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How Do High Interest Rates Affect Banks: The Roles of Loan Losses and Macroprudential Policy

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ABSTRACT: This paper examines empirically how the effect of interest rates on the three components of bank profits – loan loss provisions, net interest margin, and non-interest income – varies depending on bank characteristics and the macroprudential policy environment. A new finding is that higher interest rates lead to larger loan loss provisions for banks offering flexible-rate loans, but that this effect is attenuated when macroprudential borrower-based measures have been tight in preceding years. Tighter macroprudential settings also reduce the effect of higher unemployment on loan loss provisions recorded by banks, and thereby the negative impact of unemployment on profitability. Moreover, we find significant heterogeneity across banks: banks with strong risk appetite that extend loans at flexible rates are adversely affected by higher interest rates, as the effect on loan losses dominates the effect on the interest margin, while the profitability of other banks benefits on average from higher interest rates.

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WORKING PAPERS

How Do High Interest Rates Affect Banks: The Roles of Loan Losses and Macroprudential Policy

Prepared by Romain Bouis, Sumaiyah Mirza, and Erlend Nier[1]

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1. Introduction

As monetary policy rates moved up globally to contain inflationary pressures in the wake of the COVID-19 crisis, higher interest rates have been accompanied by mixed effects for banking sector stability. Some banks experienced a sharp drop in the valuation of their assets, as the value of long-dated fixed income securities fell when interest rates rose, leading to runs on banks (e.g., Silicon Valley Bank in March 2023), especially for banks with uninsured deposits (Drechsler et al. 2023). Higher interest rates were also expected to increase the debt service burden of borrowers, which may, with some lag, translate into higher loan defaults and loan loss provisions (IMF 2023), and some countries did see loan delinquencies rising in both the consumer and corporate segments of the credit markets. However, higher interest rates also bolstered net interest margins in several countries as banks' deposits repriced more slowly than loans. This supported bank profits and contributed to strengthening financial stability by improving banks' ability to generate capital internally through retained earnings.

Against this backdrop, this paper analyzes empirically the effect of interest rates on the three components of bank profitability – loan loss provisions, net interest margin, and non-interest income – and through these effects on overall bank profitability. Our empirical approach uses a cross-country panel of banks, allowing us to examine the roles of bank characteristics and macroprudential policies in determining the strength of the impact of higher interest rates on bank profitability, and ultimately on banking system stability.

An important contribution of this study is to explore the role of macroprudential policy in attenuating the effect of higher interest rates and other macroeconomic shocks on loan loss provisions. The rise in loan loss provisions following higher interest rates should be less pronounced when tight borrower-based measures have been in place ahead of the period of high rates, especially for floating-rate loans, which are the most likely to be directly affected by higher interest rates, or ahead of the higher unemployment that could ensue when interest rates rise.

We introduce a newly built index of the restrictiveness of borrower-based measures (BBMs) to analyze whether these measures can mitigate the effect of higher interest rates on loan loss provisions. In contrast to existing indices of macroprudential policy that mainly track tightening and loosening actions through time, our index aims to reflect the level of restrictiveness at any given point in time. This annual index is based on information from the IMF Macroprudential Policy Survey and the integrated Macroprudential Policy (iMaPP) databases, which we validate by using information from reports of IMF Financial Sector Assessment Programs (FSAPs).

By examining the potential drivers of the relationships between interest rates and each of the components of bank profitability, we aim to highlight groups of banks that are more vulnerable to higher interest rates. For example, we expect a higher interest rate to have a larger impact on loan loss provisions of banks with a large stock of loans at floating rates, by raising more strongly the probability of default of their existing borrowers, and for banks with low market shares, as these banks may have incentives to make riskier loans to grow their market share. Such negative effects should however be mitigated by a higher net interest margin, especially for banks funded mainly via core deposits rather than in wholesale markets.

The econometric analysis uses an unbalanced panel of annual bank-level data from Fitch Connect covering more than 2,100 banks in 31 countries (24 advanced economies (AEs) and 7 emerging market economies (EMEs)) from 1995 to 2023. We employ dynamic panel regressions, similar to the specifications in Borio et al.

(2017) or Claessens et al. (2018), using time and bank fixed effects and relating the components of profitability to the level of the interest rate at an annual frequency.[2]

Our main results confirm that bank business characteristics, such as a bank's market share and risk appetite (proxied by average NPL ratios), have a significant effect on the relationship between the interest rate and the components of bank profitability. Moreover, the effect on banks of higher interest rates is strongly affected by the macroprudential policy environment. More specifically:

- Loan loss provisions (as a share of average total assets) are found to increase with the interest rate, especially for banks with a high proportion of flexible-rate loans, and for banks with a smaller market share. Importantly, the effect of the interest rate on loan loss provisions is affected by the restrictiveness of BBMs ahead of the increase in the interest rate: provisions are increasing with the interest rate, especially when banks have a high share of floating rate loans, but this effect is mitigated when BBMs have been restrictive in the years preceding high rates. Moreover, we find that BBMs reduce the impact of unemployment on provisions for all types of loans (at both fixed and floating rates): a higher unemployment rate is increasing loan loss provisions but less so if BBMs have been tight in the preceding years.

- The net interest margin (interest income minus interest expense as a share of average total assets) increases with the interest rate for all banks, but the strength of this effect is subject to significant heterogeneity across banks. First, the net interest margin of banks with a large share of deposits in their funding benefits more from higher interest rates. Second, increases in the net interest margin are reduced for banks with high average non-performing loan (NPL) ratios that extend loans at flexible rates.

- The non-interest income (as a share of average total assets) decreases with the interest rate, in line with a drop in the value of securities held by banks, and much more among banks with a high proportion of held-for-trading (HFT) securities (whose values are marked to market). The non-interest income of banks with a high share of liquid assets is less sensitive to the interest rate, consistent with the idea that banks do not need to sell held-to-maturity (HTM) securities and recognize losses when they hold enough liquidity.

- Bank profitability, as measured by the return on assets (ROA), increases on average with the interest rate but again with significant heterogeneity across banks. The net effect of higher interest rates on the ROA of banks extending loans at flexible rates is negative for banks with higher average NPLs, but it remains positive for other banks. In line with the results for loan loss provisions, borrower-based macroprudential measures are found to mitigate negative effects on profitability of higher interest rates – for banks extending loans at flexible-rates – and of higher unemployment, more generally.

Overall, our findings contribute to the existing literature by identifying characteristics of banks for which higher interest rates can be associated with a decline in profitability, and thereby with a higher risk of failure or weakness that could require interventions by central banks and other authorities (see Bouis et al. 2025).[3]

[2] A few papers analyze the dynamics of bank profitability in response to an interest rate shock (e.g., English et al. 2018), using quarterly series. Given our large cross-country sample covering all types of banks – including unlisted, small institutions – only annual data are available, precluding exploring properly the dynamic effects of an interest rate shock. Our analysis focuses instead on the long-term relationship between profitability and the level of interest rate, as in Borio et al. (2017) or Claessens et al. (2018).

[3] Lower bank profitability is indeed a strong predictor of bank failures, as found by Correia et al. (2024) for a large sample of US banks, while regressions for our cross-country sample of banks indicate that the profitability of banks starts decreasing several years before the failure.

Our paper also offers novel findings pointing to the effectiveness of macroprudential measures in reducing the impact of adverse shocks on banking system stability. We find that macroprudential BBMs have important benefits in reducing loan losses due to higher interest rates. BBMs appear also to mitigate the effects of other adverse macroeconomic shocks on loan losses and profitability, thereby contributing to financial stability more broadly. These findings are robust to using various models and sample compositions.

The rest of the paper proceeds as follows. Section 2 discusses further our contributions to the literature and the conceptual framework of the paper. Section 3 outlines the econometric approach, the construction of the variables, and the data. Section 4 presents the results of the regressions for each component of profitability and Section 5 some robustness checks. Section 6 concludes.

2. Literature and conceptual framework

2.1 Contributions to the literature

This study contributes to a recent literature that explores empirically the effect of monetary tightening on financial stability by studying a range of outcome variables. Some of these studies focus on individual countries. For example, using administrative data on new bank loans to businesses and their defaults in Spain since 1995, Jiménez et al. (2022) find that a 1-percentage point increase in the policy rate in the year after loan origination raises the probability of loan default by 14.4 percent, and that the effect is much stronger for banks with weaker balance sheets (as reflected by high NPLs). Jiang et al. (2024) focus on bank fragility in the US resulting from mark-to-market losses during the Fed's monetary policy tightening from 2022Q1 to 2023Q1. They identify banks with high asset losses, low capital, and high uninsured leverage, as the most fragile.

Some other papers analyze the effect of monetary tightening on financial stability using cross-country panel data, that is, with data varying across countries and time. Boissay et al. (2023) for instance examine the conditions under which monetary policy tightening is more likely to be followed by financial stress across 157 monetary tightening episodes for advanced economies (AEs) and emerging market economies (EMEs) since 1970. They find that high private debt-to-GDP ratios at the time of the first hike increases the likelihood of financial distress in the subsequent years. Over an even longer time span starting from 1870 and for a sample of 17 countries, Jiménez et al. (2022) find that banking crises tend to be preceded by a U-shaped monetary policy rate pattern: monetary tightening increases crisis risk, but primarily if it is preceded by a period of sustained rate cuts accompanied by high credit growth.

Complementing this literature, we study effects in a cross-country bank-level panel, and focus on outcomes that can be observed at the bank level, including loan loss provisions, which capture the losses incurred by banks on their loan exposures, and the development of bank profits overall, including the net interest margin and non-interest income. This allows us to study whether adverse outcomes to some of these components are offset by others, so that overall profitability may be more resilient to increases in interest rates. It also allows us to examine a range of bank characteristics that may shape the effect of higher interest rates for each of the relevant components, including importantly the extent to which a bank's loan is at fixed or variable rates.

The empirical literature on the effect of interest rates on bank profitability (measured by the ROA) tends to find a concave relationship between the two variables. Low interest rates depress bank profits by reducing the margin between loan and deposit rates. An increase of interest rates from low levels therefore initially supports profitability, by boosting the net interest margin. But further rate increases can lead to loan losses and weigh on

the non-interest income (mainly by reducing the value of securities held by the banks), weakening the effect of interest rates on profitability.

Using a sample of 109 large international banks headquartered in 14 major advanced economies for the period 1995–2012, the seminal study by Borio et al. (2017) finds that bank profitability, measured by the ROA, increases with the level of the interest rate, suggesting that the positive impact of the interest rate on the net interest margin dominates the negative one on loan loss provisions and the non-interest income. They also find that the impact on profitability declines with the level of interest rates, although the effect is measured to remain positive for the average bank. Complementing these findings, Claessens et al. (2018) report for a sample of 3,385 banks from 47 countries from 2005 to 2013 that lower interest rates reduce the net interest margin and the ROA, and more strongly in a low than in a high-interest rate environment, especially for the net interest margin.

The effects of interest rates on bank net interest margin and profitability are complex in part because changes in interest rates not only affect rates but also volumes of loans and deposits (Pérez Montes and Ferrer, 2018). English et al. (2018) for example find that higher interest rates initially increase net interest margins and ROAs of US banks, as in Borio et al. (2017), but that these positive effects dissipate and even reverse over time, as higher interest rates reduce the volume of core deposits relative to more expensive non-core liabilities. Eichenbaum et al. (2024) find for the US that the response of banks' net interest margin to monetary tightening is state-dependent: after a period of low policy rates, a contractionary monetary policy shock leads to a significant rise in the net interest margin, while after a period of high policy rates, a further contractionary monetary policy shock leads to a fall.

Finally, some papers argue that banks match asset and liability exposures so that the net interest margin can become insensitive to fluctuations in the interest rate. Accordingly, Drechsler et al. (2021) find for a sample of more than 18,000 US commercial banks from 1984 to 2017 that the sensitivities of interest income and expense match bank-by-bank, implying that banks' net interest margin is essentially unexposed to interest rate risk. In a related study, Bergant et al. (2025) examine the effect of inflation and of monetary policy changes unrelated to inflation, on bank profitability and its components for a sample of more than 6,600 banks in 59 countries over 1995-2022. They find that increases in monetary policy rates that are independent of inflation raise both provisions and the net interest margin, with the net effect on profitability being small on average.

In this context, an important contribution of our paper is to study heterogeneity across banks and banking systems in the effect of the interest rate on each of the three components of bank profitability (provisions, net interest margin, and non-interest income). In particular, we examine differences for the impact on loan losses as to whether loans are extended at fixed or at variable rates. We also assess whether effects on the net interest margin differ depending on the bank's funding model, its risk appetite, and its competitive position, as measured by its market share. And we finally examine the role of liquidity buffers and accounting conventions in shaping the effect on securities losses, as reflected in non-interest income.

These approaches expand on a limited number of existing studies that factor in heterogeneity of the effects. Gomez et al. (2021) note for instance that when monetary policy tightens, banks that issue a large share of interest-bearing deposits (that reprice or mature within one year) experience a decrease in earnings and that banks that lend mainly at floating rates will experience an increase. They find significant variations in the income gap (the difference between the interest rate sensitivities of a bank's assets and liabilities) across banks and note that this can affect loan volumes as banks do not fully hedge their exposure to interest rates.

Banks with a larger income gap can generate significantly larger earnings as the Fed Funds rate increases and also contract lending less than other banks do.[4]

Altavilla et al. (2018) also find that heterogeneity of bank balance sheet characteristics matters for the transmission of monetary policy to bank profitability. A steepening of the yield curve has a relatively more positive impact on profitability for banks that rely more heavily on maturity transformation activities (with a large maturity gap), while tighter policy can reduce profits relatively more for banks with lower asset quality (higher NPL ratio). Hoffmann et al. (2018) find for a sample of 104 banks in 18 euro area countries that banks' exposure to interest rate risk, as measured by the projected change in the net interest margin, is small on average, but heterogeneous, with banks operating in countries where mortgages are mainly at variable rates benefiting more from higher interest rates. Claessens et al. (2018) found that smaller banks are more sensitive to the interest rate than larger ones while Windsor et al. (2023) find limited evidence that the effect of interest-rate changes differs with bank size.

Sánchez Serrano (2024) offers detailed descriptive statistics for a sample of 103 European banks in the context of the July 2022 to September 2023 hiking cycle in the euro area. The paper finds that higher interest rates increased bank profits along an inverted-U shaped curve over time, mainly reflecting higher net interest income. With a few exceptions, the increase in net interest income dominates credit losses and the effect of losses from financial assets at fair value. Therefore, in general, higher interest rates are found to generate higher profits for banks, although a non-negligible share of banks reported losses, mainly because of their high share of loans at fixed rates or of debt securities at fair value. Unlike our study, Sánchez Serrano (2024) does not estimate interactions of bank characteristics with the interest rate, however, and focuses on the latest tightening episode for the euro area only. Finally, in a recent paper focusing on the US that is close to our analysis, Uppal (2025) finds that US banks with more flexible-rate loans experience higher net interest income but also higher loan losses in response to contractionary monetary policy shocks, while the net effect on profits is negative for those banks.

Our paper also makes novel contributions to the literature on the resilience effects of macroprudential policy. A growing literature surveyed by Biljanovska et al. (2023) has examined the transmission of macroprudential policy tools. While much of the early literature has focused on measuring the effects of these tools on credit growth and asset prices, some recent studies have turned to studying the resilience effect of these tools, that is, their ability to blunt the financial stability implications of adverse shocks, based on macro-level data. For instance, Brandao et al. (2020) find that macroprudential tools reduce tail risks to GDP when they are implemented preemptively. Boissay et al. (2023) also find that macroprudential policies implemented before or after the initial interest rate hike of the monetary policy tightening episode can reduce the likelihood of financial stress. We complement this literature by using bank-level data and examining in detail the effect of borrower-based macroprudential tools on the loan loss provisions recorded by banks in the event of adverse macroeconomic shocks. By assessing the effects of borrower-based measures (BBMs) on the resilience of banks, we also complement a small number of studies that assess the impact of BBMs on borrowers' default

[4] Banks could hedge the interest rate risk by means of interest rate derivatives. However, the literature indicates that this practice is in general limited (e.g., Purnanandam, 2007 or Vuillemey, 2019 for the US and Hoffmann et al., 2018 for banks in the eurozone), and that when banks use hedges, these have limited effect on interest-rate risk. Gomez et al. (2021) for example find that hedging does not significantly reduce banks' balance sheet exposure to interest-rate risk, a finding also holding for the largest banks, consistent with results by Vickery (2008) and Begeneau et al. (2012).

rates using loan-level information or household survey data (Gross and Población 2017; Dirma and Karmelavičius 2025; Nier et al. 2019).

Overall, the existing literature on bank profitability and interest rates finds a concave relationship between the two variables, which may vary across banks, but which is generally found to remain positive for the average bank. In this paper, we analyze further the transmission of interest rates to bank profitability by examining impacts on each of the three components of bank profits (loan loss provisions, net interest margin, and non-interest income) and investigating heterogeneity arising from banks' characteristics. This helps answer under which conditions and for which type of banks high interest rates can be associated with increased financial stability risks. Such findings may be useful for central banks looking to prepare for risks that may materialize when policy rates are hiked. Finally, we link the literature on bank profitability with that on the effectiveness of macroprudential policy, by studying whether losses are better contained and profits better supported in countries where macroprudential policies were brought in ahead of the increase in interest rates. This holds implications for macroprudential policymakers that may want to contain such risks ex ante.

2.2 Conceptual framework

Bank profitability is traditionally measured by the pre-tax return on assets, which is made up of three main components, all expressed as a share of total assets:

$$Return\ on\ Assets = Net\ Interest\ Margin + Net\ Non\text{-}Interest\ Income - Loan\ Loss\ Provisions,$$

where the net interest margin is equal to the bank's interest revenue minus its interest expenses; the net non-interest income is composed of the changes in the valuation of securities held by the bank and of fees and commissions (related to loans and deposits or to investment banking activities like trading or mergers and acquisitions) minus the non-interest expenses (mainly personnel expenses and other operating expenses); and loan loss provisions represent the amount of money set aside by the bank to cover potential losses from defaulted loans.

In this paper, we hypothesize that the effect of interest rates on each of loan loss provisions, the net interest margin, and the non-interest income can be heterogeneous, reflecting bank business models and macroprudential settings, as explained below.

2.2.1 Loan loss provisions

The need to make loan loss provisions represents a key risk to bank profits that is increasing with the interest rates. Loan loss provisions are expected to increase with the interest rate through at least two channels: first, higher interest rates can increase the debt service of borrowers who carry flexible-rate loans, thereby pushing up the numerator of a borrower's debt-service-to-income ratio; second, higher interest rates can also lead to higher unemployment and thereby lower household incomes, then reducing the denominator of the debt-service-to-income ratio, which can lead to a greater risk of borrower defaults more generally (for both fixed- and variable-rate loans).

With higher interest rates, loan loss provisions are therefore expected to increase more for loans at flexible rates compared to those at fixed rates. Moreover, both effects should be stronger when loan quality is low, such as when loans have been extended in the past years to more vulnerable borrowers by fast-growing or low-market-share banks. Risks to bank profitability via higher loan loss provisions were particularly high during the GFC as many banks extended low-quality loans, especially in the US where there had been strong increases in the share of subprime mortgages.

Finally, we may expect borrower-based measures, such as limits on loan-to-value (LTV) and debt-service-to-income (DSTI) ratios, or amortization requirements, to play a key role in mitigating the effect of higher interest rates on loan loss provisions. This would occur as BBMs guard against an erosion of underwriting standards and reduce the leverage of borrowers, then making it more likely that the borrowers can continue to service debt even after shocks to the interest due, or to the income available to service the debt.

2.2.2 Net interest margin

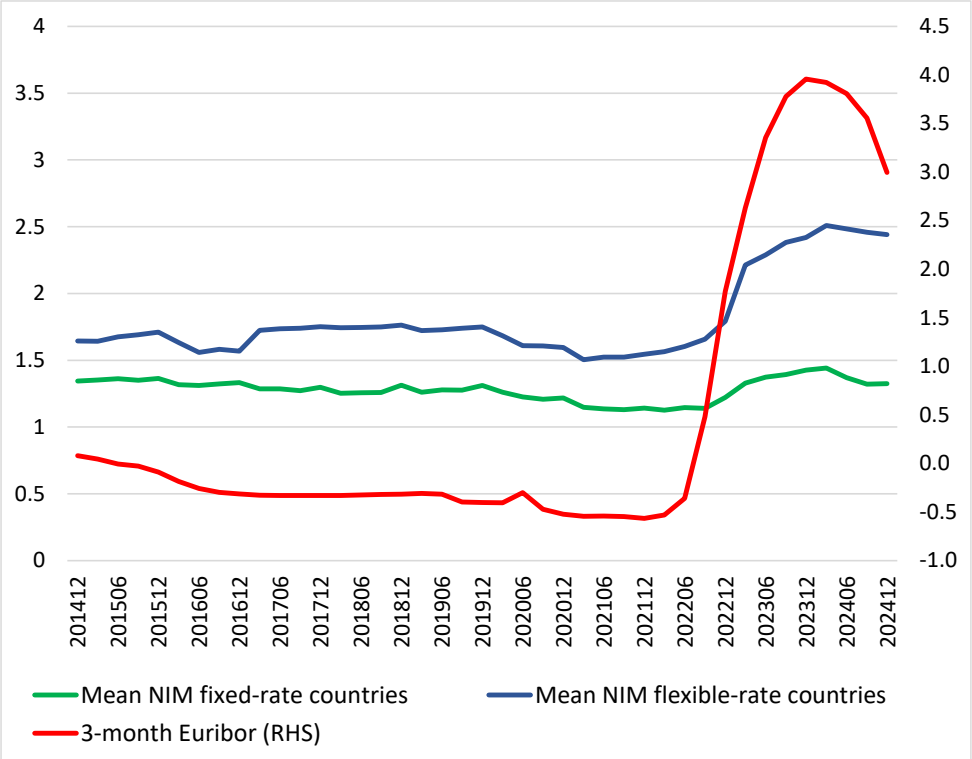
The net interest margin is usually increasing with the interest rate, but the relationship between the two variables can be complex, due to price and volume effects. More precisely:

- A higher interest rate raises the cost of liabilities but also the income from interest-earning assets, giving rise to price effects. On the asset side, interest revenue from loans increases more when loans are at flexible rates. In line with this idea, for instance, the net interest margin of banks of euro area countries where mortgages are mainly extended at flexible rates benefited more from the latest monetary tightening than the net interest margin of banks of countries where mortgages are predominantly extended at fixed rates (Figure 1), an observation in line with the findings of Hoffmann et al. (2018). On the liability side, funding costs increase when deposit rates reprice, and such repricing is in general faster for banks with a high share of funding in wholesale markets via certificates of deposits, interbank loans, or floating-rate securities. It is also likely that in countries where loans to the non-financial sector are mainly extended at flexible rates, banks are funded through loans at flexible rates, raising their exposure to interest rate risk. Historically, overreliance by some banks on certain types of wholesale funding and increasing costs of rolling over such funding played a key role in several crises, including the GFC (Oura et al. 2013). Overall, the risk to the net interest margin should be larger for banks extending loans at fixed rates and for those that use wholesale funding, at least with respect to price effects.[5]

- A higher interest rate can also affect the composition of banks' assets and liabilities, giving rise to volume effects. On the liability side, a higher interest rate can reduce the volume of core deposits, especially in banking systems where bank customers can move their deposits to alternative higher-return savings products (like certificates of deposit, bonds, or money market funds). This pushes banks to use more expensive wholesale funding over time (Gerlach et al. 2018) and reduces the net interest margin. This composition effect explains why the effect of higher rates on the net interest margin can turn negative in the medium term as documented by English et al. (2018) for US banks. On the asset side, higher interest rates are associated with increased loan losses, decreasing the volume of loans generating interest income as some loans migrate into NPLs, thereby weighing on the net interest margin.

[5] In the case of France for instance, the large share of fixed-rate loans and the increase in the cost of wholesale funding and of regulated saving deposits did not allow bank profitability to benefit from higher interest rates in the wake of the COVID-19 crisis. "While fixed-rate loans have helped prevent a deterioration in asset quality, French banks have not benefited from the record-high profits experienced by most European peers in 2023 in the face of rising interest rates. On the liability side, net interest margins have been further compressed by the higher cost of wholesale funding and the indexation of the large share of regulated savings accounts to inflation and interbank rates." (IMF 2024).

Figure 1 – Evolutions of the net interest margin and the interest rate in selected euro area countries with fixed-rate and flexible-rate mortgages (in percent)



Sources: European Bank Authority Risk Board, OECD, and authors' calculations.

Note: This figure shows the quarterly evolutions of the average net interest margins of banking sectors in four countries where mortgages are predominantly at fixed rates (Belgium, France, Germany, the Netherlands) and in four countries where mortgages are mainly at flexible rates (Austria, Finland, Portugal, Spain), and of the 3-month Euribor.

2.2.3 Non-interest income

Losses in the value of securities held by banks are another risk to bank profits that may increase with higher rates. This risk materialized in March 2023 as the US monetary tightening led several small- to medium-sized US banks (e.g., Silicon Valley Bank (SVB)) to sell their Treasury bond portfolio at a large loss, triggering bank runs.

The impact such losses on securities holdings have on a bank's profit-and-loss account depends on accounting conventions, however. Investments in debt or equity securities purchased by a bank must be classified into three different categories: held-for-trading (HFT), available-for-sale (AFS), or held-to-maturity (HTM).[6] Both HFT securities and AFS securities are reported at fair value (that is they are marked to market) but only gains

[6] An HFT security is a debt or equity investment that investors purchase with the intent of selling within a short period of time, usually less than one year. Within that time frame, the investor hopes to see appreciation in the value of the security and sell it for a profit. An AFS is a debt or equity security purchased with the intent of selling before it reaches maturity, or holding for a long period of time should it not have a maturity date. An HTM security is purchased to be owned until maturity.

or losses on HFT securities are reported on the balance sheet (the profit and losses) of the bank and will therefore impact the non-interest income. Changes in the valuation of AFS are not recorded in the profit and losses of the bank but in the Other comprehensive income (OCI) section which is reported under shareholders' equity. HTM securities are reported at book value (not at fair value) so that changes in the valuation of HTM securities affect the bank profit-and-loss account only when those securities are sold. Overall, an increase in the interest rate and the related decrease in the value of securities are instantaneously reducing the non-interest income, in case of HFT securities, and when losses or gains are realized, in the case of HTM securities.

Table 1 summarizes the expected effects of the interest rate and its interactions with bank characteristics on bank profitability and its components.

Table 1 – Expected effects of interest rate and bank characteristic interactions on bank profitability and its components

	LLP	NIM	NII	ROA	Comments
Higher interest rate (IR)	+	+/-	-	+/-	Higher interest rates increase loan loss provisions and reduce non-interest income but also boost bank profitability via higher net interest margin, thanks to "price effects". The net effect is expected to be positive on average given the large share of the net interest margin in the ROA. However, "volume effects" (that is lower deposits and lower interest-earning assets) could weigh on the net interest margin and ROA for some banks.
Interaction of IR with deposit funding	?	+	?	+	The cost of funding adjusts more slowly to higher interest rates in case of deposit funding than wholesale funding, implying a larger increase in net interest margin and bank profitability. No specific effects are expected in the case of loan loss provisions or non-interest income.
Interaction of IR with flexible-rate lending	+	+/-	?	+/-	Loan loss provisions should always be larger for loans at flexible rates as borrowers for these loans are more vulnerable to higher rates. The net interest margin on the stock of loans should increase more in the short term when loan rates are flexible but NPLs should increase more in the longer term, weighing on the net interest margin and the ROA.
Interaction of IR with market power and fast-growing banks	+	-	?	-	Banks with low market power or banks with fast-growing loans in boom years should experience a larger increase in NPLs and loan loss provisions and a smaller increase in the net interest margin and the ROA.
Interaction of IR with borrower-based measures	-	+	?	+	Borrower-based measures should mitigate the effect of a higher interest rate on loan loss provisions, attenuate the decrease in interest-earning assets (through the migration of loans to NPLs) and thereby increase the positive effect of the interest rate on net interest margin and profitability.

3. Empirical approach

3.1 Econometric specification

Following the literature (e.g., Borio et al., 2017; or Claessens et al., 2018), we estimate a dynamic panel data regression for each element of bank profitability, adding interactions of the interest rate and its square term with

various variables described in sub-section 3.2. More specifically, we estimate for year *t*, bank *k*, headquartered in country *j*:

$$Y_{k,j,t} = \delta Y_{k,j,t-1} + \alpha_0 r_{j,t} + \alpha_1 r_{j,t}^2 + \lambda_{k,j,t}\left(\beta_0 r_{j,t} + \beta_1 r_{j,t}^2\right) + \Phi' C_{k,j,t} + \Psi' X_{k,j,t-1} + crisis_{j,t} + \mu_k + \theta_t + \eta_j t + \varepsilon_{k,j,t}, \quad (1)$$

where:

- *Y* is bank loan loss provisions, the net interest margin, non-interest income, or the pre-tax return on assets (all as a share of average total assets); and *r* is the three-month interbank rate.[7]
- λ is a dummy variable capturing bank business characteristics that are expected to affect the impact of the interest rate on profitability and its components. For example, λ is taking the value 1 if bank *k*, headquartered in country *j* in year *t* has a stock of outstanding loans that is mainly at flexible rates, and 0 otherwise. In addition, we use an index of the restrictiveness of BBMs that varies with the country and over time, and examine interactions of this index with the interest rate other macroeconomic controls, and bank characteristics.
- *C* is a vector containing a set of macroeconomic indicators (the coefficient of variation of the three-month interbank rate to capture perceived uncertainty about financial conditions, the growth rates of nominal GDP, of stock market indices, and of housing prices; the change in the unemployment rate) weighted based on banks' exposures to different countries (in the case of international banks).
- *X* is a vector of time-varying bank specific variables (the bank leverage as equity-to-total-assets ratio; bank liquidity as the liquidity-to-total-assets ratio; the cost-to-income ratio (efficiency indicator); the bank size measured as the natural logarithm of the bank total assets).
- *crisis* is a dummy crisis variable from the Laeven and Valencia (2020) database taking the value of 1 if a banking crisis took place in a given year and country.
- μ_k and θ_t are bank and time-fixed effects, respectively, and $\eta_j t$ are country-specific time trends.[8,9]

Robust standard errors are clustered at the bank level. The dependent variables are winsorized at the 5th and 95th percentiles.

3.2 Interaction variables

This section presents macroprudential variables and bank business characteristics, which are expected to shape the transmission of interest rates to bank profitability components.

3.2.1 Macroprudential settings

Macroprudential borrower-based measures (BBMs) should mitigate the effect of higher interest rates on loan loss provisions and on the profitability of banks. As discussed in ESRB (2019), BBMs represent important tools to limit loan losses because "by affecting banks' lending standards, [they] may contribute to avoiding or mitigating the vulnerabilities underlying the first stage of the lifecycle of a potential NPL."

[7] In the Fitch Connect database, the variable loan loss provision is named "loan impairment charges".

[8] The banking crisis information from Laeven and Valencia (2020) database ends in 2017 and we assume that no major banking crisis appeared in the countries of our sample since that year.

[9] Exposure weights of international banks to various countries are from IMF (2023).

We build an annual index of the tightness of BBMs at the country level, taking the value 0 in the absence of significant BBMs, 0.5 when some BBMs are in place, and 1 if BBMs and their calibration are judged highly effective, using two types of information:

- First, we use information on the presence and calibration of measures from the IMF Macroprudential Policy Survey and the integrated Macroprudential Policy (iMaPP) databases. The IMF Macroprudential Policy Survey contains details on the calibration of a broad range of measures including LTV, DSTI/DTI limits, and loan restriction measures and changes to their calibration over time. The iMaPP database provides indicators of tightening and loosening actions of various macroprudential policy instruments through time with a description of each policy action.
- Second, we use qualitative information from the technical notes on macroprudential policy of the IMF Financial Sector Assessment Program (FSAP) to complement our assessment of the tightness of BBMs based on the IMF Macroprudential Policy Survey and iMaPP databases.[10] In some countries, BBMs have been introduced as guidelines under the consumer protection legislation rather than as binding macroprudential measures (e.g., in Denmark). In some other countries, the implementation of BBMs is not enshrined in the law, but long-standing system-wide practices imply that banks adopt a conservative approach in their lending activity. A narrative approach based on assessments from FSAP reports is therefore essential to properly assess the tightness of BBMs in practice, on top of using information from the IMF Macroprudential Policy Survey and iMaPP databases.

We assign the value of 0.5 to the BBM index if both the average and median values of the LTV limit are equal to or below 80 percent and no other significant BBMs are in place, or alternatively if some income-based BBMs, such as LTI/DTI/DSTI limits or loan restrictions are in place, even when the LTV limit is loose (average and median values above 80 percent). The BBM index takes the value of 1 if the overall package of both collateral-based BBMs (such as the LTV limit) and income-based constraints (the LTI/DTI/DSTI limits) or the loan restrictions are tight. It can also take the value of 1 in the absence of an LTV limit if income-based BBMs (such as LTI/DTI/DSTI limits) are considered particularly tight. These choices reflect the fact that tight income-based constraints (LTI/DTI/DSTI limits) may be sufficient to reduce substantially borrowers' probability of default in response to shocks.

Overall, our BBM index includes hard measures, as well as recommendations and system-wide practices followed by banks that imply a cautious approach, provided the FSAP found that such recommendations or practices show system-wide risk mitigating effects. Specifically, we account for such recommendations and system-wide practices, especially when they do not permit lending at ratios above certain numerical thresholds.[11]

An important characteristic of this index is that it describes the strength of BBMs applying mainly to household loans (in particular, to mortgages), rather than measures that specifically target lending to corporates. This is in line with the reality of policy practices, however, as BBMs applying to corporates remain very rare in most countries to date. The fact that BBMs mainly constrain loans to households, but that our measure of loan

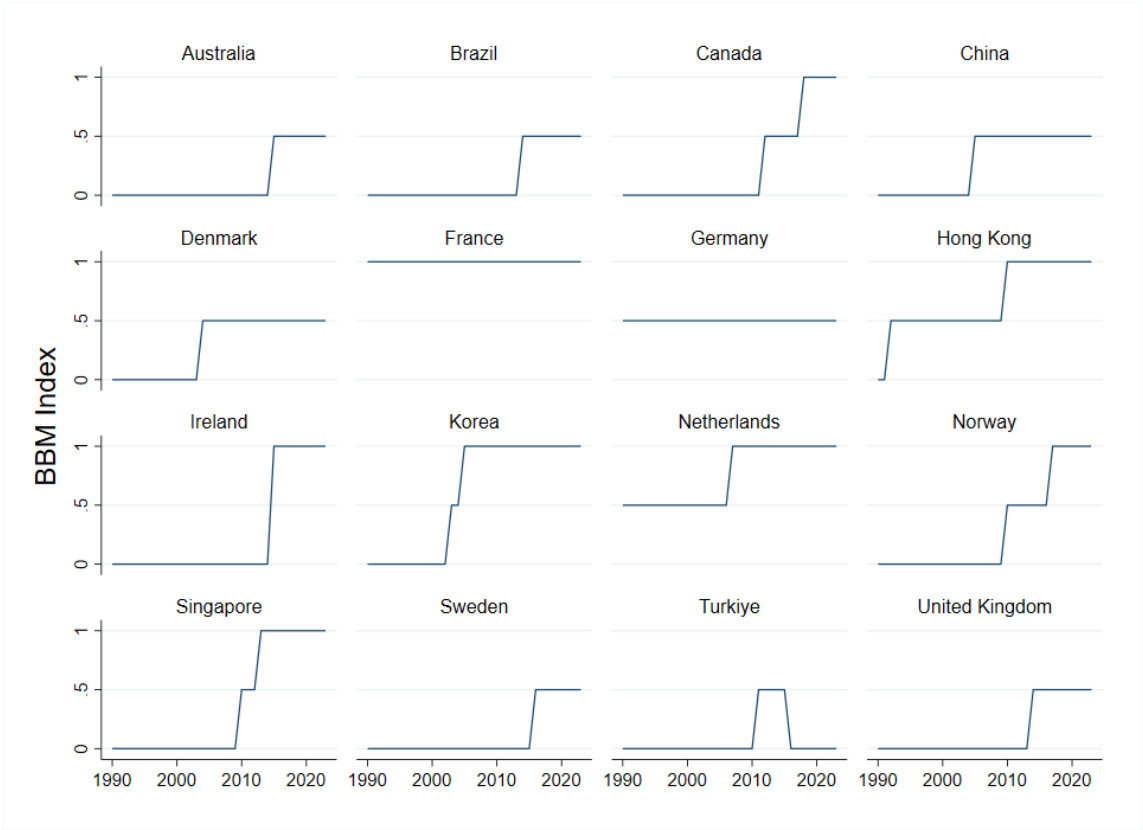
[10] The iMaPP database reports series of average and median LTV limits. The LTV limit is here considered tight if both its average and median values are equal to or below 80 percent.

[11] For example, in the case of France, DSTI and maturity limits were not binding until 2022 but the 2019 FSAP noted that "banks have strong screening mechanisms and loans with high DSTI ratios are usually extended to borrowers with steady income source." (IMF 2019). This is confirmed by Chauvin and Muellbauer (2018) who report a 40-percent recommended ceiling on DSTIs in France from the late 1990s to 2008.

losses includes losses on both loans to households and loans to corporates, reduces the odds of finding a significant effect of BBMs in the loan loss provisions regressions, and implies that our findings related to BBMs can be considered as conservative.[12]

Almost half of the countries of our sample have a null BBM index over the whole study period, while most countries with non-zero values of the index experienced a tightening of BBMs in the wake of the GFC (Figure 3).

Figure 3 – Borrower-based measure (BBM) index in selected economies



Sources: IMF Macroprudential Policy Survey and integrated Macroprudential Policy databases, IMF FSAPs, and authors' calculations.
Note: This figure shows the annual evolutions of the borrower-based measure index for countries of the sample with non-zero values of the index.

3.2.2 Bank characteristics

3.2.2.1 Flexibility of loan interest rates

When interest rates increase, loan loss provisions should increase especially for loans which are at flexible rates. Likewise, the net interest margin of banks that extend loans mainly at flexible rates should increase more

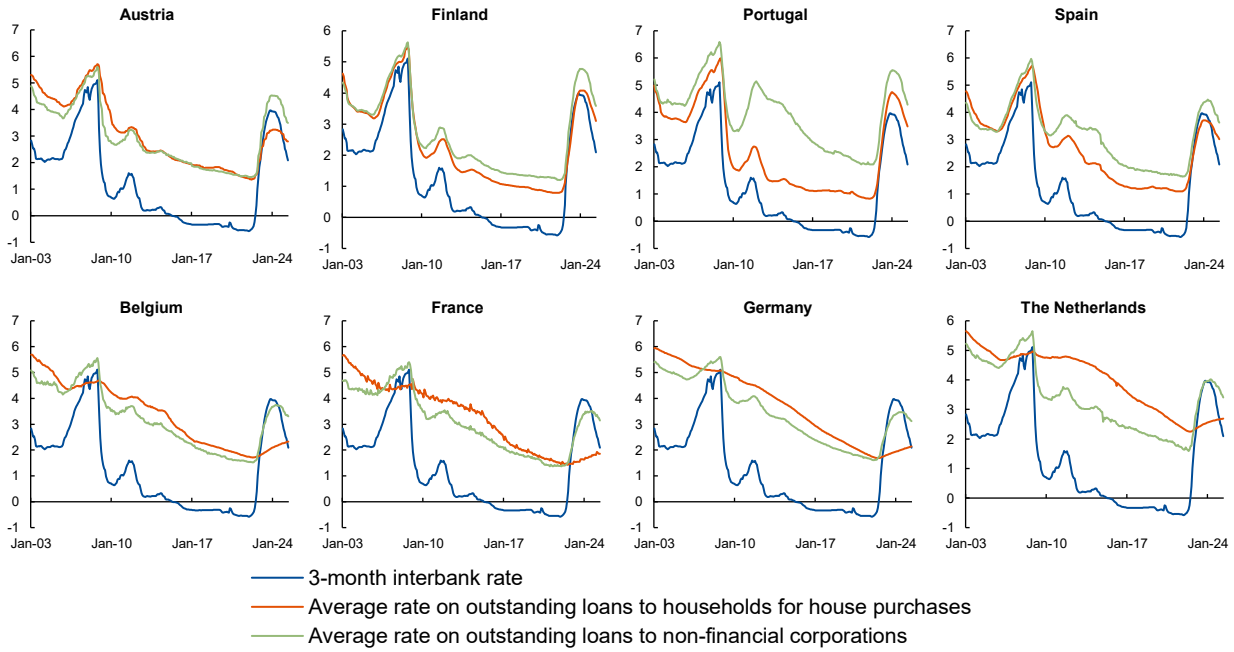
[12] It should also be noted that even BBM measures mainly targeting mortgages can have an indirect effect on corporate loan losses given that the decline in the household spending due to a debt overhang would indirectly affect corporates' revenues and thereby their capacity to service their debt.

sharply as interest rates rise, compared to that of banks that extend loans at fixed rates, although volume effects through higher NPLs can play a negative role for some banks.

Data sources used in this paper and related research do not provide direct information at the bank level on the proportion of loans contracted at fixed or variable rates. To capture differences across banks in the absence of this information, we proceed as follows. First, we classify the rate flexibility of mortgages for each country as low, medium, or high, using various sources of information on the proportion of mortgages at fixed rates (see Annex Table 1). Second, we compute the share of mortgages in total loans at the bank level using Fitch Connect data and other sources. Third, and based on this, we define bank-specific indicator variables of high exposure to fixed- and variable-rate loans as follows.

We classify as *flexible-rate loan banks* the banks that operate in countries with a high degree of flexibility of mortgage interest rates (e.g., Australia, Finland, Hong Kong SAR, Korea, Portugal…) and those banks that are mainly extending loans to non-financial corporates and/or personal loans (that is with a share of non-mortgage loans in total loans above 90 percent, or whose business description indicates that activity is focused on lending to corporates and/or consumer lending), whatever the country. This recognizes that loans to non-financial corporates are rarely extended at fixed rates (including in countries where the share of fixed-rate mortgages is high such as Belgium, France, Germany, Switzerland, or the United States) while personal loans tend to be short term and therefore more sensitive to changes in interest rates than fixed-rate mortgages. In line with this idea, average interest rates on the stock of loans to non-financial corporates (NFCs) tend to be more sensitive to the market interest rate than the ones on the stock of mortgages to households, including in countries where mortgages to households are mainly at fixed rates (Figure 2).

Figure 2 – Evolutions of 3-month interest rate and of average interest rates on outstanding loans to households for house purchases and to non-financial corporations in selected euro area countries (in percent)



Sources: ECB and OECD.
Note: This figure shows the monthly evolutions of the average interest rates on outstanding loans to households for house purchases and to non-financial corporations in four countries where mortgages are predominantly at flexible rates (Austria, Finland, Portugal, Spain), and in four countries where mortgages are mainly at fixed rates (Belgium, France, Germany, the Netherlands) and of the 3-month Euribor.

Banks that are mainly offering mortgages in countries where mortgages tend to be mostly extended at fixed rates are expected to be less exposed to changes in interest rates. In contrast, banks that are extending a small share of mortgages, or which are operating in countries where mortgages are mainly at flexible rates, are expected to be more exposed to interest rate variations.

Our proxy of the flexibility of loans can however be noisy for several reasons. First, mortgages to households are rarely fully fixed or fully flexible, depending on countries, while the proportion of flexible-rate loans has significantly changed over time in some countries. Second, a large share of loans to non-financial corporates can be at fixed rates in some countries. For example, as of mid-2024, half of the stock of loans to non-financial corporates in the euro area was at fixed rates, with a significant heterogeneity across countries: the proportion of loans to NFCs at fixed rate is relatively large in France, Germany, or the Netherlands while it is small in Finland or Greece (see e.g., Kerola et al. 2024). Results of regressions with respect to the flexible-rate loans should therefore be interpreted with some caution.

3.2.2.2 Bank market share and loan growth

Banking sector concentration might increase profitability and can also help support profits when interest rates rise. Kho (2023) finds for example that unexpected monetary policy tightening affects deposit rates more slowly in more concentrated banking sectors compared to less concentrated ones. The effect of the interest rate on profitability can also be affected by the competitive position of each bank relative to its rivals. In several countries, the banking sector is dominated by a few banks which may benefit from a large existing customer base. These banks enjoy market power and could be relatively more conservative in lending to additional borrowers. By contrast, new entrants or banks at low existing market shares may be able to grow their market share only by extending loans to riskier borrowers, making them more vulnerable to higher interest rates.

To capture the competitive position of each bank, we use the bank's market share, defined as the share of the bank total assets in the domestic banking sector total assets. We then identify banks which do not have a strong market power (or have a low market share) as those whose share of average total assets in the banking sector total assets is below the 80^{th} percentile of the sample market share. Finally, banks with fast-growing loan portfolios during credit booms may apply looser lending standards so that their loans may be more vulnerable to higher interest rates. We identify credit boom years as years when the credit-to-GDP ratio is above its country-specific median for at least two consecutive years. We then classify banks as banks with fast-growing loans if their median loan growth during the credit boom years is above the third quartile of this variable at the country level.

3.2.2.3 Funding arrangements

Interest paid by banks on their customers' deposits tend to adjust only partially and slowly to higher market interest rates, contrary to the interest paid in wholesale markets, especially in the case of short-term wholesale funding sources. The net interest margin of banks mainly funded with customers' deposits should therefore increase more with the interest rates than that of banks relying on wholesale funding sources. To capture this difference, we compute the banks' deposits-to-total liabilities ratio from Fitch Connect and classify banks with a high share of deposits as those with an average deposits-to-total liabilities ratio exceeding the median of the sample distribution.

3.2.2.4 Share of securities held for trading

As explained in Section 2, losses on securities holdings from higher interest rates feed directly into the income statement of the bank if the securities are marked to market and held for trading (HFT). They however bypass it

and go straight into equity if they are treated as available for sale (AFS). Finally, losses have an impact only when realized if the securities are treated as held-to-maturity (HTM) securities.[13]

We therefore expect that a high share of HFT securities in total securities of the bank amplifies the effect of the interest rate on the non-interest income. We measure the share of HFT securities in total securities from Fitch Connect but given missing information for some years, we consider the average share of HFT securities over time by bank and build a dummy variable for high HFT share equal to one if the bank average share is above the median share of all banks of the sample, and zero otherwise.

3.2.2.5 Liquid assets

Banks holding more eligible liquid assets should be less likely to incur non-interest income losses when the interest rate increases. This is because banks that can borrow cash from the central bank by using eligible securities as collateral, do not need to sell those securities for cash when this would force them to recognize large losses. Those banks should be able to post debt securities at cost at the central bank and obtain liquidity against those securities. Banks that hold a large amount of liquid assets should also be able to augment collateral posted in response to margin calls without incurring losses.

We measure the degree of liquid assets by the ratio of liquid assets (defined by cash, reserves at the central bank, loans and advances to banks, and liquid securities) over total assets as available from Fitch Connect annually for each bank. We then classify banks as holding a high share of liquid assets in a specific year if this ratio is above the median value of the variable over the estimation sample.

3.3 Data

We use annual information from Fitch Connect for profitability and other bank-level variables. We retain financial intermediaries categorized by Fitch Connect as “Banks”, “Development Banks”, “Financial Institutions”, “Other Banks”, “Private Banks”, “Retail & Consumer Banks”, “Universal Commercial Banks”, and “Wholesale Commercial Banks”. Other types of financial institutions are excluded from the sample. We also exclude banks with less than $100 million of total assets and which have less than five years of data. We use unconsolidated banking data where available, like Claessens et al. (2018). The final sample is composed of 2,147 banks in 31 countries (24 AEs and 7 EMEs) over the 1995-2023 period.[14] Among those banks, 917 were active at end-2023, 371 banks failed or faced serious financial difficulties that required public intervention for orderly resolution, and 859 banks merged or were acquired by other banks.[15] Most macroeconomic variables come from the IMF World Economic Outlook database, MSCI, OECD, and Oxford Economics. Additional information on the variables is reported in Annex Table 1.

[13] These distinctive effects however reflect accounting conventions and even a drop in the valuations of AFS securities matter for financial stability.

[14] Advanced economies include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong SAR, Ireland, Italy, Japan, Korea, Luxembourg, the Netherlands, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom, and United States. Emerging markets are Brazil, China, India, Mexico, Russia, South Africa, and Türkiye.

[15] In many cases, the mergers are strategic decisions to strengthen the financial stability and operational efficiency of the institutions involved and are therefore not indicative of financial failure. In some other cases, banks are dissolved due to severe regulatory violations and legal issues and are not considered as failed for “economic” reason.

4. Econometric results

This section presents the specifications for the econometric analysis of each of the three components of bank profitability and discusses the main results.

4.1 Loan loss provisions

The variable loan loss provisions (as a share of the average annual total assets) is regressed on its lagged value, the interest rate, and its squared term, as well as other controls as detailed in Section 3.1:

$$LLP_{k,j,t} = \delta LLP_{k,j,t-1} + \alpha_0 r_{j,t} + \alpha_1 r_{j,t}^2 + \lambda_{k,j,t}\left(\beta_0 r_{j,t} + \beta_1 r_{j,t}^2\right) + \Phi' C_{k,j,t} + \Psi' X_{k,j,t-1} + crisis_{j,t} + subprime_{j,t} + \mu_k + \theta_t + \eta_j t + \varepsilon_{k,j,t}. \quad (2)$$

The interaction variables λ of interest are: a dummy variable for banks mainly extending loans at flexible rates (expected to amplify the interest rate effect); variables that vary across banks and are expected to affect the quality of loan portfolios, including (1) a dummy variable indicating whether the bank has a low market share, and (2) a dummy variable indicating whether the bank has a fast-growing loan portfolio in credit boom years; and our index of BBM restrictiveness that varies across countries and time, and which can itself be interacted with the dummy variable indicating the degree of flexibility of existing loans.[16] We also control for the subprime crisis in the United States, by including a dummy variable *subprime* taking the value one in case the bank operates in the US in the years 2008-2012, zero otherwise.

As expected, results indicate that loan loss provisions are increasing significantly with the level of the interest rate (Table 2, regression (1)), but this effect varies significantly across banks' characteristics.

Banks with a high proportion of flexible-rate loans must provision more than other banks during years of high interest rates (regressions (2) to (4)). This aligns with the hypothesis that borrowers with flexible-rate loans are exposed to a higher debt service burden when market interest rates increase, then increasing their probability of default.

The interaction of the interest rate with the market share variable is significant, with the expected positive sign. Banks with a low market share need to provision more than other banks in years of high interest rates (regressions (3) and (4)), in line with the hypothesis that these banks extend loans to riskier borrowers.

Finally, the interaction of the interest rate with the dummy variable for fast-growing-loan banks during credit booms is not significant (regression (3)). However, banks that grow faster in credit boom years are found to provision more for loan losses during other years (regression (4)), in line with the idea that those banks may be relaxing lending standards during credit booms.

[16] Loan loss provisioning can be affected by other factors such as dividend policies and a smoothing behavior not related to actual losses. Also, since 2018, the expected credit loss (ECL) accounting standards under International Financial Reporting Standard 9 Financial Instruments (IFRS 9) and US Generally Accepted Accounting Principles (US GAAP) (Current Expected Credit Losses (CECL)) introduced a more forward-looking framework for the recognition of impairment (compared to the incurred loss (IL) approaches which imposed loss event thresholds to trigger loan loss recognition), possibly leading to a divergence between LLP and actual losses. However, on average and over time, the gap between LLP and actual losses should be null, while the current literature fails to reach any consensus so far on the effects of ECL and CECL compared to the IL framework (see BIS 2021).

Table 2 – Loan loss provisions

	Dependent variable: Loan loss provisions (% of average total assets)			
	(1)	(2)	(3)	(4)
Loan loss provisions, lagged	0.405***	0.404***	0.404***	0.401***
	(36.01)	(36.03)	(35.94)	(35.77)
3-month interest rate	0.018***	0.013***	0.011*	0.008
	(5.02)	(3.13)	(1.95)	(1.53)
Flexible rate loans x Interest rate		0.015***	0.015***	0.014***
		(2.95)	(3.45)	(3.14)
Change unemployment rate	0.054***	0.055***	0.054***	0.054***
	(14.81)	(14.77)	(14.69)	(14.75)
Growth rate of real GDP	-0.010***	-0.009***	-0.009***	-0.010***
	(-4.88)	(-4.65)	(-4.75)	(-4.89)
Low market share x Interest rate			0.011***	0.012***
			(2.64)	(2.88)
Fast-growing bank during boom x Interest rate			-0.003	
			(-0.85)	
Non-boom year				0.003
				(0.30)
Fast-growing bank during boom x Non-boom year				0.059***
				(5.06)
Observations	29,053	29,053	29,053	29,053
Number of banks	2,126	2,126	2,126	2,126
Time-varying macroeconomic controls	Yes	Yes	Yes	Yes
Time-varying bank controls	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Country-specific time trend	Yes	Yes	Yes	Yes
Adjusted R-squared	0.386	0.387	0.387	0.388

Note: The dependent variable is winsorized at the 5th and 95th percentiles. Low-market-share banks are banks with an average market share in terms of total assets below the 80th percentile. Fast-growing-loan banks are banks with an average annual growth of loans during credit booms above the 75th percentile. The constant term, time-varying macroeconomic controls (standard deviation of the interest rate, growth rates of stock market and of house price indices), the time-varying bank controls (leverage, liquidity, cost-to-income ratio, and size), and the squared terms of the interest rate, are included but their coefficients are not reported. *T*-stats based on robust standard errors clustered at the bank level are reported in parentheses. ***, **, * denote statistical significance at 1, 5, and 10 percent respectively.

We now turn to the effect of macroprudential BBMs on loan loss provisions. Macroprudential policy is expected to directly reduce the level of loan loss provisions by improving the quality of loans. It should also affect loan loss provisions indirectly, by shaping the impact of higher interest rates on provisions, especially for flexible-rate loans.

We consider in the regressions the index on the restrictiveness of BBMs defined in Section 3, which takes the value 0 in case of absence of significant BBMs, 0.5 for mild BBMs, and 1 for tight BBMs, in a specific country and a given year. Given that loan loss provisions are the result of vulnerabilities of loans extended over the previous years, we consider in the regressions the 5-year moving average of past values of the BBM index. This approach should allay concerns that the prevailing tightness of BBMs may be endogenous to variations in interest rates.

Results of the regressions indicate relatively weak baseline effects of the BBM index in affecting loan loss provisions (Table 3, regression (1)), and of interactions of the BBM index with the interest rate.17 These effects are weaker in particular when controlling for other variables.

[17] The interaction effect of the BBM index with the interest rate is surprisingly significantly positive in some specifications (regressions (3), (5), and (6)), but not anymore after controlling for the interaction of the unemployment rate with the BBM index (regressions (4) and (7)).

In contrast, the interaction of the BBM index with the flexible-rate loan dummy (regression (3)) is better identified and highly significant in all regressions. It suggests that the nature of the loans matters for the interaction effect of BBMs and the interest rate. If loans are at fixed rates, the impact of the interest rate on loan loss provisions should be barely affected by BBMs, contrary to what is expected for loans at flexible rates, since in the first case, borrowers are not facing any direct interest rate risk, at least as long as they do not need to refinance their loans.

We further investigate the interaction effect of BBMs with other macroeconomic variables relevant for loan loss provisions and find strong interactions with unemployment. The impact of a change in the unemployment rate on loan loss provisions is found to be attenuated by tight BBMs (regressions (4) and (7)), with this effect being statistically and economically important. A one-standard deviation increase in the change of the unemployment rate (+1 percentage point) is associated with a long-term increase in loan loss provisions of 0.1 percentage point in case of a zero BBM index. This effect is reduced to a zero-impact on loan loss provisions in case the BBM index is at its maximum value (an *F*-test fails to reject the null hypothesis of a zero-sum of the estimated coefficients of the change of the unemployment rate and of the interaction of this variable with the BBM index).

The interaction effect of the BBM index with real GDP growth is positively significant (regression (5)), but is actually significant only in case of a recession: in countries with tight BBMs in the years preceding the recession, the impact of the recession on banks' loan loss provisions is significantly smaller than in countries which have had loose BBMs (regression (6)). This finding, however, does not come through anymore once the interaction of the BBM index with the change in the unemployment rate is also included (regression (7)). This suggests that BBMs matter most to attenuate the impact of unemployment on household defaults and less in mitigating other impacts of a recession on loan loss provisions. Results are qualitatively similar when considering all the variables and their interactions with BBMs simultaneously, as well as the various proxies for the riskiness of banks' loans (results not reported).

Overall, the results indicate that BBMs can mitigate the effects of higher interest rates on loan loss provisions, when loans are extended at flexible rates and debt service is therefore sensitive to variation in interest rates. They also mitigate the effects of an increase in unemployment on loan loss provision that may arise from high interest rates or other factors, whatever the type of loan (at fixed or flexible rate). These findings are not driven by a particular country as they are robust to excluding each country one by one from the regression (7) of Table 3 (results not reported).

Table 3 – Loan loss provisions and borrower-based measures

	Dependent variable: Loan loss provisions (% of average total assets)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Loan loss provisions, lagged	0.405***	0.405***	0.402***	0.402***	0.402***	0.403***	0.403***
	(35.97)	(36.02)	(35.87)	(35.81)	(35.88)	(35.97)	(35.91)
3-month interest rate	0.018***	0.019***	0.010**	0.012***	0.010**	0.011**	0.012***
	(4.95)	(4.99)	(2.33)	(2.79)	(2.41)	(2.51)	(2.89)
BBM index (5-year MA)	-0.073*	-0.050	-0.024	-0.006	-0.039	-0.024	0.017
	(-1.71)	(-1.10)	(-0.53)	(-0.13)	(-0.86)	(-0.52)	(0.38)
BBM x Interest rate		-0.008	0.017*	0.013	0.017*	0.016*	0.011
		(-1.56)	(1.79)	(1.38)	(1.84)	(1.65)	(1.14)
Flexible rate loans x Interest rate			0.025***	0.024***	0.025***	0.024***	0.023***
			(3.62)	(3.50)	(3.67)	(3.58)	(3.38)
BBM x Flexible rate loans x Interest rate			-0.041***	-0.038***	-0.041***	-0.040***	-0.037***
			(-3.71)	(-3.51)	(-3.71)	(-3.66)	(-3.45)
Change unemployment rate	0.055***	0.054***	0.055***	0.061***	0.054***	0.054***	0.063***
	(14.82)	(14.67)	(14.71)	(14.63)	(14.41)	(14.52)	(14.09)
BBM x Change unemployment rate				-0.054***			-0.058***
				(-6.22)			(-5.93)
Growth rate of real GDP	-0.010***	-0.010***	-0.010***	-0.010***	-0.011***		
	(-4.87)	(-4.93)	(-4.80)	(-5.06)	(-5.33)		
BBM x Growth rate real GDP					0.007**		
					(2.28)		
Positive growth rate real GDP						-0.006**	-0.005*
						(-2.30)	(-1.76)
BBM x Positive growth rate real GDP						0.002	-0.007
						(0.47)	(-1.54)
Negative growth rate real GDP						-0.020***	-0.018***
						(-6.09)	(-5.42)
BBM x Negative growth rate real GDP						0.013**	0.004
						(2.56)	(0.64)
Observations	29,053	29,053	29,053	29,053	29,053	29,053	29,053
Number of banks	2,126	2,126	2,126	2,126	2,126	2,126	2,126
Time-varying macroeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-varying bank controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.387	0.387	0.388	0.389	0.388	0.388	0.389

Note: The dependent variable is winsorized at the 5th and 95th percentiles. The constant term, time-varying macroeconomic controls (standard deviation of the interest rate, growth rates of stock market and of house price indices), and time-varying bank controls (leverage, liquidity, cost-to-income ratio, and size), and the squared terms of the interest rate, are included but their coefficients are not reported. *T*-stats based on robust standard errors clustered at the bank level are reported in parentheses. ***, **, * denote statistical significance at 1, 5, and 10 percent respectively.

4.2 Net interest margin

Regressions for the net interest margin (NIM) use the same dynamic panel data approach and controls as for the loan loss provisions:

$$NIM_{k,j,t} = \delta NIM_{k,j,t-1} + \alpha_0 r_{j,t} + \alpha_1 r_{j,t}^2 + \lambda_{k,j,t}\left(\beta_0 r_{j,t} + \beta_1 r_{j,t}^2\right) + \Phi' C_{k,j,t} + \Psi' X_{k,j,t-1} + crisis_{j,t} + \mu_k + \theta_t + \eta_j t + \varepsilon_{k,j,t}. \quad (3)$$

The interaction variables λ are: (1) a dummy variable for banks mainly funded with deposits; (2) a dummy variable for banks with a high share of flexible-rate loans; (3) a dummy variable for banks with a low market share; and (4) a dummy variable indicating whether the bank has a fast-growing loan portfolio in credit boom years.

As expected, the net interest margin of banks with a high share of deposits in total liabilities is found to be more sensitive to the interest rate than that of other banks (Table 4, regression (1)). Banks with a large share of deposits in their funding are less likely to experience a significant increase in funding costs in the short term as interest rates increase, compared to banks that are funded to a greater extent on the wholesale market. Their net interest margin therefore benefits more from higher interest rates than that of other banks, in line with the idea that the value of banks' deposit franchise increases with the interest rate (Drechsler et al. 2023). The interaction coefficients of the interest rate with the low-market-share dummy or with the fast-growing loan dummy are not significant and are not reported.

Table 4 – Net interest margin

	Dependent variable: Net interest margin (% of average total assets)				
	All	Low mkt share=1	Low mkt share=0	High NPL=1	High NPL=0
	(1)	(2)	(3)	(4)	(5)
Net interest margin, lagged	0.600***	0.589***	0.630***	0.575***	0.613***
	(36.37)	(32.03)	(15.90)	(17.05)	(32.18)
3-month interest rate	0.038***	0.052***	0.010	0.074***	0.025***
	(6.11)	(3.35)	(1.32)	(5.88)	(3.39)
High deposit share x Interest rate	0.031***	0.029***	0.020	0.042**	0.022**
	(3.83)	(2.69)	(1.25)	(2.48)	(2.51)
Flexible rate loans x Interest rate	0.004	-0.001	0.012	-0.049**	0.017*
	(0.50)	(-0.04)	(0.90)	(-2.56)	(1.72)
Observations	30,348	24,319	6,029	6,803	20,297
Number of banks	2,147	1,849	298	477	1,434
Time-varying macroeconomic controls	Yes	Yes	Yes	Yes	Yes
Time-varying bank controls	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Country-specific time trends	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.536	0.532	0.588	0.570	0.534

Note: The dependent variable is winsorized at the 5th and 95th percentiles. High-market-share (high-NPL) banks are banks with an average market share in terms of total assets (average NPL ratio) above the 80th percentile (75th percentile). The constant term, time-varying macroeconomic controls (standard deviation of the interest rate, growth rates of real GDP, of the stock market and of house price indices, and the change of the unemployment rate), time-varying bank controls (leverage, liquidity, cost-to-income ratio, and size), and the squared terms of the interest rate, are included but their coefficients are not reported. *T*-stats based on robust standard errors clustered at the bank level are reported in parentheses. ***, **, * denote statistical significance at 1, 5, and 10 percent respectively.

The importance of flexible-rate loans in bank loan portfolio is not significant on average (regression (1)), which is surprising since higher interest rates could be expected to boost earnings, especially for banks whose loan book reprices faster. This result, however, varies greatly across banks. Further analysis reveals that the coefficient of the interaction of the interest rate with the flexible-rate loan dummy is significantly negative for banks with high average NPLs (regression (4)), while it is positive for other banks (regression (5)).[18] One

[18] In contrast, splitting the sample based on banks' market shares does not show any heterogeneity with respect to the interaction with the flexible-rate dummy (regressions (2) and (3))

interpretation of this finding is that banks with weaker balance sheets experience a larger migration of flexible-rate loans into NPLs as the interest rate increases, reducing their interest income.[19]

This conjecture is supported by estimates of regressions of the interest income (as a share of interest-earning assets) and of the interest expenses (as a share of interest-bearing liabilities), separately. As expected, for the whole sample, banks offering flexible rate loans see their interest income increase more strongly with the interest rate (Table 5, regression (1)), although this finding hides some heterogeneity across banks. Banks with high average NPL ratios actually see their interest income increase less with the interest rate when offering flexible-rate loans (regression (2)). In contrast, banks that do not have high average NPLs see their interest income increase more with the interest rate when extending loans at flexible rates (regression (3)), driving the finding of a positive interaction of the interest rate with the flexible-rate loan dummy for the whole sample (given that these banks dominate the sample).

Table 5 – Interest income and interest expense

Dependent variable:	Interest Income (% of earning assets)			Interest Expense (% of interest bearing liabilities)		
	All	High NPL=1	High NPL=0	All	High NPL=1	High NPL=0
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged dependent variable	0.534***	0.475***	0.538***	0.533***	0.450***	0.560***
	(35.22)	(11.95)	(32.41)	(38.16)	(12.83)	(38.34)
3-month interest rate	0.297***	0.316***	0.309***	0.281***	0.289***	0.295***
	(19.59)	(11.11)	(17.52)	(23.62)	(15.35)	(18.81)
High deposit share x Interest rate	0.001	-0.024	-0.004	-0.042***	-0.037*	-0.052***
	(0.05)	(-0.87)	(-0.24)	(-4.07)	(-1.95)	(-4.16)
Flexible rate loans x Interest rate	0.056***	-0.063**	0.088***	0.066***	0.014	0.074***
	(2.76)	(-2.04)	(4.07)	(4.61)	(0.55)	(4.81)
Observations	29,901	6,697	20,040	29,874	6,681	20,029
Number of banks	2,133	473	1,426	2,133	473	1,426
Time-varying macroeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes
Time-varying bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country-specific time trends	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.784	0.753	0.814	0.825	0.770	0.859

Note: The dependent variables are winsorized at the 5th and 95th percentiles. High-NPL banks are banks with an average NPL ratio above the 75th percentile. The constant term, time-varying macroeconomic controls (standard deviation of the interest rate, growth rates of real GDP, of the stock market and of house price indices, and the change of the unemployment rate), time-varying bank controls (leverage, liquidity, cost-to-income ratio, and size), and the squared terms of the interest rate, are included but their coefficients are not reported. *T*-stats based on robust standard errors clustered at the bank level are reported in parentheses. ***, **, * denote statistical significance at 1, 5, and 10 percent respectively.

[19] The effect of interest rates on the net interest margin is indeed complex due to changes in the composition of bank balance sheet over time. On the one hand, the interest revenue of banks extending loans at flexible rates benefits more in the short term from higher interest rates thanks to an instantaneous “price effect”. On the other hand, higher interest rates are associated in the longer term with a negative “volume effect” due to the migration of performing loans into NPLs, reducing the interest income and thereby the net interest margin. The “volume effect” varies depending on bank characteristics and could be stronger among weaker banks extending loans at flexible rates and thereby experiencing a larger increase in NPLs than other banks.

Interest expenses also increase with the interest rate, but less so for banks with a high proportion of deposits in total liabilities, whatever the type of bank (regressions (4) to (6)). Interestingly, banks offering flexible-rate loans tend to also exhibit a higher increase in interest expenses when the interest rate rises. This could be because these banks often operate in countries where flexible-rate loans are prevalent, requiring them to raise funding also at flexible rates.[20] Alternatively, causation could go the other way around as banks with more floating-rate liabilities may aim to reduce mismatch by extending more floating-rate loans, as found by Kirti (2020) for US banks.

Overall, the NIM increases more with the interest rate for banks with a high share of deposits in total liabilities. For banks that exhibit high average NPL ratios, flexible-rate loans reduce the increases in the NIM that come with higher interest rates, while for other banks, flexible-rate loans boost the positive effect of higher interest rates on the NIM. However, the overall effect of the interest rate on the NIM is positive on average for all types of banks considered. This result is consistent with the finding obtained by Gentil et al. (2023) from a simulated model of a positive effect of the interest rate on the NIM in the euro area.

4.3 Non-interest income

Similar to previous regressions, we use a dynamic panel regression for non-interest income (NII):

$$NII_{k,j,t} = \delta NII_{k,j,t-1} + \alpha_0 r_{j,t} + \alpha_1 r_{j,t}^2 + \lambda_{k,j,t}\left(\beta_0 r_{j,t} + \beta_1 r_{j,t}^2\right) + \Phi' C_{k,j,t} + \Psi' X_{k,j,t-1} + \mu_k + \theta_t + \eta_j t + crisis_{j,t} + \varepsilon_{k,j,t}, \quad (4)$$

where two different interaction variables are considered: (1) a dummy variable for banks with a large share of HFT securities in total securities (that is above the median average value of HFT share), and (2) a time-varying dummy variable for banks/years with a large share of liquid assets in total assets (that is above the median value of the sample).

The non-interest income is expected to decrease with the interest rate mainly due to a drop in the value of securities held by the banks. Although this is not the case for the whole sample (regression (1)), the interest rate is highly significant statistically when focusing on banks in AEs (regression (2)), in line with results of other papers considering exclusively AEs (Borio et al. 2017, English et al. 2018). In contrast, the interest rate is not significant in explaining the non-interest income for banks in EMEs (regression (3)). As noted by IMF (2023), which uses a similar sample of countries as ours, banks in EMEs tend to keep most of their securities as HTM securities which are recorded at book value, as opposed to HFT and AFS securities which are marked to market.[21] This could partly explain why the non-interest income of banks in EMEs of our sample is not related to the interest rate.

We then classify banks based on the share of their HFT securities in total securities.[22] Banks with a high proportion of HFT securities are expected to have a non-interest income that is more sensitive to the interest rate than other banks since HFT securities are marked to market in the profit and loss statement of the banks. Results indicate that this is indeed the case: the estimated coefficient of interaction between a high share of

[20] The coefficient on the flexible-rate-loan interaction indeed becomes insignificant when dropping those banks (results not reported)

[21] Altavilla et al. (2018) also fail to find a significant impact of the interest rate on the non-interest income of euro area banks, a finding they attribute to the small share of securities held at market values by banks of their sample.

[22] In Fitch Connect, the variable Total Securities is the sum: Trading Securities and at FV + Available for Sale Securities + Held to Maturity Securities + Other Securities.

HFT securities and the interest rate is significantly negative, while the main coefficient on the interest rate remains negative but turns statistically unsignificant (regression (4)).

Finally, the interaction coefficient of high liquid assets observations with the interest rate is significantly positive (regression (5)), with a non-negligible economic impact. This finding is in line with the idea that banks do not need to sell HTM securities and recognize large losses in years when they hold enough liquid assets, as liquid assets allow them to respond to margin calls by posting more collateral or to other liquidity stress by obtaining reserves from the central bank through repos.

Table 6 – Non-interest income

	Dependent variable: Non-interest income (% of average total assets				
	All	AEs	EMEs	AEs	AEs
	(1)	(2)	(3)	(4)	(5)
Non-interest income, lagged	0.530***	0.549***	0.444***	0.548***	0.547***
	(35.14)	(35.51)	(11.99)	(35.59)	(35.39)
3-month interest rate	-0.006	-0.039***	-0.014	-0.034***	-0.037***
	(-1.19)	(-5.39)	(-1.26)	(-4.25)	(-4.56)
High share of Held-for-trading securities x Interest rate				-0.026***	-0.028***
				(-2.98)	(-3.22)
High liquidity ratio (time-varying)					-0.009
					(-0.86)
High liquidity ratio (time-varying) x Interest rate					0.013***
					(3.28)
Observations	30,324	27,075	3,249	27,075	27,075
Number of banks	2,147	1,850	297	1,850	1,850
Time-varying macroeconomic controls	Yes	Yes	Yes	Yes	Yes
Time-varying bank controls	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Country-specific time trends	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.366	0.398	0.286	0.398	0.399

Note: The dependent variable is winsorized at the 5th and 95th percentiles. The constant term, time-varying macroeconomic controls (standard deviation of the interest rate, growth rates of real GDP, of the stock market and of house price indices, and the change of the unemployment rate), time-varying bank controls (leverage, liquidity, cost-to-income ratio, and size), and the squared terms of the interest rate, are included but their coefficients are not reported. *T*-stats based on robust standard errors clustered at the bank level are reported in parentheses. ***, **, * denote statistical significance at 1, 5, and 10 percent respectively.

4.4 Return on assets

The regressions for the ROA include all the variables considered so far in the dynamic panel regression:

$$ROA_{k,j,t} = \delta ROA_{k,j,t-1} + \alpha_0 r_{j,t} + \alpha_1 r_{j,t}^2 + \lambda_{k,j,t}\left(\beta_0 r_{j,t} + \beta_1 r_{j,t}^2\right) + \Phi' C_{k,j,t} + \Psi' X_{k,j,t-1} + crisis_{j,t} + subprime_{j,t} + \mu_k + \theta_t + \eta_j t + \varepsilon_{k,j,t}, \quad (5)$$

where the interaction variables λ are the main ones already used to investigate the components of profitability, that is: (1) a dummy variable for banks mainly funded with deposits; (2) a dummy variable for banks with a high share of flexible-rate loans; (3) a dummy variable for banks with a low market share; (4) a dummy variable indicating whether the bank has a fast-growing loan portfolio in credit-boom years; and (5) a time-varying dummy variable for banks with a high share of liquid assets. Moreover, as for the regressions on loan loss provisions, we investigate here again interactions with our index of the tightness of BBMs.

As expected, and in line with findings for the net interest margin, a higher share of deposits in total liabilities increases the sensitivity of the ROA of banks to the interest rate (Table 7). Interactions of the interest rate with the low-market-share or the fast-growing-loans dummies are not significant though and not reported.

Table 7 – Return on assets

	Dependent variable: Return on assets (% of average total assets)				
	All	Low mkt share=1	Low mkt share=0	High NPL=1	High NPL=0
	(1)	(2)	(3)	(4)	(5)
Return on assets, lagged	0.499***	0.503***	0.422***	0.463***	0.492***
	(50.69)	(46.31)	(19.18)	(25.76)	(40.29)
3-month interest rate	-0.001	0.010	-0.010	0.022	-0.005
	(-0.12)	(0.83)	(-0.72)	(1.36)	(-0.58)
High deposit share x Interest rate	0.024***	0.022**	0.028*	0.000	0.030***
	(3.40)	(2.45)	(1.92)	(0.01)	(3.43)
Flexible rate loans x Interest rate	-0.019***	-0.028***	-0.004	-0.076***	-0.004
	(-2.62)	(-2.80)	(-0.29)	(-4.01)	(-0.43)
High liquidity ratio (time-varying)	-0.075***	-0.122***	-0.022	-0.009	-0.090***
	(-5.51)	(-7.78)	(-0.84)	(-0.27)	(-5.47)
High liquidity ratio (time-varying) x Interest rate	0.018***	0.028***	0.003	0.006	0.019***
	(5.49)	(6.20)	(0.61)	(0.99)	(4.14)
Observations	30,348	24,319	6,029	6,803	20,297
Number of banks	2,147	1,849	298	477	1,434
Time-varying macroeconomic controls	Yes	Yes	Yes	Yes	Yes
Time-varying bank controls	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Country-specific time trends	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.425	0.436	0.397	0.472	0.436

Note: The dependent variable is winsorized at the 5th and 95th percentiles. The constant term, time-varying macroeconomic controls (standard deviation of the interest rate, growth rates of real GDP, of the stock market and of house price indices, and the change of the unemployment rate), time-varying bank controls (leverage, liquidity, cost-to-income ratio, and size), and the squared terms of the interest rate, are included but their coefficients are not reported. *T*-stats based on robust standard errors clustered at the bank level are reported in parentheses. ***, **, * denote statistical significance at 1, 5, and 10 percent respectively.

The profitability of banks that hold more liquid assets appears to hold up better when interest rates rise, (regressions (1), (2) and (5)), possibly reflecting a lower decrease in their non-interest income, as found in the previous section. Specifically, a higher level of liquid assets enables banks to avoid fire-sales of assets even when deposits flow out in response to higher rates. However, higher banks' holdings of liquid assets reduce ROA unconditionally (the time-varying dummy variable for observations with a high liquidity ratio is significantly negative), in line with the idea that liquid assets generate lower returns than other assets, imposing an opportunity cost on banks (Bordeleau and Graham 2010).

The ROA of banks with a large share of flexible-rate loans benefits less from high interest rates on average (regression (1)). This is in line with findings reported in previous sections that banks with a large share of flexible-rate loans: (1) need to make greater loan loss provisions as interest rates rise, and (2) may see some erosion of their net interest margin from an increase in non-performing assets.

This result, however, hides some heterogeneity across banks. The negative interaction of the interest rate with the share of flexible-rate loans holds strongly for the sample of banks with a low market share and for the sample of banks with high average NPLs (regressions (2) and (4)), probably reflecting the fact that higher initial risk-taking leads to higher credit risk materializing for floating-rate loans when interest rates rise. In contrast, this interaction effect is not significant in the samples of banks which do not have low market shares or high

average NPLs, as those banks may be more cautious in their lending practices, so their flexible-rate loans are less exposed to risks from higher interest rates.

Overall, the net effect of higher interest rates on the ROA of banks with high NPL ratios extending loans at flexible rates can turn negative (the null hypothesis of a zero-sum of the coefficients on the interest rate of regression (4) is rejected) – in line with the finding of Altavilla et al. (2018) that tighter monetary policy can reduce profits relatively more for banks with lower asset quality.

Our findings suggest that banks experiencing the largest decrease in profitability as interest rates increase are those with higher loan loss provisioning due to riskier credit (as proxied by high average NPL ratios) and more interest rate-sensitive loans (as proxied by the flexible-rate loan measure), as well as banks whose cost of funding increases the most due to a large share of wholesale funding and those with few liquid assets. They relate closely to results obtained by Correia et al. (2024), who investigate drivers of the risk of failure for a sample of 37,000 US banks from 1865 to 2023, of which 5,000 failed. The authors report that failing banks experience a rise in NPLs and deteriorating solvency several years before failing, and following a period of rapid loan growth, while they relied more on expensive non-core funding in the run-up to the failure.

Table 8 – Return on assets and borrower-based measures

Dependent variable: Return on assets (% of average total assets)				
	(1)	(2)	(3)	(4)
Return on assets, lagged	0.514***	0.514***	0.499***	0.498***
	(53.66)	(53.68)	(50.59)	(50.61)
3-month interest rate	0.029***	0.027***	0.019***	0.016**
	(4.59)	(4.26)	(2.66)	(2.19)
Flexible rate loans x Interest rate	-0.037***	-0.037***	-0.025***	-0.025***
	(-5.55)	(-5.55)	(-3.16)	(-3.10)
BBM x Flexible rate loans x Interest rate	0.048***	0.045***	0.035**	0.031**
	(3.50)	(3.33)	(2.30)	(2.05)
Change unemployment rate	-0.047***	-0.055***	-0.051***	-0.061***
	(-9.19)	(-9.94)	(-9.99)	(-10.87)
BBM x Change unemployment rate		0.072***		0.092***
		(5.17)		(6.43)
BBM index (5-year MA)	0.121***	0.126***	-0.074	-0.103
	(2.91)	(3.04)	(-1.06)	(-1.48)
BBM x Interest rate	-0.032***	-0.032***	-0.027*	-0.021
	(-2.62)	(-2.60)	(-1.80)	(-1.40)
High deposit share x Interest rate	0.019***	0.018***	0.015**	0.014**
	(2.91)	(2.80)	(2.20)	(2.02)
Observations	30,348	30,348	30,348	30,348
Number of banks	2,147	2,147	2,147	2,147
Time-varying macroeconomic controls	Yes	Yes	Yes	Yes
Time-varying bank controls	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Country-specific time trends	No	No	Yes	Yes
Adjusted R-squared	0.418	0.419	0.424	0.425

Note: The dependent variable is winsorized at the 5th and 95th percentiles. Control variables are the same as those used in Table 7, but coefficients are not reported for all of them. *T*-stats based on robust standard errors clustered at the bank level are reported in parentheses. ***, **, * denote statistical significance at 1, 5, and 10 percent respectively.

Turning finally to the effect of borrower-based measures (Table 8), the results are in line with the findings for loan loss provisions: borrower-based measures can support bank profitability by mitigating the negative effects of higher interest rates for flexible-rate loans specifically or of higher unemployment, more generally. We do not find strong baseline effects of BBMs on bank profitability or interactions with the interest rate, however, and these effects turn insignificant once controlling for country-specific time trends and other variables (regression (4)).

5. Robustness checks

This section presents the results of several robustness checks on our main findings. Details are reported in Annex II.

5.1 Focusing on active banks

Our main sample includes both banks that are still active at the end of our sample period and banks with information ending prior to the end-point because they failed, merged with another entity, or were acquired between 2000 and 2023.[23] The latter may be more likely to have encountered financial difficulties and may have experienced higher loan loss provisions and a lower return on assets than active banks ahead of their failure or merger/acquisition.[24] To assess whether these banks' experiences are a major driver of our results, we are rerunning all of our regressions for a trimmed sample that only includes banks that were still active at end-2023. We find, however, that the results for this smaller sample are qualitatively the same as those obtained for the whole sample (Annex Table 2). In particular, flexible-rate loans are associated with higher loan loss provisions and lower ROA when interest rates are higher, and this effect is attenuated by BBMs. Likewise, the adverse effect of unemployment on loan loss provisions and profitability is mitigated by BBMs, just as in the larger sample.

5.2 Excluding the United States

US banks represent almost 40 percent of the total sample. Moreover, a relatively high proportion of US banks failed (representing more than three quarters of all failed banks of the sample), as many US banks went bankrupt in the wake of the subprime crisis, while more generally, banking failures are more common in the US than in other countries of the sample. This could give rise to a concern that differences between the US and other countries might be driving some of the results in our study. Indeed, Claessens et al. (2018), for instance, exclude the US entirely from their estimation sample, although they also report that their regression results are robust to including it. We therefore rerun all our regressions on a sample excluding the United States. As reported in Annex Table 3, the main findings of our paper for loss provisions, the non-interest margin, the non-interest income, and the ROA also hold true when excluding US banks from the estimation sample.

5.3 Using more parsimonious models

Our main regressions include a rich set of control variables. While this should help identification, it also raises the question as to whether inclusion of some of the controls could be driving some of the results. We therefore investigate whether our findings are robust to using more parsimonious models. Specifically, we drop the

[23] The estimation sample starts in 1995, but banks must have at least five years of data to be part of it.

[24] Results of regressions (not reported) indicate that banks of our sample showed higher loan loss provisions and a lower ROA several years before failing or experiencing a merger and acquisition.

squared terms on the interest rates (including when interacted with the flexible rate or the high deposit share variables), the country-specific time trends, and the time-varying bank-specific variables. Results reported in Annex Table 4 for the regressions of loan loss provisions, the net-interest margin, the non-interest income, and the ROA are qualitatively similar, implying that our main findings are maintained when dropping these controls.

5.4 Using lagged interest rate in loan loss provision regressions

The relationship between the interest rate and loan loss provisions is usually considered contemporaneously. However, the results of our regressions may underestimate the effect of the interest rate on loan loss provisions when higher interest rates may affect borrowers with some delay. Moreover, when loan loss provisions increase, the monetary policy cycle may already have switched to an easing phase. Higher levels of interest rates could therefore be more positively correlated to loan loss provisions when the interest rates enter with a lag. We re-estimate the impact of the interest rate on loan loss provisions by considering a one-year lag between the interest rate and loan loss provisions. Results reported in Annex Table 5 are qualitatively similar as when using the contemporaneous interest rate, however. In particular, the interaction effects related to the BBM index are qualitatively unchanged. Moreover, the results do not suggest that a specification using the lagged interest rate delivers more sizable or more significant positive coefficients on the effects of interest rates on loan loss provisions.

5.5 Controlling for inflation

The focus of our analysis is on the effects of policy rates, and our main regressions do not include inflation as a control (like Borio et al. 2017 or Claessens et al. 2018). However, inflation can affect bank profitability through several channels, as discussed in detail by Bergant et al. (2025). Some of these effects are direct, such as when inflation affects the debt service capacity of borrowers. Other effects are indirect, when inflation induces policymakers to change policy rates, affecting outcomes for banks.

To investigate whether not including inflation as a control leads to an omitted variable bias, we include a simple measure of realized inflation in our regressions (Annex Table 6). Overall, we obtain results that are closely aligned with those reported by Bergant et al. (2025), while our main results are largely unaffected by whether inflation is included or not.25

First, we find that inflation increases loan loss provisions as in Bergant et al. (2025), possibly because inflation reduces the real income available for borrowers that can be spent on the purchase of goods and services on the one hand, and on debt service on the other. This effect is consistent with the idea that following a bout of inflation, wages catch up with increases in the cost of goods and services only with a lag, thereby leading to a reduction in real incomes available to service debt on impact.

Second, in line with Bergant et al. (2025), we find that inflation tends to boost banks' net interest margin. One interpretation of this finding could be that deposit rates do not adjust to the increase in consumer prices, while banks have some latitude to increase rates charged on new and existing loans when inflation rises, even in the absence of an increase in the policy rate.

[25] Bergant et al. (2025) use policy rates that are orthogonal to inflation and find that expected inflation is raising the net interest margin, while unexpected inflation is raising loan loss provisions. However, neither expected inflation, nor unexpected inflation, are significantly related to the net non-interest income or to bank profitability, while higher policy rates increase loan loss provisions.

And third, again in line with Bergant et al. (2025), we find that the net effect of inflation on the banks' overall profitability is not significant, suggesting that the negative contribution from lower loan loss provisions is on average offset by the positive contribution from a higher net interest margin.

Importantly, our main findings on the effect of policy rates on each of the components of bank profits are similar as without controlling for inflation, with all the interaction effects qualitatively unchanged, suggesting that the main regressions do not suffer any biases when omitting inflation.[26]

5.6 Dropping the lagged dependent variable

The inclusion of a lagged dependent variable alongside fixed effects in panel regressions that are estimated with the least-square dummy variable (LSDV) estimator can deliver biased estimates due to the well-known Nickell (1981) bias.[27] Similar to Bergant et al. (2025) who do not include any lagged dependent variable in their regressions, we re-estimate regressions by dropping the lagged dependent variable. This eliminates the concern related to the Nickell (1981) bias (although it may also give rise to an omitted variable bias, given the strong persistence of the dependent variables). Although the value of the estimated coefficients on our variables of interest can change significantly, results are qualitatively the same (Annex Table 7). Overall, this leads to the conclusion that, while the Nickel bias could be material in principle given the small number of periods *T* relative to the number of cross-sectional units *N*, possibly affecting results qualitatively, this is not the case for the specification we use.

6. Conclusion

This paper examines the extent to which high interest rates can pose risks to bank profits and ultimately financial stability, using bank-level analysis in a large cross-country panel, and considering each of three components of bank profits (loan-loss provisions, net interest margin, and non-interest income).

We find that increases in loan loss provisions are an important risk to bank profits as interest rates rise, especially for banks extending loans at flexible rates. The effects are stronger also for banks with a low market share, thereby implying greater vulnerability to increases in rates ex post.

Importantly, we find that the tightness of macroprudential borrower-based measures in place several years before interest rates increase attenuates the rise in loan loss provisions, especially when those loans are at flexible rates. These borrower-based measures also moderate increases in provisions that would otherwise flow from an increase in unemployment.

Moreover, these effects carry through when we analyze effects on profitability (ROA). Borrower-based measures mitigate the negative effects on bank profitability of higher interest rates for banks with flexible-rate loans and of higher unemployment more generally. These findings confirm the important role played by borrower-based measures in limiting the buildup of vulnerabilities that could later materialize in the face of adverse aggregate shocks.

[26] Results are also qualitatively the same in all regressions when using the real interest rate instead of the nominal interest rate as explanatory variable.

[27] An alternative to the LSDV estimator is the system Generalized Method of Moments (GMM) estimator. However, this estimator can produce results which are very sensitive to the choice of the lag length for the instruments and to model specification, including for our sample.

The net interest margin is affected by increases in rates through a range of price and volume effects. It increases with interest rates, thereby offering a natural hedge to risks to other components of profits. However, it increases less for banks that are funded to a greater extent in wholesale markets. Moreover, for banks extending loans mainly at flexible rates, the effect of higher interest rates is complex, potentially because the net interest margin is subject to both a price effect, that leads to higher interest earnings, and a volume effect that reduces interest earnings through increases in non-performing assets.

We find that losses from securities holdings are another important source of risk for bank profits, especially in advanced economies, as reflected by the negative effect of the interest rate on the non-interest income. However, we find that this negative effect is mitigated when banks hold a high share of liquid assets, permitting them to borrow from the central bank and obviating the need to sell HTM securities at a loss.

Accordingly, this paper finds that the relationship between the level of the interest rate and the ROA, which is found in the literature to be positive for the average bank, can turn negative for subsets of banks. This can notably include banks extending more risky loans, while offering loans at flexible rates. For those banks, the positive effect of higher interest rates on the net interest margin is more than offset by larger loan losses implied by higher debt service costs and default probabilities.

The bank-level results on the effect of BBMs obtained in this study support the finding obtained at the macroeconomic level that macroprudential measures are able to increase resilience to adverse future shocks. When these measures are implemented in normal times and ahead of the increase in interest rates, they reduce the risk of financial stress as interest rates increase, and thereby provide central banks with more policy room to fight inflation (Boissay et al. 2023). In that respect, borrower-based measures introduced and/or tightened in the wake of the GFC likely supported the resilience of borrowers in face of the sharp increase in interest rates following the COVID-19 crisis.[28] This, in turn, may have contributed to a greater stability of banks in the more recent tightening episode compared to the tightening cycle that led up to the GFC.

[28] The larger share of fixed-rate mortgages also played a role in improving the resilience of households with respect to interest rate increases. Given low interest rates in the years following the GFC, many households indeed opted for fixed- rather than flexible-rate mortgages in several countries, thereby limiting the rise in their debt service burden as monetary policies tightened from 2022.

Annex I. Variable descriptions and data sources

Annex Table 1 – Variable descriptions and data sources

Variable	Description	Source
ROA	Banks' return on assets defined as pre-tax profits as a share of average total assets	Fitch Connect
Net interest margin	Banks' net interest margin defined as net interest income as a share of average total assets	Fitch Connect
Non-interest income	Banks' non-interest income defined as total non-interest operating income as a share of average total assets	Fitch Connect
Loan loss provisions	Banks' loan impairment charges as a share of average total assets	Fitch Connect
Deposits-to-total liabilities	Share of banks' deposits in total liabilities	Fitch Connect
Interest rate	Three-month interbank rate	OECD, WEO database
Bank size	Natural logarithm of total assets	Fitch Connect
Bank leverage	Equity-to-total-assets ratio	Fitch Connect
Efficiency indicator	Cost-to-income ratio	Fitch Connect
Liquidity ratio	Liquid assets to total assets	Fitch Connect
NPL ratio	Ratio of non-performing loans to total gross loans	Fitch Connect
Loan growth rate	Banks' annual loan growth rate	Fitch Connect
Credit boom	Dummy variable taking the value one in years of credit boom based on annual credit-to-GDP ratios	BIS
Variable rate loans at the country level	Indicator of the importance of banks' loans at variable rates. For each country, the importance of flexible-rate loans in the economy is classified as low, medium, or high	European Mortgage Federation via DataStream, national sources, ECB
Variable rate loans at the bank level	Indicator based on the share of mortgages in total loans at the bank level or on the business description of the bank	Fitch Connect, various sources on bank business description
Consumer price index	Quarterly average consumer price index	WEO database
Real GDP growth	Year-on-year growth rate of real GDP	WEO database
Unemployment rate	Number of unemployed persons as a percentage of the labor force	WEO database
Banking crisis	Dummy variable for years/quarters of systemic banking crises	Laeven and Valencia (2020) systemic banking crises database
Total assets of the banking sector	Country-level total commercial banking assets in domestic currency	Fitch Connect
Stock market	Stock market index	DataStream, MSCI
Housing prices	Housing price index	DataStream, Oxford Economics
Exchange rate	Domestic currency units per U.S. dollar, average	WEO database
Bank's country exposure	Bank's measure of exposure to a specific country	BIS International Banking Statistics

Annex II. Robustness checks

Annex Table 2 – Active banks only

Dependent variable:	LLP	NIM	NII	ROA
	(1)	(2)	(3)	(4)
Lagged dependent variable	0.434***	0.645***	0.591***	0.473***
	(25.49)	(29.30)	(28.52)	(34.08)
3-month interest rate	0.004	0.033***	-0.027***	0.020**
	(0.67)	(4.57)	(-3.19)	(2.12)
Flexible rate loans x Interest rate	0.020***	-0.004		-0.025***
	(3.08)	(-0.50)		(-2.68)
BBM x Flexible rate loans x Interest rate	-0.026**			0.040**
	(-2.25)			(2.22)
Change unemployment rate	0.050***	0.000	0.006	-0.031***
	(9.45)	(0.04)	(1.24)	(-4.42)
BBM x Change unemployment rate	-0.052***			0.060***
	(-5.55)			(3.78)
High share of Held-for-trading securities x Interest rate			-0.017***	
			(-3.57)	
High liquidity ratio (time-varying)			-0.005	
			(-0.35)	
High liquidity ratio (time-varying) x Interest rate			0.013***	
			(2.83)	
High deposit share x Interest rate		0.042***		0.012
		(3.73)		(1.32)
Observations	15,392	16,310	13,300	16,310
Number of banks	905	917	646	917
Time-varying macroeconomic controls	Yes	Yes	Yes	Yes
Time-varying bank controls	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Country-specific time trends	Yes	Yes	Yes	Yes
Adjusted R-squared	0.352	0.585	0.498	0.346

Note: The sample is composed of banks which were still active (that is, that did not fail, were acquired, or merged) as of end 2023. The dependent variables are winsorized at the 5th and 95th percentiles. The constant term, time-varying macroeconomic controls (standard deviation of the interest rate, growth rates of real GDP, of the stock market and of house price indices, and the change of the unemployment rate), time-varying bank controls (leverage, liquidity, cost-to-income ratio, and size), and the squared terms of the interest rate, are included but their coefficients are not reported. *T*-stats based on robust standard errors clustered at the bank level are reported in parentheses. ***, **, * denote statistical significance at 1, 5, and 10 percent respectively.

Annex Table 3 – Excluding the United States

Dependent variable:	LLP	NIM	NII	ROA
	(1)	(2)	(3)	(4)
Lagged dependent variable	0.426***	0.608***	0.520***	0.483***
	(29.91)	(29.54)	(27.49)	(36.75)
3-month interest rate	0.008	0.032***	-0.009	0.023***
	(1.10)	(4.52)	(-0.98)	(2.59)
Flexible rate loans x Interest rate	0.024***	-0.009		-0.044***
	(3.34)	(-1.01)		(-4.81)
BBM x Flexible rate loans x Interest rate	-0.042***			0.062***
	(-3.64)			(3.67)
Change unemployment rate	0.040***	0.004	0.001	-0.016***
	(8.79)	(0.76)	(0.24)	(-2.90)
BBM x Change unemployment rate	-0.027***			0.037***
	(-2.93)			(2.61)
High share of Held-for-trading securities x Interest rate			-0.011**	
			(-2.39)	
High liquidity ratio (time-varying)			-0.014	
			(-0.65)	
High liquidity ratio (time-varying) x Interest rate			0.011**	
			(2.40)	
High deposit share x Interest rate		0.035***		0.010
		(3.46)		(1.31)
Observations	20,458	21,694	18,421	21,694
Number of banks	1,338	1,357	1,060	1,357
Time-varying macroeconomic controls	Yes	Yes	Yes	Yes
Time-varying bank controls	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Country-specific time trends	Yes	Yes	Yes	Yes
Adjusted R-squared	0.316	0.565	0.407	0.354

Note: The dependent variables are winsorized at the 5th and 95th percentiles. The constant term, time-varying macroeconomic controls (standard deviation of the interest rate, growth rates of real GDP, of the stock market and of house price indices, and the change of the unemployment rate), time-varying bank controls (leverage, liquidity, cost-to-income ratio, and size), and the squared terms of the interest rate, are included but their coefficients are not reported. T-stats based on robust standard errors clustered at the bank level are reported in parentheses. ***, **, * denote statistical significance at 1, 5, and 10 percent respectively.

Annex Table 4 – Parsimonious models

Dependent variable:	LLP	NIM	NII	ROA
	(1)	(2)	(3)	(4)
Lagged dependent variable	0.429***	0.625***	0.579***	0.516***
	(37.85)	(41.75)	(38.89)	(53.84)
3-month interest rate	0.000	0.001	0.006	0.004
	(0.05)	(0.12)	(1.50)	(0.61)
High deposit share x Interest rate		0.013**		0.019***
		(2.33)		(4.06)
Flexible rate loans x Interest rate	0.013***	-0.002		-0.012**
	(4.82)	(-0.42)		(-2.19)
BBM x Flexible rate loans x Interest rate	-0.028***			0.026**
	(-3.89)			(1.99)
Change unemployment rate	0.063***	-0.023***	0.009**	-0.058***
	(15.00)	(-5.42)	(2.40)	(-10.38)
BBM x Change unemployment rate	-0.041***			0.078***
	(-4.75)			(5.58)
High share of Held-for-trading securities x Interest rate			-0.018***	
			(-4.20)	
High liquidity ratio (time-varying)			-0.014	
			(-0.95)	
High liquidity ratio (time-varying) x Interest rate			0.015***	
			(3.51)	
Observations	29,055	30,367	27,080	30,367
Number of banks	2,126	2,147	1,850	2,147
Time-varying macroeconomic controls	Yes	Yes	Yes	Yes
Time-varying bank controls	No	No	No	No
Bank fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Country-specific time trends	No	No	No	No
Adjusted R-squared	0.372	0.523	0.382	0.415

Note: The dependent variables are winsorized at the 5th and 95th percentiles. The constant term and time-varying macroeconomic controls (standard deviation of the interest rate, growth rates of real GDP, of the stock market and of house price indices, and the change of the unemployment rate) are included but their coefficients are not reported. *T*-stats based on robust standard errors clustered at the bank level are reported in parentheses. ***, **, * denote statistical significance at 1, 5, and 10 percent respectively.

Annex Table 5 – Using lagged interest rate in loan loss provision regressions

	Dependent variable: Loan loss provisions (% of average total assets)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Loan loss provisions, lagged	0.424***	0.404***	0.402***	0.402***	0.402***	0.403***	0.402***	0.402***
	(37.78)	(36.22)	(36.13)	(35.99)	(36.15)	(36.22)	(36.08)	(35.91)
3-month interest rate, lagged	0.003	0.010**	0.006	0.007	0.006	0.006	0.007*	0.001
	(0.77)	(2.54)	(1.35)	(1.56)	(1.35)	(1.48)	(1.71)	(0.17)
BBM index (5-year MA)	-0.103***	0.033	0.058	0.043	0.050	0.070	0.084*	0.089**
	(-3.76)	(0.74)	(1.33)	(0.98)	(1.13)	(1.58)	(1.90)	(2.00)
BBM x Interest rate, lagged		-0.024***	0.002	0.012	0.003	0.002	0.007	0.008
		(-3.98)	(0.19)	(1.20)	(0.35)	(0.19)	(0.75)	(0.79)
Flexible rate loans x Interest rate			0.019**	0.020**	0.019**	0.018**	0.019**	0.021***
			(2.41)	(2.45)	(2.41)	(2.31)	(2.32)	(3.11)
BBM x Flexible rate loans x Interest rate, lagged			-0.044***	-0.047***	-0.045***	-0.043***	-0.043***	-0.045***
			(-3.79)	(-3.98)	(-3.80)	(-3.66)	(-3.69)	(-4.01)
Change unemployment rate	0.058***	0.056***	0.058***	0.064***	0.058***	0.059***	0.067***	0.066***
	(15.34)	(15.05)	(15.17)	(14.82)	(15.11)	(15.16)	(14.59)	(14.44)
BBM x Change unemployment rate				-0.048***			-0.057***	-0.058***
				(-5.70)			(-5.92)	(-6.01)
Growth rate of real GDP	-0.011***	-0.014***	-0.014***	-0.014***	-0.014***			
	(-6.02)	(-7.20)	(-7.16)	(-7.18)	(-6.99)			
BBM x Growth rate real GDP					0.002			
					(0.74)			
Positive growth rate real GDP						-0.010***	-0.008***	-0.008***
						(-3.66)	(-3.12)	(-3.32)
BBM x Positive growth rate real GDP						-0.004	-0.013***	-0.013***
						(-0.92)	(-2.65)	(-2.64)
Negative growth rate real GDP						-0.023***	-0.021***	-0.021***
						(-7.09)	(-6.23)	(-6.28)
BBM x Negative growth rate real GDP						0.011**	0.002	0.002
						(2.20)	(0.40)	(0.44)
Low market share x Interest rate, lagged								0.010**
								(2.38)
Fast-growing bank during boom x Interest rate, lagged								0.004
								(1.31)
Observations	29,053	29,053	29,053	29,053	29,053	29,053	29,053	29,053
Number of banks	2,126	2,126	2,126	2,126	2,126	2,126	2,126	2,126
Time-varying macroeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-varying bank controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-specific time trends	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.376	0.385	0.386	0.386	0.386	0.386	0.387	0.387

Note: The dependent variable is winsorized at the 5th and 95th percentiles. The constant term, time-varying macroeconomic controls (standard deviation of the interest rate, growth rates of real GDP, of the stock market and of house price indices, and the change of the unemployment rate), time-varying bank controls (leverage, liquidity, cost-to-income ratio, and size), and the squared terms of the interest rate, are included but their coefficients are not reported. *T*-stats based on robust standard errors clustered at the bank level are reported in parentheses. ***, **, * denote statistical significance at 1, 5, and 10 percent respectively.

Annex Table 6 – Controlling for inflation

Dependent variable:	LLP	NIM	NII	ROA
	(1)	(2)	(3)	(4)
Lagged dependent variable	0.401***	0.599***	0.547***	0.498***
	(35.65)	(36.17)	(35.39)	(50.46)
3-month interest rate	0.008	0.025***	-0.036***	0.012
	(1.40)	(3.71)	(-4.36)	(1.37)
Flexible rate loans x Interest rate	0.025***	0.006		-0.024***
	(4.31)	(0.76)		(-2.87)
BBM x Flexible rate loans x Interest rate	-0.038***			0.030*
	(-3.56)			(1.93)
Change unemployment rate	0.060***	-0.022***	0.007**	-0.061***
	(14.44)	(-5.19)	(2.07)	(-10.78)
BBM x Change unemployment rate	-0.060***			0.095***
	(-7.05)			(6.65)
High share of Held-for-trading securities x Interest rate			-0.030***	
			(-3.21)	
High liquidity ratio (time-varying)			-0.010	
			(-0.89)	
High liquidity ratio (time-varying) x Interest rate			0.013***	
			(3.31)	
High deposit share x Interest rate		0.026***		0.016**
		(2.92)		(2.01)
Inflation	0.009***	0.011***	0.004	-0.004
	(3.67)	(4.00)	(1.13)	(-1.55)
Observations	29,053	30,348	27,075	30,348
Number of banks	2,126	2,147	1,850	2,147
Time-varying macroeconomic controls	Yes	Yes	Yes	Yes
Time-varying bank controls	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Country-specific time trends	Yes	Yes	Yes	Yes
Adjusted R-squared	0.390	0.537	0.399	0.425

Note: The dependent variables are winsorized at the 5th and 95th percentiles. The constant term, time-varying macroeconomic controls (standard deviation of the interest rate, growth rates of real GDP, of the stock market and of house price indices, and the change of the unemployment rate), time-varying bank controls (leverage, liquidity, cost-to-income ratio, and size), and the squared terms of the interest rate, are included but their coefficients are not reported. *T*-stats based on robust standard errors clustered at the bank level are reported in parentheses. ***, **, * denote statistical significance at 1, 5, and 10 percent respectively.

Annex Table 7 – Dropping the lagged dependent variable

Dependent variable:	LLP	NIM	NII	ROA
	(1)	(2)	(3)	(4)
3-month interest rate	0.004	0.035***	-0.063***	0.038***
	(0.46)	(2.80)	(-6.06)	(3.44)
Flexible rate loans x Interest rate	0.040***	-0.004		-0.053***
	(5.29)	(-0.34)		(-4.46)
BBM x Flexible rate loans x Interest rate	-0.057***			0.067***
	(-3.71)			(2.73)
Change unemployment rate	0.062***	-0.022***	-0.000	-0.075***
	(13.31)	(-3.67)	(-0.03)	(-10.72)
BBM x Change unemployment rate	-0.062***			0.106***
	(-6.19)			(6.43)
High share of Held-for-trading securities x Interest rate			-0.022***	
			(-2.73)	
High liquidity ratio (time-varying)			-0.024	
			(-1.45)	
High liquidity ratio (time-varying) x Interest rate			0.024***	
			(3.99)	
High deposit share x Interest rate		0.060***		0.042***
		(3.98)		(3.93)
Observations	29,298	30,348	27,081	30,348
Number of banks	2,130	2,147	1,850	2,147
Time-varying macroeconomic controls	Yes	Yes	Yes	Yes
Time-varying bank controls	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Country-specific time trends	Yes	Yes	Yes	Yes
Adjusted R-squared	0.271	0.279	0.129	0.241

Note: The dependent variables are winsorized at the 5th and 95th percentiles. The constant term, time-varying macroeconomic controls (standard deviation of the interest rate, growth rates of real GDP, of the stock market and of house price indices, and the change of the unemployment rate), time-varying bank controls (leverage, liquidity, cost-to-income ratio, and size), and the squared terms of the interest rate, are included but their coefficients are not reported. *T*-stats based on robust standard errors clustered at the bank level are reported in parentheses. ***, **, * denote statistical significance at 1, 5, and 10 percent respectively.

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