitability by not lowering interest rates on their lending after a fall in the policy rate then this could impair the transmission of monetary policy. Central banks have

1 While we are only concerned with estimating the direct impact of lower rates, it is important to recognise that lower interest rates *indirectly* contribute to higher bank profits by stimulating economic activity.

2 Banks in some jurisdictions engage in interest rate swaps to hedge interest rate risk stemming from holding a greater amount of fixed-rate liabilities relative to fixed-rate assets. However, these hedges become less effective when rates have been lower for longer because they gradually roll onto lower interest rates.

3 These include banks being subject to an occasionally binding equity constraint (and so being unable to raise external equity) as well as being net investors in debt securities.

acknowledged these potential side effects and have in some cases adapted their operations in low-rate environments to lower the burden of low or negative interest rates on bank profitability.[4]

2. Overview of the Data and Methodology

This paper summarises the association between interest rates and bank profitability using unique confidential bank-level data across 10 countries. These data were made accessible as part of a collaboration between 10 central banks organised by the International Banking Research Network (IBRN).[5] Each participating central bank in the IBRN examined the association between interest rates and bank profitability using a common methodology that takes into account underlying economic conditions as well as differences in banks' business models. This paper also draws on qualitative information obtained from a survey of each contributing central bank. The survey asked respondents to describe, among other things, the impact of low rates on banks' profits; actions taken by banks to mitigate any negative impact; and various features of the operating environment, such as the interest rate structure of banks' assets.

The use of confidential bank-level data – complemented by the survey information – sharpens existing cross-country empirical evidence on the association between rates and profitability. Previous studies have tended to rely on commercially available databases such as BankScope or S&P Global Market Intelligence's SNL Financial, which use strict criteria to ensure all variables are consistently reported across countries.[6] While this consistency is invaluable to researchers, it typically results in more missing observations and smaller sample sizes. Conversely, the use of confidential data gives our banking sector experts more flexibility to adjust sample sizes and adjust the construction of particular variables to best represent the underlying concept of interest. For example, the use of confidential bank-level data for Australia – made available to central bank researchers by the prudential regulator – significantly increases the available sample size and reduces the incidence of missing observations. Our research goal, and the main contribution of this paper, is to use the best available data to answer our research question and add a degree of nuance to existing cross-country work in this area by drawing on the insights from our qualitative survey.

Relative to previous approaches, our estimation strategy is akin to a completely flexible cross-country panel regression, in which every independent variable is allowed to vary by country. By allowing our estimated effects to vary by country under a common methodology, we are better able to compare results between countries relative to other large cross-country studies using estimates obtained from a pooled cross-country sample. We focus on four different dependent variables: the return on assets (ROA), the NIM, non-interest income (Non-II) and loan-loss provisions (LLPs). This way we can better identify the channels through which low and negative interest rates affect profitability. In contrast to previous research, we also permit country-specific thresholds for what are considered

4 See, for example, Mario Draghi's quote from 27 March 2019: 'We will continue monitoring how banks can maintain healthy earning conditions while net interest margins are compressed. And, if necessary, we need to reflect on possible measures that can preserve the favourable implications of negative rates for the economy, while mitigating the side effects, if any. That said, low bank profitability is not an inevitable consequence of negative rates.' The proportionality assessment of non-conventional measures and the need to 'counteract undesirable side effects' is explicitly mentioned in the Strategy Review of the ECB, which was concluded in July 2021 – see the overview note (ECB 2021).

5 Further information on the IBRN can be found on its official website (https://www.newyorkfed.org/ibrn).

6 See, for example, Borio, Gambacorta and Hofmann (2017), CGFS (2018) and Claessens, Coleman and Donnelly (2018). Altavilla, Boucinha and Peydró (2018) use a mix of proprietary data in conjunction with data from several commercial providers, but only focus on the euro area.

low interest rate episodes and identify these from the history of short-term interest rates within each country. A common definition of 'low' across all countries – such as the 1.25 per cent threshold used in Claessens *et al* (2018) – would mean that several countries in our sample – such as Australia, Canada and Chile – only spend limited periods of time below the low-rate threshold. Country-specific thresholds ensure there is sufficient within-country variation in interest rates within the low-rate environment to identify any 'nonlinear' effects.[7] While the magnitude of any nonlinear effects (should they exist) could differ between countries – depending on the proximity of their low-rate thresholds to zero – our approach allows these effects to be identified for all countries in the sample. Furthermore, we separately examine whether prolonged low or negative interest rates disproportionately impair bank profitability. Finally, the richness of our data allows us to disaggregate banks by size: large, global banks – defined here as the 80 or so banks that are included in the Bank for International Settlements global systemically important banks (G-SIB) assessment sample – could have the capacity to better shield their profit margins in a low interest rate environment, and we can test this empirically.[8]

The general result that – all else equal – lower policy rates decrease margins is much clearer for the NIM than for ROA, suggesting that many banks can partially offset the effect of low interest rates on overall profitability. Our results for banks' LLPs suggest that lower rates reduce debt-servicing burdens. There also appear to be subtle nonlinearities in low interest rate environments and results tend to indicate that the reaction of bank profitability to interest rate changes can differ between larger, often more sophisticated banks, relative to their smaller peers. More broadly, a key finding from this work is that there is not a one-size-fits-all answer to the impact of monetary policy on overall bank profitability. The qualitative information obtained with the abovementioned survey also informs some of these cross-country differences.

The rest of the paper is organised as follows. Section 3 reviews the relevant literature. Section 4 discusses the main channels that link interest rates to bank profitability. Section 5 presents the data and key stylised facts. Section 6 turns to the analytical framework and empirical strategy followed in the paper. The results are presented in Section 7. Section 8 concludes the paper.

3. Literature on Bank Profitability and Interest Rates

There is widespread empirical support that lower interest rates are associated with a decline in banks' NIMs. However, there is less agreement on the impact of monetary policy on overall bank profitability as well as the impact of negative rates.[9] Table A1 summarises some of the existing bank-level studies. One goal of this paper is to bring the best available bank-level data to bear on these questions and tie together the seemingly disparate evidence about the impact on overall profitability and nonlinear effects when short-term interest rates are below zero.

Starting with the impact on banks' interest margins, several studies identify a nonlinear relationship between interest rates and NIMs, with the marginal impact of a cut to the cash rate larger in low interest rate environments – see, for example, Borio *et al* (2017). A prolonged period of low rates is

7 Throughout this paper, we capture 'nonlinear' effects by allowing the linear impact of rates on profitability to change if the bank is operating in a low-rate regime.

8 As defined by the Basel Committee on Banking Supervision, see <https://www.bis.org/bcbs/gsib/gsib_assessment_samples.htm> for details of the sample.

9 See, for example, Borio *et al* (2017), Claessens *et al* (2018), Altavilla *et al* (2018), Bikker and Vervliet (2018), CGFS (2018) and Beauregard and Spiegel (2020).

also found by several studies to have a larger negative effect on margins than a relatively short period – see, for example, Claessens *et al* (2018).

However, there is less consensus in the literature on the impact of monetary policy on overall profitability. Several country-specific papers find modest effects of lower interest rates on bank profitability – for example, Alessandri and Nelson (2015) for UK banks and Busch and Memmel (2015) for German banks – while larger impacts are reported in cross-country studies – for example, Borio *et al* (2017). In contrast, other papers find a negligible effect of interest rates on bank profitability. For example, Genay and Podjasek (2014) and Bikker and Vervliet (2018) both find that interest rates have a negligible effect on US banks' profitability, mainly because higher fees and lower LLPs offset downward pressure on NIMs.

In recent years studies have focused specifically on the effect of negative rates on bank profitability, with no common ground established. For Denmark and Sweden, Turk (2016) finds that the profitability of banks was resilient following the introduction of negative interest rates, at least in the short and medium term, as does Basten and Mariathasan (2018) for Swiss banks. Focusing on a large cross-country sample of European and Japanese banks, Lopez, Rose and Spiegel (2020) report that the benign implications of negative rates for bank profitability were because banks were able to offset interest income losses under negative rates with gains in non-interest income, including fees and capital gains. By contrast, Rostagno *et al* (2019) estimate that euro area bank profitability would have been lower in counterfactual scenarios in which the policy interest rate remained at zero or above. Urbschat (2018), Molyneux, Reghezza and Xie (2019) and Beauregard and Spiegel (2020) find that negative interest rates reduce bank profitability in the longer run, partly because of banks' limited ability to pass on negative rates to depositors or otherwise adjust their business models.

4. Channels of Monetary Policy to Bank Profitability

A bank's overall profitability, as measured by its ROA, can be decomposed simplistically according to the identity below – see Brassil (2022) for a more complete decomposition:

$$ROA_t \equiv \left(Non\text{-}II_t + NIM_t - LLP_t \right), \text{ where } NIM_t \equiv \frac{i_A A - i_L L}{A} = \left(i_A - i_L \right) + i_L \left(\frac{E}{A} \right)$$

In this identity, ROA, $Non\text{-}II$, NIM and LLP are defined as a share of assets. The average interest rates on banks' interest-bearing assets and liabilities are i_A and i_L respectively, and A, L, and E are the values of banks' assets, liabilities and equity. This decomposition motivates us to examine not only the association between interest rates and ROA, but also the association with NIMs, Non-II and LLPs. This allows us to unpack the channels through which changes in interest rates and the slope of the yield curve affect overall profitability. These channels are considered in detail below.

NIMs: As interest rates fall a larger share of bank deposits pay very low interest rates. This can squeeze NIMs because as rates fall, deposits that already receive zero or very low interest rates have not been repriced lower in line with lending rates or the return on liquid assets. This is especially true if market rates become negative, as banks may be unable to adjust deposit rates. There is also a mechanical association between interest rates and banks' NIMs. This occurs because a share of banks' funding is from equity, which does not bear interest. This limits the extent to which a

reduction in interest rates flows through to lower funding costs and mechanically reduces NIMs. To see this, note that in the identity above, even with constant spreads, the NIM falls as the level of interest rates declines. The slope of the yield curve also matters, as banks' loans and other assets typically have longer durations than their liabilities.

The impact of policy rates on profits is also likely to vary by bank size. Large banks have more complex business models and more diverse sources of income which may make them more nimble in shoring up profitability as NIMs decline. Larger banks also tend to rely less on deposit funding and more on market-based sources of funding, and so their NIMs could be expected to compress less when interest rates decline because of the effective lower bound on deposit rates. This hypothesis is consistent with the idea that larger banks with global operations are more insulated from changes in monetary policy (Cetorelli and Goldberg 2012).

Non-II: The reduction in NIMs could be offset by changes in Non-II. When interest rates fall, banks gain from the revaluation of longer-term assets given their role in maturity transformation and the associated positive duration gap between assets and liabilities. Banks can also offset lower NIMs through other endogenous adjustments to the way they operate. For instance, banks can pivot to Non-II-generating activities as well as increase their fees.

LLPs: Low interest rates may also affect LLPs. Lower rates make the existing stock of debt easier to service, thereby reducing overall debt burdens and estimated probabilities of default (PDs). These PDs are an important input into banks' forward-looking provisioning models. On the other hand, low interest rates may also lower the quality of new loans through the risk-taking channel of monetary policy. The literature on a risk-taking channel of monetary policy suggests falling interest rates can increase risk-taking by banks in three ways. First, lower profits and sticky nominal return targets can increase banks' willingness to extend loans to riskier borrowers (Rajan 2006; Haldane 2011). Second, higher income and collateral values may lead to falling risk perceptions (Jiménez *et al* 2014). And finally, forward guidance by central banks might reduce risk premia in low-rate environments (Borio and Zhu 2012). However, a risk-taking channel of monetary policy (to the extent that it matters) will only affect the flow of new loans. Given the stock of variable-rate loans is larger than the flow, lower interest rates are expected to lower provisions.

4.1 Other factors

Several other factors mean the channels outlined above are unlikely to have a uniform impact across countries.

Funding behaviour: Differences in the composition of banks' liabilities will affect the impact of very low rates on profits. Funding from wholesale markets (such as bonds) is not constrained by the zero lower bound in contrast to what has been observed for deposit funding. As a result, banks that rely more heavily on wholesale funding markets are less likely to be affected by a reduction in the policy rate from already low levels. Macroeconomic and institutional factors mean that some banking systems make greater use of wholesale funding relative to others. For instance, the Australian, Norwegian and Swedish banking systems are less reliant on deposit funding relative to their international peers, which could be expected to attenuate the impact of lower rates on profitability, all else equal.

Prevalence of fixed rate loans: Countries with a higher share of fixed-rate lending are likely to be more affected by changes in the slope of the yield curve relative to countries with a higher share of variable-rate loans. For example, in France, fixed-rate loans comprise around 90–95 per cent of the stock of lending. This contrasts with other countries such as Canada, where the stock of fixed rates is around one-half, and Sweden and Australia where the share is lower still.

Hedging: Likewise, in countries where hedging is less common – for example, countries in the euro area; see Hoffmann *et al* (2019) – movements in the yield curve are likely to have a larger impact on bank profits. Ordinarily, NIMs will narrow when yield curves flatten because banks are exposed to interest rate risk from maturity mismatches because of borrowing short and lending long. The extent to which banks reduce their exposure to this risk by hedging will impact their sensitivity to changes in the yield curve.

Banks are also exposed to interest rate risk stemming from holding a greater amount of fixed-rate liabilities (such as non-interest bearing deposits) relative to fixed-rate assets, such that when interest rates decline net income from these positions falls. Banks can choose to hedge this risk using swaps whereby the bank receives cash flows linked to fixed rates and pays cash flows linked to variable rates. As a result, when variable rates decline the income from these hedges increases, thereby providing the necessary hedge. The extent to which some banking systems use interest rate swaps to hedge this risk will also cause differences in the pass through of lower rates to profits in the short run.[10]

Competition: Banks operating in countries with less competitive banking systems will have more pricing power. As a result, following a cut to cash rates, these banks can ensure the fall in their lending rates is closer to the decrease in their funding costs, leaving NIMs less affected than otherwise similar banks operating in more competitive environments.

Central bank term funding facilities: The introduction of various funding schemes since the 2008 financial crisis is another factor that is likely to cause cross-country heterogeneity in the responsiveness of bank profits to lower rates. Term funding schemes involve providing low-cost, longer-term funding to banks, often with incentives for banks to increase their lending to the private sector. These schemes have been used as an alternative tool to provide stimulus when policy rates are near their effective lower bounds. Differences in the availability of these schemes, their design features and take-up across countries are likely to drive differences in the impact of low rates on bank profitability.

Tiered rates in the implementation of monetary policy: Finally, another measure that can be deployed by central banks to address the side effects of low/negative interest rates is a so-called tiering system. For example, the ECB introduced tiering in September 2019 to support the bank-based transmission of monetary policy. Under this scheme, banks' holdings of excess liquidity were exempted from the negative deposit rate facility. As explained later, this system is particularly relevant for French and German banks (both included in our sample) who hold a large share of total system liquidity – see, for example, Baldo *et al* (2017) and Grossmann-Wirth and Hallinger (2018). Other countries in our sample have also used similar schemes, including Norway and Switzerland.

10 In the long run these hedges become less effective and so are unlikely to drive cross-country differences in the long-run responsiveness of bank profits to changes in the cash rate.

5. Data Description

The current project is conducted under the auspices of the IBRN, a network of central bank researchers who focus on global banking. To examine the impact of interest rates on banks' profitability, we rely on confidential bank-level data. Each country's data are only available to subject matter experts from that country's central bank and we rely on the expert judgement of each contributor to construct the most appropriate sample for their jurisdiction.

Details of the sample for each country are provided in Table 1. Around 1,500 banks across the 10 jurisdictions are examined, with a bank broadly defined as an institution whose business is to receive deposits and/or close substitutes and grant credits or invest in securities on their own account. Most jurisdictions use data at a quarterly frequency, although some use semiannual and annual data. Seven countries use unconsolidated banking data, with the decision to rely on consolidated versus unconsolidated data left to subject matter experts from each central bank. While most data series start in the early 2000s or earlier, for Sweden they start only in 2010.

Table 1: Key Statistics for the Country Samples

	AUS[(a)]	CAN	CHL	CZE	FRA	DEU	NOR	POL	SWE	CHE
Start date	2003	1994	2004	2002	2000	2000	2000	2000	2010	2000
Frequency	QoQ	QoQ	QoQ	QoQ	HoH	YoY	YoY	QoQ	YoY	YoY
No of banks	181	76	13	21	562	203	221	23	56	104
No of time periods	68	104	62	72	40	20	20	80	10	20
Consolidation	C	C	UC	UC	UC	UC	UC	UC	C	C
Low-rate threshold	2.0	1.2	2.8	0.5	1.2	1.2	1.6	1.9	0.9	0.2
Negative rates	No	No	No	No	Yes	Yes	No	No	Yes	Yes
Windsorisation (%)	1	1	1	1	10	1	0.5	1	5	1

Notes: International Monetary Fund country abbreviations: AUS: Australia; CAN: Canada; CHL: Chile; CZE: Czech Republic; FRA: France; DEU: Germany; NOR: Norway; POL: Poland; SWE: Sweden; CHE: Switzerland.
(a) Sample includes banks, credit unions and building societies, foreign branches and foreign subsidiaries.
Source: Contributing central banks

Table 2 provides a full list of variables used in our analysis. Unlike previous studies, our definition of a 'low-rate environment' is country-specific, defined as the 25th percentile of each country's historical rate distribution. In choosing the most appropriate time period over which to define 'low' rates we again rely on our participating subject matter experts, with the sample period not necessarily the same as that shown in Table 1. The low-rate threshold for each central bank is plotted in Figure 1.

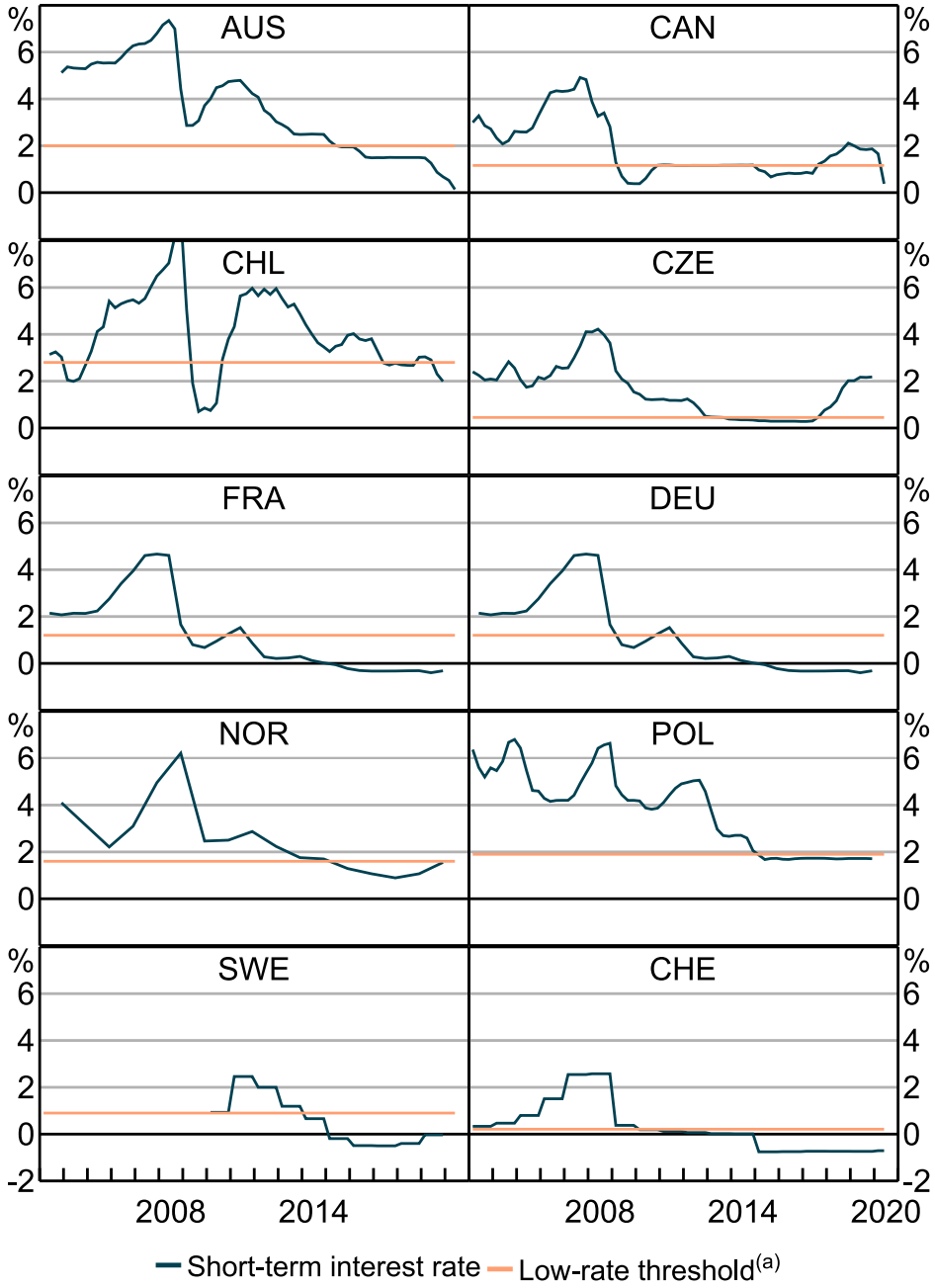
Table 2: Definitions

Term	Definition
Panel A: Dependent variables	
Return on assets (ROA)	The ratio of net income expressed as a percentage of average total assets (ATA).
Net interest margin (NIM)	The ratio of net interest income (NII) expressed as a percentage of average interest earning assets (AEA). NII includes gross interest and dividend income minus total interest expense. AEA is the sum of total loans, total securities, investments in property and earning assets not otherwise categorised, including non-current assets held for sale which are not loans.
Non-interest income ($Non\text{-}II$)	The ratio of Non-II expressed as a percentage of ATA. Non-II is the value of operating income from continuing operations for the reporting period, excluding the value of interest income and interest expense.
Loan-loss provisions (LLP)[a]	The ratio of LLPs (or impairment expenses) to cover non-performing loans expressed as a percentage of ATA. This is a flow item from the income statement.
Panel B: Variables of interest	
Short-term interest rate	Three-month interbank rate.
Spread	Difference between the 10-year sovereign bond yield and the 3-month interest rate.
Low-rate dummy variable	Equal to 1 when the 3-month interbank rate is in the first quartile of the country-specific historical rate distribution.
Lower-for-longer variable	The number of consecutive years that a country's 3-month interest rate is in the 'low' period.
Large bank dummy[b]	Equal to 1 if the bank is in the group of global banks that made the main G-SIB assessment sample.
Panel C: Baseline bank controls	
Deposits over liabilities	The ratio of deposits and short-term funding (STF) expressed as a percentage of total liabilities. Deposits and STF include total customer deposits, deposits from banks, money market instruments, certificates of deposit and other deposits.
Liquid assets over total assets	The ratio of cash, liquid assets and securities expressed as a percentage of ATA. Securities include reverse repos and cash collateral, trading securities, all in-the-money trading derivatives and derivatives recognised for hedging (less the value of netting arrangements), available for sale securities, held to maturity securities, at-equity investments, and other securities.
Equity ratio	The ratio of total equity expressed as a percentage of ATA. Total equity includes common equity, non-controlling interest, securities revaluation reserves, foreign exchange revaluation reserves, and other revaluation reserves.
Panel D: Baseline macro controls	
Real GDP growth	Year-on-year growth in real GDP.
CPI growth	Year-on-year inflation.
Housing price growth	Year-on-year growth in housing prices (apartments and houses).

Notes: (a) **Canada** uses the stock of provisions.
(b) For **Poland** the large bank dummy variable is equal to 1 for Polish subsidiaries of G-SIB banks. For **Sweden** a bank is classified as a large bank if it is included in main assessment sample at least once during the time period 2014–18. For **Germany** and the **Czech Republic** the dummy is equal to 1 for all domestic systemically important banks.

Source: Contributing central banks

Figure 1: Policy Rates



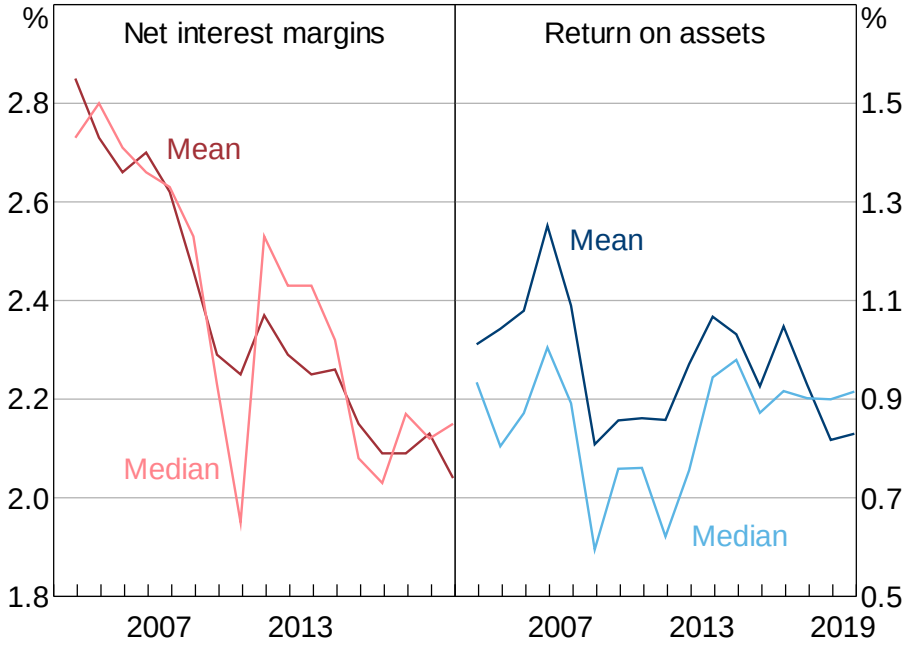
Notes: AUS: Australia; CAN: Canada; CHL: Chile; CZE: Czech Republic; FRA: France; DEU: Germany; NOR: Norway; POL: Poland; SWE: Sweden; CHE: Switzerland.
(a) Does not show the full history over which the low-rate threshold was calculated for some countries.

Source: Contributing central banks

Trends in profitability for the mean and median banking systems in the sample are plotted in Figure 2. Despite the broad-based decline in short-term interest rates over the sample, on average across the countries examined in this paper, banks' ROAs were largely unchanged over the sample, although volatile around the financial crisis in 2008. By contrast, the median NIM has been declining over the past decade, consistent with the decline in policy rates. For both the NIM and ROA the median is more volatile than the mean, suggesting there is substantial heterogeneity in country experiences.

Figure 2: Trends in Bank Profitability

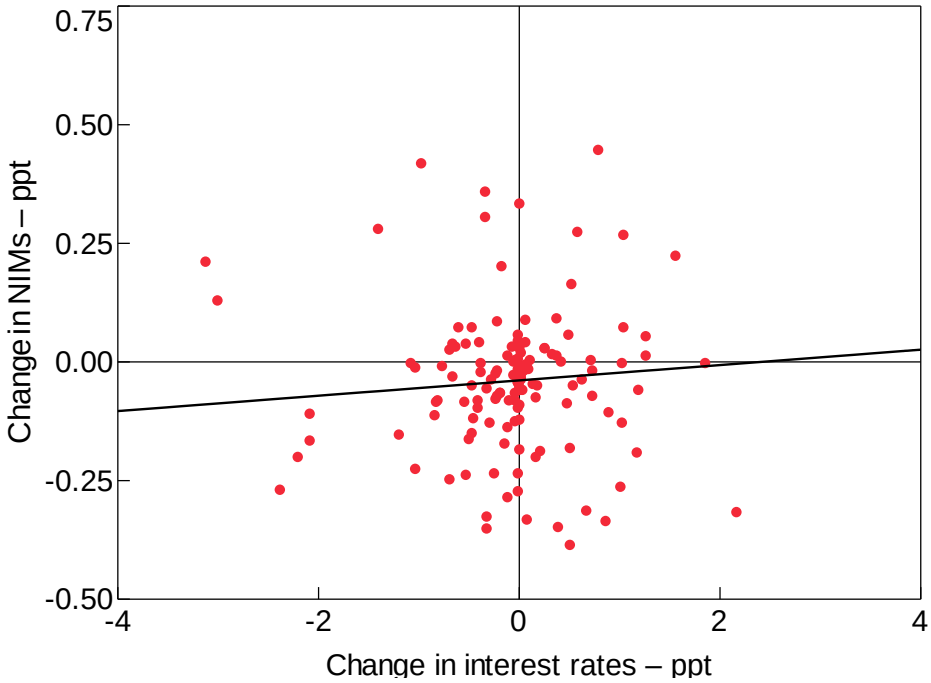
Average of contributing central banks



Note: Australia, Canada, Chile, Czech Republic, France, Germany, Norway, Poland, Sweden (from 2010) and Switzerland.
Source: Contributing central banks

For a cursory and preliminary look at the association between changes in interest rates and profitability, Figures 3 and 4 plot the period-to-period change in NIMs and ROAs against the change in interest rates for the mean bank in all countries. There appears to be a positive association between changes in interest rates and banks' NIMs; however, there is no equivalent relationship for banks' ROAs. This preliminary evidence, along with the trends presented in Figure 2, is consistent with the idea that banks' may have shielded the impact of lower rates on overall profitability by increasing fee-based business and reducing costs. This notwithstanding, these bivariate associations fail to control for a host of relevant factors, including country and bank fixed effects as well as other relevant balance sheet controls, motivating our much more careful assessment of these relationships in the next section.

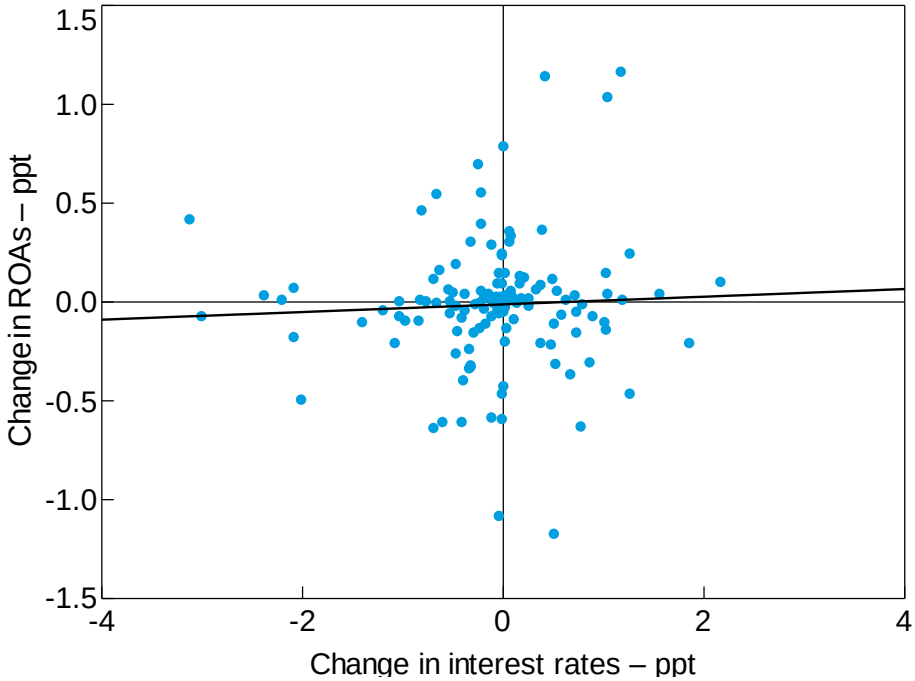
Figure 3: Policy Rates and NIMs



Notes: Australia, Canada, Chile, Czech Republic, France, Germany, Norway, Poland, Sweden (from 2010) and Switzerland. First and last percentile of the distribution removed.

Source: Contributing central banks

Figure 4: Policy Rates and ROAs



Notes: Australia, Canada, Chile, Czech Republic, France, Germany, Norway, Poland, Sweden (from 2010) and Switzerland. First and last percentile of the distribution removed.

Source: Contributing central banks

6. Analytical Framework

In this project, 10 central banks estimate the same regressions using bank-level data for their country – that is, Equation (1) below is estimated separately for each country. Our baseline model is a variant of the specification used in Borio *et al* (2017):

$$\begin{aligned} profit_{i,t} = {} & \alpha_0 + \alpha_1 profit_{i,t-1} + \alpha_2 r_t + \alpha_3 spread_t + \alpha_4 low_t + \alpha_5 large_i + \alpha_6 r_t * low_t + \alpha_7 r_t * large_i \\ & + \alpha_8 r_t * low_t * large_i + \alpha_9 spread_t * low_t + \alpha_{10} spread_t * large_i + \alpha_{11} spread_t * low_t * large_i \\ & + \gamma_1 Y_t + \gamma_2 X_{i,t-1} + \delta_i + \varepsilon_{i,t} \end{aligned} \quad (1)$$

Here $profit_{i,t}$ is the profit of bank i in period t. In our baseline specification, $profit$ is measured as the ROA. We also explore specifications in which profit is replaced by one of its underlying components – the NIM, $Non\text{-}II$ and LLP.

The variables of interest are the 3-month interest rate, r_t, and the spread between the yield on 10-year government bonds and the short-term rate, $spread_t$, as well as their interactions. The coefficient α_6 on the interaction term $r_t * low_t$ indicates the differential impact a change in the short-term rate has on the profitability of smaller banks when interest rates are low. low_t is a dummy equal to 1 if the home country in a specific year t is in a 'low-rate environment'. In our baseline specification, we consider a country to be in a low-rate environment when its 3-month interest rate is in the first quartile of the country's sample distribution (Figure 1). The coefficient α_7 on the interaction term between r_t and the $large_i$ dummy indicates the differential impact a change in the policy rate has on profitability for large banks compared to their smaller counterparts in a normal rate environment. The $large_i$ dummy is equal to 1 if the bank is in the group of around 80 global banks that made the BIS' main G-SIB assessment sample for the end-2019 G-SIB exercise. Finally, the coefficient α_8 on the triple interaction term $r_t * low_t * large_i$ indicates the differential impact of a change in short-term rates in a low-rate environment for larger banks compared to their smaller counterparts. All of these interactions are repeated for the spread between the 10-year rate and the 3-month rate, $spread_t$.

Y_t are macroeconomic controls and consist of real GDP growth, housing price growth and CPI inflation. $X_{i,t-1}$ are bank-level controls that include deposits over total liabilities, the liquidity ratio and total equity capital over total assets, all lagged one period (definitions are provided in Table 2). These controls remove any correlation interest rates might indirectly have with profitability via their impact on the state of the economy and funding conditions. Bank-level controls are lagged one period as bank profitability could have a contemporaneous impact on these controls. δ_i are bank fixed effects and $\varepsilon_{i,t}$ is an error term. We use robust standard errors, clustered by bank to accommodate within-bank serial correlation.

In addition to the baseline regression given by Equation (1), contributing central banks estimated two additional regressions. The first of these replaces the low_t dummy with a variable that captures for how long interest rates have been low. A longer period of low interest rates could be expected to increase the negative effect of lowering rates on profitability because interest rate hedges become less effective in a protracted low-rate environment. The second of these replaces the low_t dummy with a dummy variable for whether rates are negative. Negative interest rates could have a

detrimental effect on banks' profitability because of banks' limited willingness to pass along negative rates to depositors.

Each contributing country estimated this model over their confidential data using a fixed effects (FE) estimator. Because of the lagged dependent variable we have relaxed the strict exogeneity assumption ($E\left(\epsilon_{it}\left|controls_{i1},\ldots,controls_{iT},\delta_i\right.\right)\neq 0$) and our regressors are instead weakly exogenous ($E\left(\epsilon_{it}\left|\left\{controls_{is}\right\}_{s\leq t},\delta_i\right.\right)=0$) , assuming ϵ_{it} is serially uncorrelated. The implication of non-strictly exogenous regressors is that the FE estimator is downward biased. However, when the time period is reasonably large, as it is here for most jurisdictions, this bias is negligible. This notwithstanding, estimates obtained for Germany, Norway, Sweden and Switzerland should be considered lower bounds.

Finally, the dynamic specification used in Equation (1) allows us to examine the short- and long-run impact of changes in policy rates on profitability. The longer-term impact of a permanent change in interest rates on profitability for small banks is given by the expression $\alpha_2/\left(1-\alpha_1\right)$ which is obtained by recursively substituting for $profit_{i,t-1}$ in Equation (1).

The benefit of the simple baseline specification used here is it could be easily communicated to each central banking expert and commonly estimated over their own confidential bank-level data. However, this simplicity means we necessarily omit a number of other interactions that might have been interesting to explore. First, additional evidence might be obtained by interacting the interest rate level and the slope of the yield curve with bank-specific variables, such as excess reserves and deposit dependence, which both could increase the sensitivity to rates. We also do not control for expected macroeconomic conditions. Others have argued that policy and profitability might share a common association with expected economic conditions, and failing to control for these could result in biased estimates (Altavilla *et al* 2018). For example, improvement to the economic outlook could give rise to higher rates and profitability by stimulating investment and increasing current loan demand. On the supply side, banks might also increase their profitability by increasing their business lending as the improved economic outlook translates into lower credit risk. While these channels are plausible, finding good controls for expected demand that are consistently available across countries is challenging (beyond controlling for current economic conditions). Finally, our specification assumes that bank profitability does not affect monetary policy decisions. As noted in Borio *et al* (2017), while aggregate banking conditions might affect the stance of monetary policy, the profitability of any given bank is unlikely to affect central bank decisions. This is a key feature of running our baseline regression at the bank level, rather than aggregating across all banks for a given country and estimating a time series regression.

7. Empirical Findings across Countries

7.1 Net interest margins

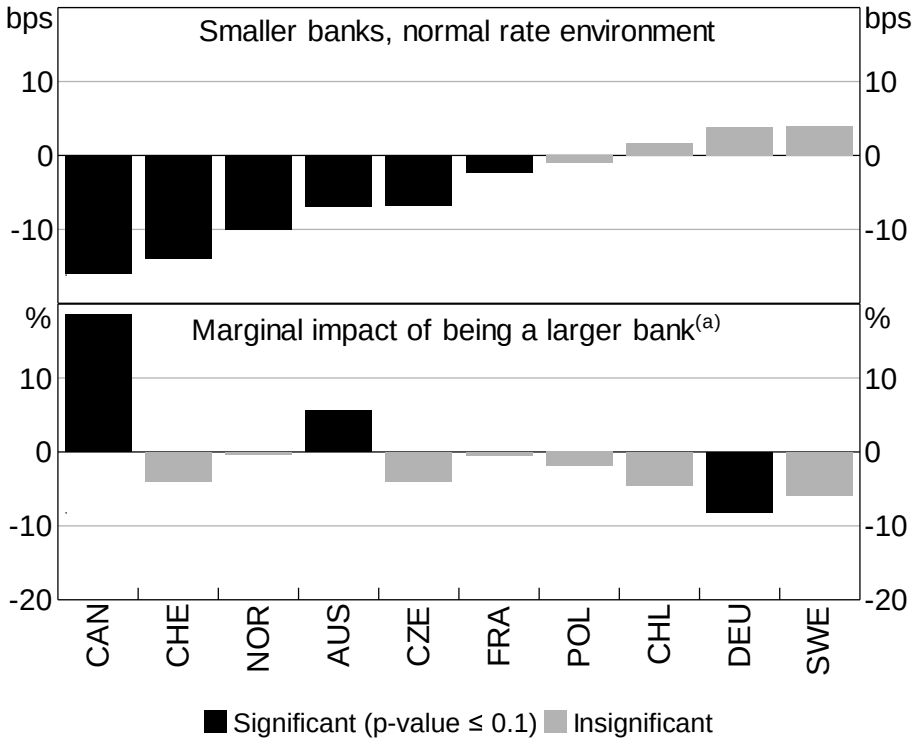
In line with expectations, our estimates point to a clear positive relationship between the short-term interest rate and banks' NIMs during normal times: a fall in the interest rate is associated with a fall in NIMs. From our sample of 10 countries spanning around 1,500 banks, the estimates suggest that during normal times, a 100 basis point reduction in short-term interest rates reduces smaller banks'

NIMs by around 5 basis points in the short run (Table 3 top panel; Figure 5, top panel).[11] The mean long-run impact, calculated using the expression towards the end of Section 6, which assumes the change in interest rates is permanent, is much higher, at around 15 basis points.[12] Similarly, there is broad-based evidence that a flattening of the yield curve (as measured by the spread between 10-year and 3-month interest rates) is associated with lower NIMs. Our findings are broadly consistent with those reported by Claessens *et al* (2018) for their sample spanning 47 countries, but is noticeably smaller than the impact reported in Borio *et al* (2017) for their sample of large, advanced economy banks.

We find limited evidence that the effect of interest-rate changes differs for larger banks compared to smaller banks (Table 3, top panel; Figure 5, bottom panel), though Germany, Canada and Australia are exceptions. In Germany, the expected positive association between short-term interest rates and margins is only evident for larger banks. By contrast, larger Canadian banks' margins appear completely insulated from changes in the short-term interest rate, reflecting the higher degree of diversification between interest and non-interest income. Likewise, in Australia, the impact of a reduction in interest rates on the margins of larger banks is significantly lower relative to smaller banks, possibly reflecting their greater use of wholesale funding markets.

Figure 5: Monetary Policy and Banks' NIMs

Impact of a 100 basis point cut to the policy rate



Notes: AUS: Australia; CAN: Canada; CHL: Chile; CZE: Czech Republic; FRA: France; DEU: Germany; NOR: Norway; POL: Poland; SWE: Sweden; CHE: Switzerland.
(a) Large banks defined as those in the BIS main G-SIB assessment sample.

Source: Contributing central banks

11 The full regression outputs are available upon request.

12 This figure is obtained using the average coefficient on the lagged dependent variable, α_1, in Equation (1), which is 0.7.

Table 3: Results for Low Rate and Large Bank Interactions

(*continued next page*)

	AUS	CAN	CHL	CZE	DEU	FRA	NOR	POL	SWE	CHE
Net interest margin (NIM)										
r	0.070***	0.160***	–0.017	0.068***	–0.038	0.024**	0.101***	0.010	–0.040	0.14***
$spread$	0.054***	–0.044	0.014	0.049*	0.075	0.136***	0.088***	0.029*	–0.281	0.08***
$large * r$	–0.056***	–0.186***	0.046	0.041	0.082*	0.005	0.004	0.019	0.059	0.04
$large * spread$	–0.026**	–0.334*	0.015	0.036	–0.028	–0.026	–0.013	0.069	0.352	0.03
$low * r$	–0.024	0.069	0.184***	–0.182	0.111	–0.012***	–0.219**	–0.531*	0.319	–0.04
$low * spread$	–0.040***	0.191**	0.076***	0.009	0.025	0.002	–0.273***	–0.039	0.382*	–0.01
$large * low * r$	0.021	0.270*	0.052	0.254	–0.215***	–0.026***	0.589	0.336	–0.294	–0.78**
$large * low * spread$	–0.012	0.318*	0.052	–0.023	–0.012	–0.033	0.206*	–0.053	–0.467	–0.50*
Observations	6,940	4,830	696	1,274	2,909	12,380	3,092	1,249	408	1,857
Within R^2	0.790	0.705	0.842	0.571	0.471	0.690	0.565	0.895	0.492	0.73
Return on assets (ROA)										
r	0.063***	–0.047	0.009	0.064**	–0.064	0.042***	–0.014	–0.017*	–0.237	–0.01
$spread$	0.046***	–0.159*	0.043**	0.037	0.043	–0.012	0.167***	–0.030**	0.190	–0.04*
$large * r$	–0.067***	0.069	0.013	0.047	–0.003	–0.012	–0.122***	–0.013	0.077	–0.38***
$large * spread$	–0.110***	0.150*	–0.003	0.108**	–0.010	0.000	–0.516***	–0.025	–0.414	–0.10
$low * r$	0.008	0.280	0.026	–0.045	0.453**	–0.051	–0.014	–0.116	0.556**	0.04
$low * spread$	–0.021	0.207	–0.011	–0.050	–0.197	0.048*	–0.272**	–0.029	–0.217	0.07
$large * low * r$	0.002	0.029	–0.105**	0.396	–0.356	–0.003	0.288	0.071	–0.183	–0.05
$large * low * spread$	0.265**	–0.126	–0.005	–0.051	0.232	–0.010	0.944**	0.039	0.463	0.52
Observations	6,940	4,830	696	1,274	2,909	12,380	3,092	1,249	408	1,857
Within R^2	0.164	0.173	0.812	0.105	0.092	0.250	0.184	0.279	0.178	0.19

Table 3: Results for Low Rate and Large Bank Interactions

(*continued*)

	AUS	CAN	CHL	CZE	DEU	FRA	NOR	POL	SWE	CHE
Non-interest income ($Non\text{-}II$)										
r	0.102***	0.091	0.028*	0.055**	–0.111	0.175***	–0.021***	0.045***	–0.128	–0.05***
$spread$	0.059***	0.113	0.031*	0.038	–0.158**	0.105**	–0.014*	0.044**	–0.046	–0.02
$large*r$	–0.037**	0.012	–0.001	0.053**	–0.029	0.115*	0.000	0.012	–0.062	–0.22**
$large*spread$	–0.048**	–0.045	0.021	0.045	0.029	0.112	–0.001	-0.009	–0.223	–0.20
$low*r$	–0.050**	1.190*	–0.016	–0.077	0.101	–0.234	0.077	0.126	0.312	0.09**
$low*spread$	–0.061***	0.367	–0.010	–0.007	0.105*	0.016	0.035	–0.097***	0.058	–0.02
$large*low*r$	0.074***	–0.864	–0.154*	0.183	–0.082	–0.120	0.123	–0.240	0.068	–0.08
$large*low*spread$	0.160**	–0.283	–0.063	–0.008	0.102	–0.276*	0.222	0.004	0.121	0.55
Observations	6,940	4,830	696	1,274	2,909	12,380	3,092	1,249	408	1,857
Within R^2	0.439	0.719	0.815	0.392	0.181	0.450	0.456	0.873	0.604	0.54
Loan-loss provisions (LLP)										
r	0.015***	0.031***	0.017	0.009	0.128	0.009***	0.062***	0.062**	0.017	0.00
$spread$	0.007*	0.024***	0.001	0.056***	0.138	0.009***	0.045***	0.102***	0.162	0.00
$large*r$	0.023***	–0.027***	0.012	–0.002	–0.075	–0.017***	–0.024	0.018	–0.028	0.07***
$large*spread$	0.078***	–0.026**	0.021	–0.030	0.042	–0.021***	–0.029	0.075	–0.081	–0.25**
$low*r$	–0.039***	–0.109**	0.055	0.269*	0.236*	–0.010	–0.235**	0.671**	–0.032	0.01
$low*spread$	0.008	0.010	0.033	0.006	–0.343**	–0.008	–0.157**	0.044	–0.119	–0.01
$large*low*r$	–0.050*	0.120**	–0.041	0.247	–0.064	–0.011	–0.354	0.018	–0.064	0.18**
$large*low*spread$	–0.155***	–0.001	–0.024	–0.029	0.101	0.030***	–0.379	–0.127	0.023	–0.13
Observations	6,940	4,830	696	1,274	2,909	12,380	3,092	1,249	408	1,857
Within R^2	0.083	0.894	0.845	0.944	0.189	0.160	0.157	0.886	0.356	0.24

Notes: ***, ** and * denote a positive coefficient and significance at the 1, 5 and 10 per cent levels, respectively. Explanatory variables are presented for regressions run with return on assets (ROA), net interest income (NIM), non-interest income ($Non\text{-}II$) and loan-loss provisions (LLP) separately. Coefficients on the lagged dependent variable, bank-level controls, macroeconomic controls as well as dummy variables for low , $large$, $low*large$ are omitted for brevity. Full regression results are available upon request.

Source: Contributing central banks

During low interest rate periods, and for most countries, the relationship between the short-term interest rate and NIMs is not statistically distinguishable from that during normal times. In fact, for France, Norway and Poland a further reduction in the cash rate from already low levels appears to have a relatively lower impact on NIMs. For larger banks operating in a low-rate environment, the available evidence tends to suggest that a further reduction in short-term interest rates has a relatively lower impact on NIMs for banks in Germany, France and Switzerland.[13] This is despite the distribution of liquidity in the euro area, which sees large banks from 'core' countries tending to hold large amounts of liquidity in the deposit facility, which should make them more sensitive to reductions in interest rates.[14] One explanation for this is the ECB's tiering scheme, which may have shielded larger euro area banks' NIMs, although this is unlikely to be a major driver of our results given it was introduced only towards the end of our sample period. Another factor that could have contributed to this result is the increase in high margin lending that was facilitated by the introduction of the Targeted Longer-Term Refinancing Operations II program (Jobst and Lin 2016). Between June 2016 and the end of the period studied, French and German banks could borrow up to 30 per cent of the volume of eligible private non-mortgage loans for a four-year period at the prevailing main refinancing operations (MRO) rate, which was 0 per cent. With lower short-term interest rates compressing NIMs, banks reacted by increasing loan volumes, which were funded at the MRO rate. The increase in volumes led to an increase in NIMs given the favourable spread between lending rates (positive) and the MRO rate (0 per cent).

Next, we examine the effect of policy rates that are not just briefly low but 'low-for-long'. In these regressions, we replace the 'low' dummy variable (a binary variable equal to 1 when interest rates are low and zero otherwise) with a low-for-long variable, equal to the number of time periods during which interest rates have been low. The motivation for doing this is that the nonlinear effects one may expect in a low interest rate environment may materialise with a delay, perhaps because interest rate hedges become less effective over time.[15] The results are reported in Table 4. To facilitate comparison with the low interest rate findings, Table 4 compares the coefficients for the variables of interest from both specifications: the low-for-long results are in bold, directly below the low interest rate coefficients as reported in Table 3. For brevity, we do not report the coefficients of the non-interacted variables (the interest rate, the yield curve, the dummy for large banks interacted with the interest rate and the yield curve) as they are almost identical to those of Table 3. These additional results are available upon request.

13 By contrast, for large Canadian banks, there is an interesting nonlinearity: while a rate reduction in normal times does not appear to affect their profitability, a reduction from already low levels is detrimental. This suggests there could be limits to the benefits of diversification for larger Canadian banks.

14 The ECB deposit facility rate reached zero in July 2012; it became negative in 2014; and was set to –0.40 per cent in 2016 and –0.5 per cent in 2019.

15 Here we are assuming the marginal impact of being in a low-rate environment changes linearly with the amount of time spent in the low-rate environment. If the impact is nonlinear then it is unclear whether the dummy or our linear variable is a better approximation of the true nonlinear effect.

Table 4: Results Comparing the Low and Low-for-long (LFL) Rates

	AUS	CAN	CHL	CZE	DEU	FRA	NOR	POL	SWE	CHE
Net interest margin (*NIM*)										
low∗r	–0.024	0.069	0.184***	–0.182	0.111	–0.012***	–0.219**	–0.531*	0.319	–0.04
LFL	**0.006*** **	**0.008**	**0.060** **	**0.478**	**0.024*** **	**0.125*** **	**–0.105***	**–0.090**	**–1.510***	**–0.07*** **
low∗spread	–0.040***	0.191**	0.076***	0.009	0.025	–0.002	–0.273***	–0.039	0.382*	–0.01
LFL	**–0.005*** **	**0.040** **	**0.030*** **	**–0.029**	**0.003**	**–0.043*** **	**–0.099*** **	**–0.002**	**omitted**	**–0.01** **
large∗low∗r	–0.002	0.270*	0.052	0.254	–0.215***	–0.026***	0.589	0.336	–0.294	–0.78***
LFL	**0.003**	**–0.000**	**0.050***	**1.050***	**–0.249***	**0.031**	**–0.031**	**0.031**	**–0.140**	**–0.12**
Return on assets (*ROA*)										
low∗r	0.008	0.280	0.026	–0.045	0.453**	–0.051	–0.014	–0.116	0.556**	0.04
LFL	**0.009*** **	**0.021**	**0.002**	**–0.770**	**0.967** **	**–0.010**	**–0.057**	**–0.146**	**–0.348**	**0.00**
low∗spread	–0.021	0.207	–0.011	–0.050	–0.197	0.048*	–0.272**	–0.029	–0.271	0.07
LFL	**–0.005*** **	**0.026**	**–0.002**	**–0.009**	**–0.135**	**0.017**	**–0.095** **	**–0.001**	**omitted**	**0.00**
large∗low∗r	0.010	0.029	–0.105**	0.396	–0.356	–0.003	0.288	0.071	–0.183	–0.05
LFL	**0.002**	**0.008**	**–0.042** **	**0.991**	**–0.660**	**0.004**	**–0.054**	**–0.084**	**0.035**	**0.37*** **
Non-interest income (*Non-II*)										
low∗r	–0.050**	1.190*	–0.016	–0.077	0.102	–0.234	0.077	0.126	0.312	0.09**
LFL	**–0.001**	**0.123**	**–0.012**	**0.381**	**–0.195**	**0.084**	**0.017**	**–0.053**	**–0.713**	**0.01**
low∗spread	–0.061***	0.367	–0.010	–0.007	0.105*	0.016	0.035	–0.097***	0.058	–0.02
LFL	**–0.006*** **	**0.051**	**–0.003**	**–0.024**	**–0.111*** **	**–0.010**	**0.006**	**–0.007*** **	**omitted**	**–0.01**
large∗low∗r	0.024	–0.864	–0.154*	0.183	–0.082	–0.120	0.123	–0.240	0.068	–0.08
LFL	**0.001**	**–0.111**	**–0.057**	**1.086** **	**–0.331**	**0.036**	**0.058**	**–0.234**	**0.069**	**0.06**
Loan-loss provisions (*LLP*)										
low∗r	–0.039***	–0.109**	0.055	0.269*	0.236*	–0.010	–0.235**	0.671**	–0.032	0.01
LFL	**–0.007*** **	**–0.019*** **	**0.019**	**0.555*** **	**0.931*** **	**0.001**	**–0.058***	**0.427** **	**0.354**	**–0.01**
low∗spread	0.008	0.010	0.033	0.006	–0.343**	–0.008	–0.157**	0.044	–0.119	–0.01
LFL	**0.003*** **	**0.007***	**0.013**	**–0.024**	**–0.114**	**–0.004***	**–0.038***	**0.003**	**omitted**	**–0.00**
large∗low∗r	–0.088***	0.120**	–0.041	0.247	–0.064	–0.011	–0.354	0.018	–0.064	0.19**
LFL	**–0.002**	**0.020** **	**–0.003**	**0.495** **	**–0.007**	**–0.012** **	**–0.165**	**–0.247**	**–0.101**	**–0.14*** **

Notes: ***, ** and * denote a positive coefficient and significance at the 1, 5 and 10 per cent levels, respectively. Explanatory variables are presented for regressions run with return on assets (*ROA*), net interest income (*NIM*), non-interest income (*Non-II*) and loan-loss provisions (*LLP*) separately. Coefficients are only presented for the interaction term of interest. Full regression results are available upon request.

Source: Contributing central banks

The main takeaway from Table 4 is that the results using the low-for-long variable are qualitatively similar to those using the low dummy. Starting with the effect on the NIM in the top panel, the coefficient of the interacted variable is significant for more countries using the low-for-long variable, suggesting that the effect of low interest rates on NIMs is nonlinear and larger when rates have been kept low for a while. In the case for Australia, Chile, Germany and France, NIMs decline as rates are kept lower-for-longer; however, for Norway, Sweden and Switzerland the reverse is true. For the other dependent variables (discussed in more detail in the next section) there is some weak evidence that the impact of a rate reduction on ROA starts to exert itself slightly more after a period of time (e.g. for smaller Australian and German banks). But overall, the results using the low-for-long variable are similar to those using the low dummy for both ROA and LLPs. For Non-II, there is no evidence of lower-for-longer impacts.

Finally, there is mixed evidence that negative rates exacerbate the detrimental impact of low interest rates on banks' NIMs. In two of the four jurisdictions that have implemented negative short-term interest rates, the marginal impact of a cut to the interest rate is significantly larger in negative-rate environments (Table 5). For German banks, by contrast, a further cut to the short-term rate when it is already negative has a beneficial impact on larger banks' NIMs. For smaller banks, it is the opposite.

One important caveat to this analysis is the limited within-country variation in policy rates once they reach the zero lower bound, which makes it harder to identify the effect on the dependent variable. As a consequence, results need to be interpreted with caution. Still, the results indicate that there is no clear-cut nonlinearity below zero, which is consistent with the mixed findings from the existing literature.

Table 5: Results with Negative Rate and Large Bank Interventions

	DEU	FRA	SWE	CHE
		Net interest margin (NIM)		
r	0.018	0.036***	–0.331***	0.12***
$spread$	0.142***	0.143***	–0.623***	0.10***
$large * r$	–0.010	0.018**	0.164	0.04
$large * spread$	–0.096***	–0.009	0.347	0.30**
$neg * r$	0.476***	0.181**	–0.311	0.06
$neg * spread$	0.013	–0.142***	0.163	–0.15
$large * neg * r$	–0.484***	0.147	–0.331	–0.32
$large * neg * spread$	0.019	–0.124*	–0.425	–0.15
Within R^2	0.473	0.680	0.491	0.74
		Return on assets (ROA)		
r	–0.002	0.041***	0.190	–0.02
$spread$	0.105	–0.006	0.694***	–0.04*
$large * r$	0.090**	–0.004	–0.050	–0.28
$large * spread$	0.027	–0.002	–0.405	0.26*
$neg * r$	0.409	0.125	1.473**	0.01
$neg * spread$	–0.231*	0.076	0.101	–0.02
$large * neg * r$	0.416	0.009	0.372	0.18
$large * neg * spread$	0.113	–0.017	0.691	–0.25
Within R^2	0.085	0.250	0.177	0.19
		Non-interest income ($Non\text{-}II$)		
r	–0.009	0.102***	0.130	–0.06
$spread$	–0.036	0.035	0.264	–0.01
$large * r$	–0.013	0.042	–0.105	–0.02
$large * spread$	0.018	–0.052	–0.211	–0.09
$neg * r$	–0.529***	0.225	0.916*	–0.07
$neg * spread$	–0.121**	–0.246	0.274	–0.01
$large * neg * r$	0.480**	0.168	0.385	0.10
$large * neg * spread$	0.241	0.303	0.261	0.05
Within R^2	0.185	0.450	0.604	0.55
		Loan-loss provisions (LLP)		
r	0.033	0.004**	0.022	–0.01
$spread$	0.022	0.003	0.167	–0.00
$large * r$	0.103***	–0.003	–0.044	0.07
$large * spread$	0.118**	–0.005	–0.082	–0.02
$neg * r$	0.370	–0.044	–0.006	–0.02
$neg * spread$	–0.214*	–0.021	–0.106	0.01
$large * neg * r$	0.531	–0.061	–0.258	–0.30
$large * neg * spread$	–0.103	0.163***	–0.092	0.18
Within R^2	0.182	0.170	0.356	0.24

Notes: ***, ** and * denote a positive coefficient and significance at the 1, 5 and 10 per cent levels, respectively. Explanatory variables are presented for regressions run with return on assets (ROA), net interest income (NIM), non-interest income ($Non\text{-}II$) and loan-loss provisions (LLP) separately. Coefficients on the lagged dependent variable, bank-level controls, macroeconomic controls as well as dummy variables for neg , $large$, $low * large$ are omitted for brevity. Full regression results are available upon request.

Source: Contributing central banks

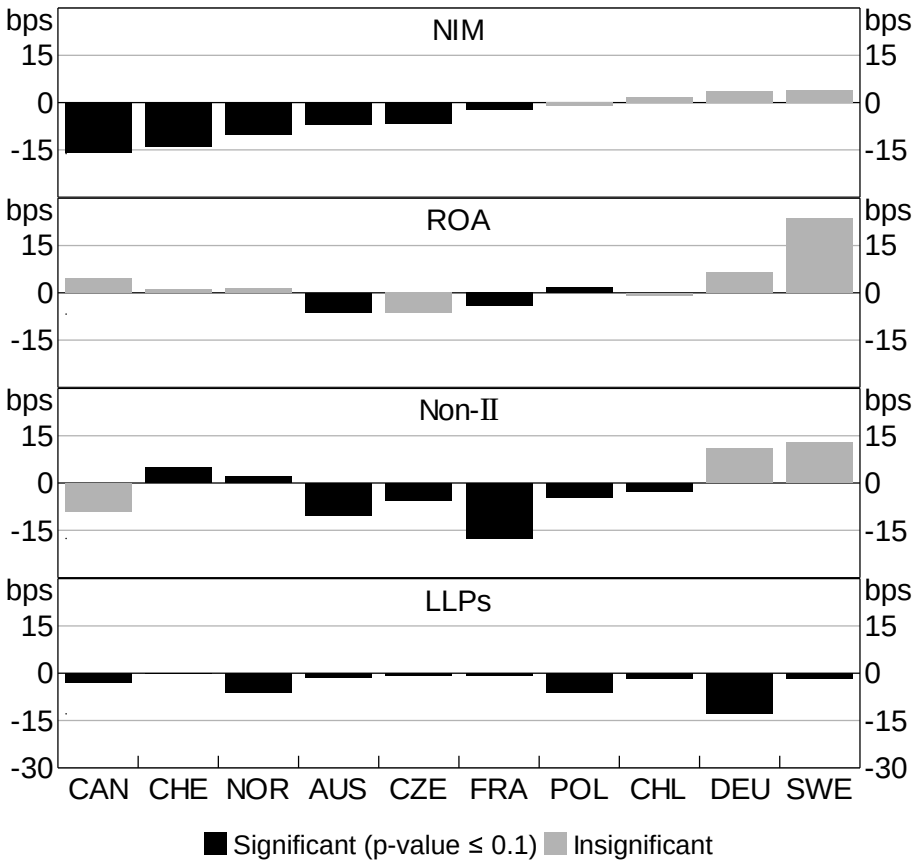
7.2 Overall bank profitability

In Section 7.1, we observed the relationship between short-term interest rates and banks' NIMs during normal times to be positive and significant, as expected. The effect of lower interest rates on overall bank profitability (as measured by banks' ROAs) is less clear owing to other mitigating factors.

Both Table 3 (second panel) and Figure 6 (second panel) show the results for our ROA regression. Our results confirm that there is not a clear-cut association between lower interest rates and overall bank profitability; for about half the sample a reduction in short-term interest rates lowers bank profitability, while for the other half it is associated with an increase in profits. The magnitude of the impact of monetary policy on overall profitability is modest. The largest impact among the 10 countries examined is that a 100 basis point fall in the short-term interest rate is associated with a 6 basis point reduction in smaller banks' ROAs in the short run. These estimates would be smaller still if one were to add back any effects that operate indirectly through monetary policy's effect on aggregate demand.

Figure 6: Effect of Monetary Policy

Impact of a 100 basis point cut to the policy rate for smaller banks in a normal rate environment



Note: AUS: Australia; CAN: Canada; CHL: Chile; CZE: Czech Republic; FRA: France; DEU: Germany; NOR: Norway; POL: Poland; SWE: Sweden; CHE: Switzerland.

Source: Contributing central banks

There is only limited evidence that Non-II has played a counterbalancing role (Table 3, third panel; Figure 6, third panel). That is, there is no consistent result across countries indicating that non-interest income increases as interest rates fall, either owing to one-off revaluations of long-term assets or banks shifting their business towards non-interest sources of income. Nor does the non-interest income effect appear to be significantly different for larger banks or during low-rate periods.

Our results do, however, show that lower rates uniformly lower LLPs by reducing debt-servicing burdens on the stock of existing debt (Table 3, fourth panel; Figure 6, fourth panel). There is no evidence that this effect is meaningfully offset by an increase in risk-taking by banks during low-rate periods (i.e. a risk-taking channel of monetary policy), which would instead result in a positive and significant coefficient on LLPs.

There is considerable country-specific heterogeneity underlying these key results. Some of these *quantitative* differences are discussed in the next sub-section, including the impact on overall profitability when rates are negative.

To *qualitatively* inform some of the cross-country differences and unpack some of the attenuating factors that have enabled banks to maintain their level of overall profitability as short-term rates have fallen, we can turn to the insights received from our *qualitative survey.* Overall, the responses received point to a range of mitigating actions, including banks striving to become more cost efficient and streamlining their business models.

For example, starting first with Canada, responses from our survey indicate that banks whose NIM was affected by the low interest rate environment took considerable measures to safeguard profits by becoming more cost efficient, selling non-core underperforming businesses and pivoting to focus on higher growth areas in the short term. Moreover, in some cases, banks adjusted the pricing of assets/liabilities to preserve spread (e.g. lower deposit rates) to mitigate the impact on margins.

For larger Swiss banks, the survey noted that fee and commission income accounts for the largest share of their operating income, with revenues coming mostly from wealth and asset management businesses. As such, their overall profitability was less affected by the impact of the low-rate environment on interest rate margins and benefited from fee and commission revenue streams. For individual Swiss banks, the survey pointed to evidence of search-for-yield behaviour among smaller banks when interest rates were low and negative as they increased mortgage volumes and took on more risk. Some banks also grew their fee and commission business, particularly in the low interest rate environment.

The *qualitative survey* responses highlight that in Poland there was little discernible impact of lower rates on overall profitability due to banks increasing the share of more profitable credit products (e.g. consumer loans); a reduction in less profitable credit products; and a decrease of the interest on liabilities. The NIM in Poland remained relatively high compared to other EU countries, which was also related to the level of interest rates in Poland remaining significantly higher than the zero lower bound. In addition, while fee and commission margins have declined – in part due to statutory and regulatory activities aimed at increasing consumer protection by reducing the costs incurred by them – banks were able to reduce their operating costs partly through digitalising processes.

In Australia, lower rates do appear to lower bank profitability. However, the size of this effect is not economically significant. Several factors, highlighted in the *qualitative survey*, help to explain this result. Around one-third of Australian banks' funding comes from wholesale markets, which is a larger share than for many international banks. The cost of wholesale funding is not constrained by an effective zero lower bound in contrast to what has been observed for deposit interest rates internationally. Moreover, Australian banks tend to have interest rate hedges, which smooth profits and so delays the reduction in profits from falls in interest rates. Moreover, around three-quarters of Australian banks' assets are variable-rate loans that are funded with variable-rate deposits and other debt. The implication of this is that changes in the slope of the yield curve do not have a large impact on Australian banks' profits.

7.2.1 Overall bank profitability: quantitative results in more detail

At the individual country level, several channels are at play. In Canada, Switzerland and Norway there is suggestive evidence that banks have taken measures to offset the low-rate impact on NIMs to safeguard ROAs. That is, in these jurisdictions, the effect of lower interest rates on NIMs has not transferred through to ROAs (Table 3; Figure 6). For Switzerland and Norway, the effect on bank profitability of larger banks differs significantly from smaller banks, with larger banks benefiting from lower rates.

In the case of France, the rate impact on ROAs is almost double in size relative to the impact on NIMs. In the case of the Czech Republic, the magnitude of the rate impact on ROAs is similar in magnitude to that for NIMs but is not statistically significant. However, for the Czech Republic this result does not hold in the low-rate environment. Additional tests indicate that the positive association between NIMs and interest rates only holds when rates are increasing, suggesting banks in the Czech Republic shielded themselves against rate decreases, including through lower loan-loss provisions.

In negative interest rate regimes, we find no clear evidence that the impact of policy on overall profitability is any different, with exceptions for Germany and to some extent Sweden. In Germany, a decline in short-term interest rates reduces ROAs for smaller banks during the low interest rate regime, whereas it seems insignificant during the negative interest rate regime. The insignificant impact might arise from two sub-components of ROAs – the NIM and Non-II – that seem to counterbalance each other: on the one hand, smaller banks seemed to have safeguarded profits by increasing their Non-II (for example, fee and commission income), while on the other hand their NIM declined (Michaelis 2022). This suggests that small banks in Germany found means to shield overall profitability in the face of negative interest rates. The story is different for Sweden. Here, a rate cut during the negative interest rate regime reduces ROAs for smaller banks by much more than during the low interest rate regime.

8. Conclusion

This paper has provided an empirical analysis of the effect of lower interest rates on bank profitability – including differential responses when rates are very low – looking back at the period when central banks lowered interest rates to mitigate the risks of deflation. At the time, particular concerns were raised about possible nonlinear effects of low interest rates in the neighbourhood of the effective and zero lower bounds. Banks tend not to reduce deposit rates below a certain threshold, a threshold which may vary across jurisdictions and over time. Because of this, lower interest rates may significantly affect bank profitability near these bounds and hamper monetary policy transmission. It is therefore of utmost importance for policymakers and researchers to carefully assess the magnitude of this effect.

Based on bank-level data for 10 different countries, we have investigated these effects empirically with a consistent methodology between countries, focusing on different measures and components of profitability (NIM, ROA, Non-II and LLPs). A key takeaway from this investigation is that the effect of a decline in interest rates on bank profitability is small, economically speaking. The immediate effect of a 1 percentage point decrease in the short-term interest rate on NIMs is only 5 basis points. While this hides sizeable cross-country differences (and the long-run effect is closer to 15 basis points), the measured effect is lower than previous estimates.

We find some evidence of nonlinearities in low interest rate environments, but only for a handful of countries in the sample. More importantly perhaps, we find that the effect of low interest rates on ROAs is smaller than on NIMs, suggesting that banks have found ways to offset the effect of lower interest rate margins. In addition, holding interest rates 'lower for longer' does not appear to change the results noticeably. Similarly, focusing on the countries that moved interest rates into negative territory yields coefficients that are not economically large. Overall therefore, the evidence presented here points to smaller effects of falling and low policy rates on bank profitability than previously estimated.

Appendix A: Summary of Selected Bank-level Papers

Table A1: Summary of Selected Bank-level Papers

Paper	Sample	Data	Method	Main findings
Borio, Gambacorta and Hofmann (2017)	• Sample: 14 advanced economies • Banks: 109; large international • Time period: 1995–2012	BankScope	Dynamic panel regressions	• Lower rates are associated with lower profits • Lower rates lower net interest income, which more than offsets positive impact on non-interest income and loan-loss provisions
Claessens, Coleman and Donnelly (2018)	• Sample: 47 countries • Banks: 3,385 • Time period: 2005–13	BankScope	Panel with FE regressions	• Lower interest rates lower bank profitability • Impact is larger for net interest margins compared to overall profitability
Altavilla, Boucinha and Peydró (2018)	• Sample: euro area • Banks: 288 • Time period: 2000–16	iBSI; BankScope; SNL Financial; Bloomberg; Capital IQ	Panel with FE regressions	• Lower rates have a negative impact on net interest margins, which is offset by a positive impact on loan-loss provisions • Lower rates are not associated with lower profits if current and expected economic and financial conditions are controlled for
Bikker and Vervliet (2018)	• Sample: US • Banks: 3,582 • Time period: 2001–15	Federal Deposit Insurance Corporation	Panel GMM estimation	• Lower interest rates compress net interest margins, but lower loan-loss provisions • Lower rates are not associated with lower profits
Molyneux, Reghezza and Xie (2019)	• Sample: 33 OECD countries • Banks: 7,352 • Time period: 2012–16	Orbis BankFocus; SNL Financial	Panel DiD regressions	• Bank margins and overall profitability fared worse in countries with negative interest rate policies • Large banks were able to mitigate negative effects; stronger adverse effects were found in countries with more competitive banking systems
Lopez, Rose and Spiegel (2020)	• Sample: 27 European countries and Japan • Banks: 5,200 • Time period: 2010–17	Fitch Global Banking	Panel with FE regressions	• Negative rates lower net interest income • This impact largely offset by increases in non-interest income stemming from 'other income' sources, such as capital gains on securities
Beauregard and Spiegel (2020)	• Sample: 27 European countries and Japan • Banks: 5,300 • Time period: 2010–18	Fitch Global Banking	Panel with FE regressions	• A protracted period of negative rates reduces bank profitability, primarily due to banks' reluctance to pass negative rates along to retail depositors

References

Alessandri P and BD Nelson (2015), 'Simple Banking: Profitability and the Yield Curve', *Journal of Money Credit and Banking*, 47(1), pp 143–175.

Altavilla C, M Boucinha and J-L Peydró (2018), 'Monetary Policy and Bank Profitability in a Low Interest Rate Environment', *Economic Policy*, 33(96), pp 531–586.

Baldo L, B Hallinger, C Helmus, N Herrala, D Martins, F Mohing, F Petroulakis, M Resinek, O Vergote, B Usciati and Y Wang (2017), 'The Distribution of Excess Liquidity in the Euro Area', European Central Bank Occasional Paper Series No 200.

Basten C and M Mariathasan (2018), 'How Banks Respond to Negative Interest Rates: Evidence from the Swiss Exemption Threshold', CESifo Working Paper No 6901.

Beauregard R and MM Spiegel (2020), 'Commercial Banks under Persistent Negative Rates', *FRBSF Economic Letter* No 2020-29.

Bikker JA and TM Vervliet (2018), 'Bank Profitability and Risk-Taking under Low Interest Rates', *International Journal of Finance & Economics*, 23(1), pp 3–18.

Borio C, L Gambacorta and B Hofmann (2017), 'The Influence of Monetary Policy on Bank Profitability', *International Finance*, 20(1), pp 48–63.

Borio C and H Zhu (2012), 'Capital Regulation, Risk-Taking and Monetary Policy: A Missing Link in the Transmission Mechanism?', *Journal of Financial Stability*, 8(4), pp 236–251.

Brassil A (2022), 'The Consequences of Low Interest Rates for the Australian Banking Sector', RBA Research Discussion Paper No 2022-08.

Brunnermeier MK and Y Koby (2018), 'The Reversal Interest Rate', NBER Working Paper No 25406.

Busch R and C Memmel (2015), 'Banks' Net Interest Margin and the Level of Interest Rates', Deutsche Bundesbank Discussion Paper No 16/2015.

Cetorelli N and LS Goldberg (2012), 'Banking Globalization and Monetary Transmission', *The Journal of Finance*, 67(5), pp 1811–1843.

CGFS (Committee on the Global Financial System) (2018), *Financial Stability Implications of a Prolonged Period of Low Interest Rates*, CGFS Papers No 61, Bank for International Settlements, Basel.

Claessens S, N Coleman and M Donnelly (2018), '"Low-for-Long" Interest Rates and Banks' Interest Margins and Profitability: Cross-Country Evidence', *Journal of Financial Intermediation*, 35(Part A), pp 1–16.

Draghi M (2019), 'Monetary Policy in the Euro Area', President's Address to 'The ECB and Its Watchers XX' Conference, Frankfurt am Main, 27 March.

ECB (European Central Bank) (2021), 'An Overview of the ECB's Monetary Policy Strategy', ECB *Economic Bulletin*, 5/2021.

Gambacorta L and HS Shin (2018), 'Why Bank Capital Matters for Monetary Policy', *Journal of Financial Intermediation*, 35(Part B), pp 17–29.

Genay H and R Podjasek (2014), 'What Is the Effect of a Low Interest Rate Environment on Bank Profitability?', *Chicago Fed Letter* No 324.

Grossmann-Wirth V and B Hallinger (2018), 'Monetary Policy and Liquidity Concentration in the Euro Area', Eco Notepad Post No 93, Banque de France blog, 20 November, viewed August 2021. Available at <https://blocnotesdeleco.banque-france.fr/en/blog-entry/monetary-policy-and-liquidity-concentration-euro-area>.

Haldane A (2011), 'Control Rights (and Wrongs)', Wincott Annual Memorial Lecture, London, 24 October.

Hoffmann P, S Langfield, F Pierobon and G Vuillemey (2019), 'Who Bears Interest Rate Risk?', *The Review of Financial Studies*, 32(8), pp 2921–2954.

Holston K, T Laubach and JC Williams (2017), 'Measuring the Natural Rate of Interest: International Trends and Determinants', *Journal of International Economics*, 108(Supplement 1), pp S59–S75.

Jiménez G, S Ongena, J-L Peydró and J Saurina (2014), 'Hazardous Times for Monetary Policy: What Do Twenty-Three Million Bank Loans Say about the Effects of Monetary Policy on Credit Risk-Taking?', *Econometrica*, 82(2), pp 463–505.

Jobst A and H Lin (2016), 'Negative Interest Rate Policy (NIRP): Implications for Monetary Transmission and Bank Profitability in the Euro Area', IMF Working Paper No WP/16/172.

Lopez JA, AK Rose and MM Spiegel (2020), 'Why Have Negative Nominal Interest Rates Had Such a Small Effect on Bank Performance? Cross Country Evidence', *European Economic Review*, 124, Article 103402.

Michaelis H (2022), 'Going below Zero – How Do Banks React?', Deutsche Bundesbank Discussion Paper No 33/2022.

Molyneux P, A Reghezza and R Xie (2019), 'Bank Margins and Profits in a World of Negative Rates', *Journal of Banking & Finance*, 107, Article 105613.

Rajan RG (2006), 'Has Finance Made the World Riskier?', *European Financial Management*, 12(4), pp 499–533.

Rostagno M, C Altavilla, G Carboni, W Lemke, R Motto, A Saint Guilhem and J Yiangou (2019), 'A Tale of Two Decades: The ECB's Monetary Policy at 20', European Central Bank Working Paper Series No 2346.

Turk RA (2016), 'Negative Interest Rates: How Big a Challenge for Large Danish and Swedish Banks?', IMF Working Paper No WP/16/198.

Urbschat F (2018), 'The Good, the Bad, and the Ugly: Impact of Negative Interest Rates and QE on the Profitability and Risk-Taking of 1600 German Banks', CESifo Working Paper No 7358.