LAPSE OF TIME

SM/20/94

May 1, 2020

To: Members of the Executive Board

From: The Secretary

Subject: **April 2020 Global Financial Stability Report—Analytical Chapter 4**

Board Action:	Further to the Executive Board discussion on April 7, 2020, this Analytical Chapter of the Global Financial Stability Report is being circulated for **Executive Directors' comments** in advance of publication.
Deadline to Provide Comments:	**Friday, May 15, 2020** **12:00 (noon)**
Publication:	Proposed, after Friday, May 15, 2020
Questions:	Mr. Natalucci, MCM (ext. 37108) Mr. Raddatz Kiefer, MCM (ext. 36636) Mr. Kerry, MCM (ext. 37204)
Additional Information:	The paper will be revised for publication in light of the comments from Executive Directors. If Executive Directors have comments, they should notify Mr. Natalucci (ext. 37108), Mr. Raddatz Kiefer (ext. 36636), and Mr. Kerry (ext. 37204) by **12:00 p.m. on Friday, May 15, 2020.**

CHAPTER 4

BANKING SECTOR

CONTENTS

Low Rates, Low Profits?

Chapter 4 at a Glance

- Over the past decade, very low interest rates have been associated with compressed bank net interest margins in several advanced economies, and this should continue over the medium term.
- The support to earnings provided by falling rates in recent years—stemming from gains on securities holdings and lower provisions—will fade in the medium term, putting sustained pressure on banks' profits.
- Cost cutting and higher fee income should help, but these mitigating factors are unlikely to fully lessen pressures on banks' profitability.
- Looking ahead, there is a danger that profitability challenges could induce banks to take on excessive risks once the economy fully recovers.
- Once the COVID-19 emergency is resolved, a combination of structural and financial policies could help mitigate future vulnerabilities and ensure an adequate supply of credit to the economy.

Profitability has been a persistent challenge for banks in several advanced economies since the global financial crisis. While monetary policy accommodation has helped sustain economic growth during this period and has provided some support for bank profits, very low interest rates have compressed banks' net interest margins (the difference between interest earned on assets and interest paid on liabilities). Looking beyond the immediate challenges faced by banks as a result of the coronavirus (COVID-19) outbreak, a persistent period of low interest rates is likely to put further pressure on bank profitability over the medium term. A simulation exercise conducted for a group of nine advanced economies indicates that a large fraction of their banking sector, by assets, may fail to generate profits above their cost of equity in 2025. Once immediate challenges recede, banks could take steps to mitigate pressures on profits, including by increasing fee income or cutting costs, but it may be challenging to fully mitigate profitability pressures. Over the medium term, banks may seek to recoup lost profits by taking excessive risks. If so, vulnerabilities could build in the banking system, sowing the seeds of future problems. Authorities can take a number of policies to help mitigate vulnerabilities arising from excessive risk taking and ensure an adequate flow of credit to the economy, including the removal of structural impediments to bank consolidation, the incorporation of a low-interest-rate-environment scenario on banks' risk assessments and supervision, and the use of macroprudential policies to tame banks' incentives for excessive risk taking.

Banks Have Faced Persistent Profitability Challenges

1. Banks globally have more and better-quality capital, hold more liquid assets, and borrow less from short-term markets than they did before the global financial crisis. This means that, on

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aggregate, the banking sector is better prepared to confront losses and liquidity stresses. The resilience of banks, however, may be tested in some countries in the face of the sharp slowdown in economic activity resulting from the COVID-19 pandemic and the associated, necessary containment measures, especially if the downturn turns out to be more severe and lengthier than currently anticipated.

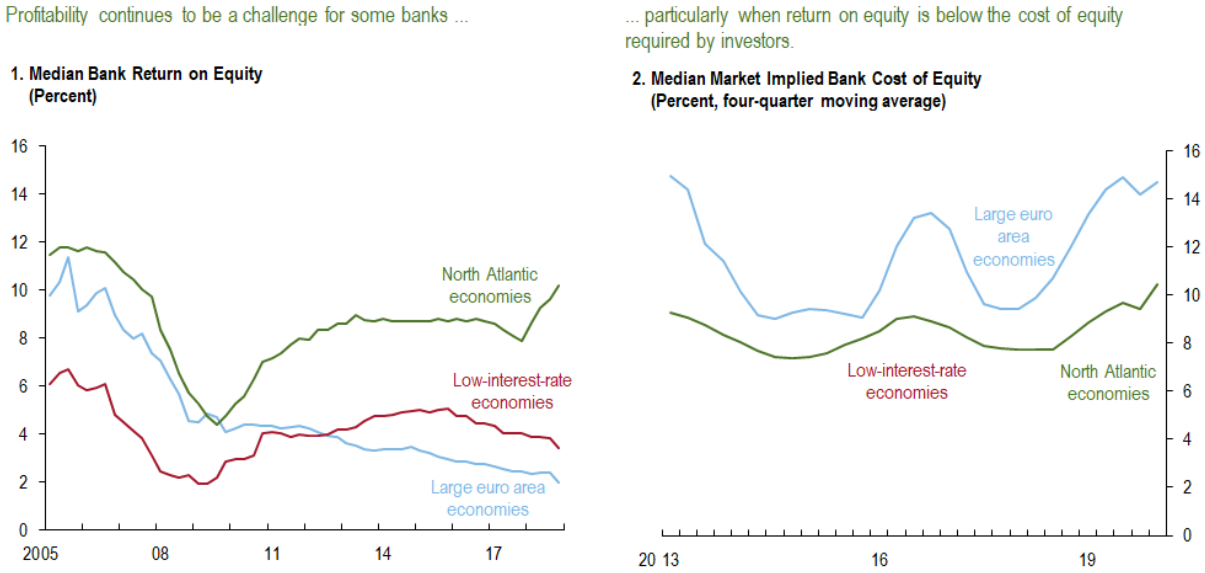
2. Rather than looking at the immediate challenges facing banks, which are discussed in detail in Chapter 1, this chapter focuses on bank profitability over the next few years in an environment of persistent low interest rates and flat yield curves. The analysis is based on a large sample of banks in nine advanced economies—the Group of Seven economies plus two other advanced economies that currently have, or have experienced, negative policy rates. These countries are divided into the North Atlantic economies (Canada, United Kingdom, United States), the large euro area economies (France, Germany, and Italy), and the low-interest- rate economies (Japan, Sweden, Switzerland). The chapter presents an econometric analysis of the drivers of bank profitability and a novel forward-looking simulation of profitability to illustrate the challenges banks could face in a scenario consistent with the latest medium-term projections of economic activity in the *World Economic Outlook* and market expectations of interest rates.[1]

3. Bank profitability challenges came to the fore during the global financial crisis, which delivered a devastating blow to bank profits in these advanced economies (Figure 4.1, panel 1). Over time, profitability has recovered in North Atlantic banks (particularly in Canada and the United States), where interest rates have been higher. However, there has been less improvement among banks in large euro area countries beset with the sovereign debt crisis; low economic growth; and a number of structural challenges, such as high operational costs and debt overhang (as discussed in the April 2017 *Global Financial Stability Report* [GFSR]). Profits in the low-interest-rate economies—especially Japan—have been weak for years, and this trend has been deepening as policy rates have been cut further.

4. Profitability is a concern because it affects bank resilience. While a very high level of profitability could indicate excessive risk taking, low profits mean that it takes longer for banks to build capital against unexpected losses. Slower capital accumulation also constrains banks' provision of credit to support the economy and their ability to absorb shocks, such as mark-to-market losses on their investments or credit losses on loans extended to households and firms. Consistently weak profitability—where the ex-post return on equity is below the ex-ante cost of equity capital (the return that shareholders require)—also makes it more difficult for banks to raise new capital from the market.

[1]The number of banks included varies across the exercise because of their different data requirements. While the econometric exercise relies on a sample of about 12,000 banks, the estimation of the effective maturity profiles that are fed into the forward-looking simulation and the actual simulation rely on 1,000 banks. The details of the sample composition are reported in Online Annex 4.1 (all annexes are available at www.imf.org/en/Publications/GFSR). Consolidated data for individual banks are used for these analyses.

Figure 4.1. Large Advanced Economy Bank Profitability and Equity Market Valuations



Sources: Bloomberg Finance L.P; S&P Market Intelligence; SNL Financial; and IMF staff calculations.
Note: The figure is based on a sample of banks in nine advanced economies. Large euro area economies = France, Germany, Italy; Low-interest-rate economies = Japan, Sweden, Switzerland; North Atlantic economies = Canada, United Kingdom, United States.

5. This last factor provides a useful benchmark for profitability. Banks with a return on equity below the cost of equity can be said to have an insufficient level of profitability. In this chapter, the cost of equity is measured as the ratio of a bank's return on equity to the price-to-book ratio (this formulation is based on the Gordon growth model; see Online Annex 4.1).[2] While this market-implied cost of equity varies over time, the median for each region has ranged from 8 percent to 14 percent since 2013 (Figure 4.1, panel 2).

6. A decline in interest rates can affect bank profitability through four main channels.[3]

- *Changes in net interest margins*: The replacement of maturing loans by new ones issued at lower interest rates, along with a repricing of bank deposits and other funding instruments, affects banks' net interest margins.[4] Between 2013—the year immediately after the euro area debt

[2]According to the Gordon growth model, the share price of a firm can be written as the ratio of its dividend per share to the difference between its cost of equity and long-term growth of earnings. Under the usual assumption that earnings remain stable in the long term, the formula described above can be easily derived (see Online Annex 4.1). Alternative methods can be used to estimate the cost of equity. For example, Kovner and van Tassel (2019), using the capital asset pricing model, estimates US banks' cost of equity at 10.5 percent. Surveys of banks, conducted by the European Banking Authority (2018), find that two out of three banks estimate that their cost of equity was between 8 percent and 10 percent.

[3]These four channels are always present, but the overall direction of variables, such as provisions or credit, will depend on whether the decline in interest rates takes place in response to other shocks. For instance, adverse macroeconomic shocks, such as the recent COVID-19 shock, can induce policymakers to cut short-term policy rates and, at the same time, trigger adverse movements in all four of the channels that affect bank profitability described above, and this could lead to a situation where low rates coincide with higher credit losses and lower credit growth.

[4]This repricing effect depends on the whole term structure of interest rates—the rates prevailing at different maturities, their past trajectory, the prevalence of fixed and floating rate loans, and the use of interest rate derivatives, for example for hedging purposes.

crisis—and 2015, interest rates on deposits fell at a faster rate, on average, than rates on loans, helping cushion the impact on net interest margins (phase 1 in Figure 4.2, panel 1). After 2015, however, deposit rates flattened out while interest rates on loans continued to fall (phase 2 in Figure 4.2, panel 1). This dynamic led to a fall in net interest margins in many countries (Figure 4.2, panel 2).

- *Declines in loan loss provisions*: Low interest rates can stimulate economic activity (Box 4.1 discusses this in more detail). Continued accommodative monetary policy—including asset purchase programs, forward guidance, and negative policy rates—has been crucial in supporting the global economic recovery over the past decade and is playing a key role in responding to the COVID 19-related challenges currently faced by the global economy. A more dynamic economy benefits households and firms by increasing their incomes and profits while, at the same time, lower rates reduce their interest burdens. These two factors tend to reduce borrowers' probability of default, enabling banks to lower their provisions against expected loan losses.
- *Higher credit growth*: Low interest rates and higher economic activity stimulate credit growth, resulting in higher revenues for a given level of net interest margins. However, this would not mechanically result in higher return on assets, unless the expansion took place through a shift to customer loans from lower yielding securities and interbank assets. Higher credit growth, nevertheless, could lead to an increase in return on equity if the expansion in assets is accompanied by an increase in leverage.
- *Higher noninterest income*: A more dynamic economy could also result in higher noninterest income (for example, through fees) if some activities, such as mergers and acquisitions, become more prevalent. Another source of banks' noninterest income—gains on their securities portfolios—could also increase when rates decline, as the latter would lead to a rise in asset prices (Figure 4.2, panel 3).

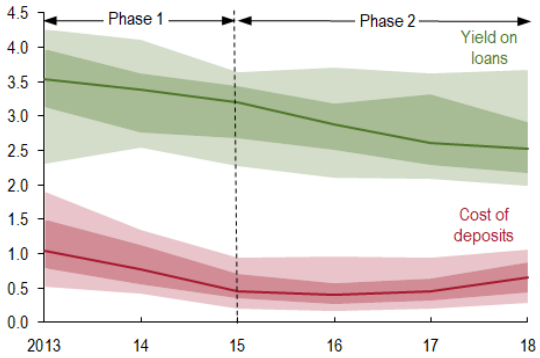
7. The change in the median bank's profitability as a result of these various channels is shown in Figure 4.2 (panel 4) for 2013–18. While the compression in net interest margins has contributed importantly to lower median net interest income in most countries, this has been partly offset by lower provisioning and, in a few cases, higher noninterest income. Banks have also sought to offset lower revenues by cutting operating expenses. The overall result has been mixed so far, with median return on assets actually rising in three of the economies, falling in four others, and remaining stable in the other two. This result is consistent with a strand of the literature that estimates that low rates have had little impact on bank profitability so far but express concern that further cuts or prolonged low rates will depress future profitability (see, for example, IMF 2017).

8. An econometric exercise for the nine banking systems considered in this chapter reveals how much of the fall in net interest margins between 2013 and 2018 has been due to lower rates and flatter yield curves. This analysis relates bank net interest margins to bank characteristics, the economic environment, short-term interest rates, and the term spread between long- and short-

Figure 4.2. Interest Rates and Bank Profits

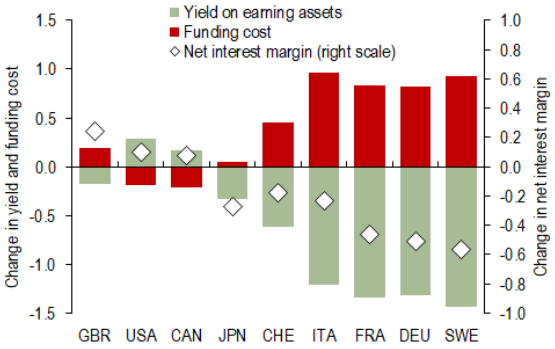
Bank deposit rates fell quickly but have stabilized near zero, while bank lending rates have continued to fall ...

1. Bank Interest Rates across Economies (Percent)



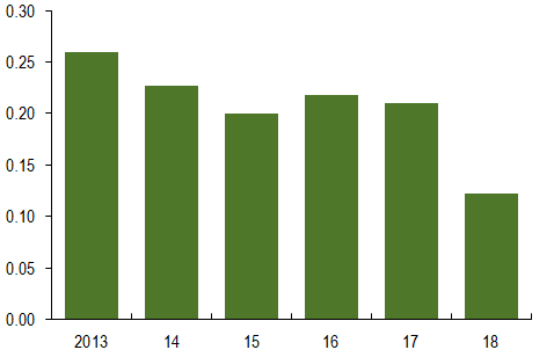
... which has squeezed bank net interest margins.

2. Change in Bank Yields and Funding Costs, 2013—18 (Percentage points)



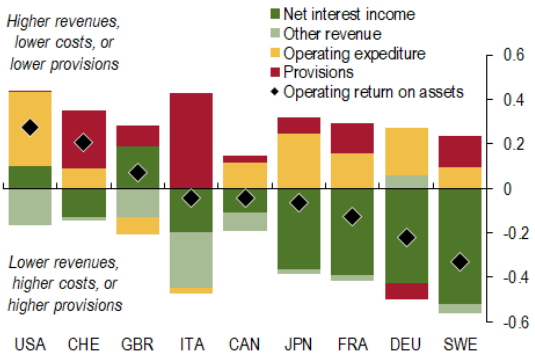
Gains on securities have been shrinking and this trajectory may continue.

3. Banks' Net Gain on Securities (Percent of assets)



Lower net interest income has been partly offset by a cut back in provisioning and lower operating expenses.

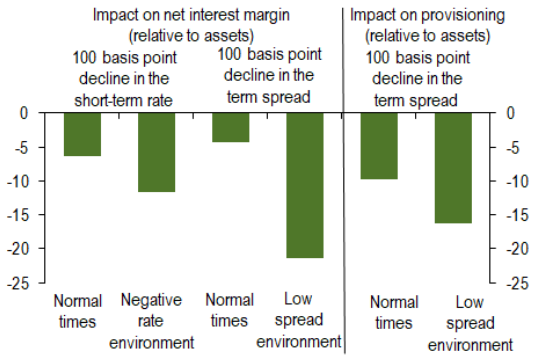
4. Change in Median Bank's Return on Assets, 2013—18 (Percentage points)



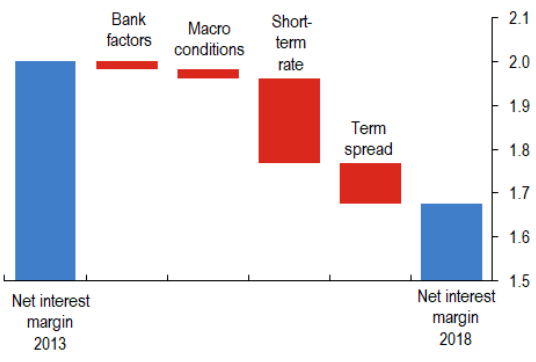
These results are supported by an econometric analysis ...

... which can be used to illustrate the main drivers of the fall in net interest margins.

5. Impact of a Decline in Rates and Term Spreads on Bank Net Interest Margins and Provisions (Basis points)



6. Contributions to the Change in Net Interest Margins: Large Euro Area and Low-Interest-Rate Economies (Percentage points)



Sources: Bloomberg Finance L.P; European Central Bank; Fitch Connect; Haver Analytics; S&P Market Intelligence; SNL Financial; and IMF staff calculations.
Note: The figure is based on a sample of banks from nine large advanced economies. In panel 1, the shaded areas show the 10th-90th percentiles of the interest rates across the nine economies, while the dark shading shows the 25th-75th percentiles, and the line shows the median. Panels 5 and 6 are based on the econometric exercise described in Online Annex 4.1. In panels 2 and 4, data labels use International Organization for Standardization (ISO) country codes.

term interest rates (see Online Annex 4.1 for an explanation of the methodology).[5] The analysis—summarized in Figure 4.2, panel 5—indicates that a 100 basis point decline in short-term interest rates reduces net interest margins (relative to assets) for the average bank in the sample by about 6 basis points in normal times (when short-term interest rates are positive); this effect, however, is larger—12 basis points—when short-term interest rates are negative, indicating a nonlinear relationship. Similarly, a 100 basis point fall in the term spread leads to a decline in net interest margins (relative to assets), on average, and this effect is much larger—at nearly 21 basis points—in a period of low spreads (when the spread between the 10-year and 3-month rates is below 1 percent).[6]

9. The same exercise also confirms the offsetting impact that lower interest rates can have on bank profitability through lower provisioning (Figure 4.2, panel 5). A 100 basis point decline in the term spread is estimated to lead to a 15 basis point fall in provisions (relative to assets) in a low spread environment. In addition, a 1 percent increase in economic growth is associated with a 1.2 basis point reduction in the ratio of loan loss provisions to assets.

10. The results from this econometric exercise can also be used to decompose the relative importance of the interest rate environment and other factors in driving changes in net interest margins (Figure 4.2, panel 6). Such a decomposition reveals that, for the average bank in the large euro area and low-interest-rate economies included in the sample, lower short-term rates and a tightening in term spreads can account for a sizable part of the fall in net interest margins over 2013–18.[7] The role of the interest rate environment is relatively lower in North Atlantic economies over this period.

Bank Profits are Likely to Come under Further Pressure

11. The bank profitability outlook for the near-term (2020–21) is likely to be adversely affected by sharply rising credit costs due to the economic downturn resulting from the COVID-19 outbreak (see Chapter 1). As discussed, banks in most of the countries considered in this chapter had already displayed significant margin pressure before this shock materialized. That margin compression is likely to persist and intensify as longer-term rates have declined

[5]Bank characteristics include lagged values of the deposit-to-liabilities ratio, capital ratio, and the ratio of securities to assets; the economic environment includes the contemporaneous growth rate of real GDP and inflation, and the current forecasts of these variables for the upcoming year; the short-term rate corresponds to the 3-month benchmark rate for each country; and the term spread corresponds to that between the 10-year and 3-month benchmark rates. The short-term rate is also interacted with a dummy that takes the value 1 when the rate is negative, and the term spread is interacted with a dummy that takes the value 1 when the spread is below 1 percent (the 10th empirical percentile). Each of these dummies is also included in the specification. Furthermore, dummies for the years of the global financial crisis and the European sovereign crisis are included (see Online Annex 4.1 for a detailed discussion and presentation of the econometric results). This specification closely follows those previously used in the literature, such as Borio, Gambacorta, and Hofmann (2017) and Claessens, Coleman, and Donnelly (2018).

[6]Other studies (Borio, Gambacorta, and Hofmann 2017; Claessens, Coleman, and Donnelly 2018; Eggertsson and others 2019) are consistent with these observations: net interest margins decline with falling rates and declining term spreads (flattening yield curves); these effects are nonlinear as short-term rates approach zero and they are particularly nonlinear when policy rates fall below zero.

[7]An alternative specification of this econometric analysis, where there is a full set of time fixed effects, assigns the biggest role to macro factors—which include these fixed effects—than presented here, followed by the short-term rate and the term spread.

sharply as a result of more accommodative monetary policy (while deposit rates have already stabilized to levels close to zero). Furthermore, two key earnings tailwinds—falling loan-loss provisions and investment and trading gains linked to falling interest rates—had been largely exhausted by the end of 2018, and are increasingly unable to remediate margin pressure going forward. Thus, underlying profitability pressures are likely to persist over the medium- and longer-term even once the global economy begins to recover from the current shock.

12. This chapter quantifies these pressures by simulating bank profitability over the next five years for the nine economies covered in this chapter.[8] The simulation uses market expectations of benchmark interest rates and the baseline IMF economic growth and inflation forecasts.[9] Investors expect short-term interest rates to remain at very low levels for a while and term spreads to recover gradually over the next few years, albeit to levels below historical norms and with different trajectories across countries (Figure 4.3, panel 1).

13. In the baseline IMF scenario, growth is expected to experience a sharp contraction in 2020 and start recovering in 2021. However, because of the unprecedented nature of the shock affecting the global economy, there is considerable uncertainty about the intensity and duration of the economic contraction, and risks to the outlook are on the downside, as discussed in the April 2020 *World Economic Outlook*. Moreover, although the forecasts should account, at least to some extent, for the support provided by the recent monetary, fiscal, and financial policy actions, the simulation does not consider the direct implications of measures directly targeting the banking sector or providing relief to borrowers, among others.

14. The simulation incorporates the four channels through which the future interest rate and growth trajectories affect bank profitability, as previously discussed: (1) changes in net interest margins resulting from the repricing of maturing loans and deposits, (2) changes in loan-loss provisions resulting from the interest rate and economic environment, (3) changes in credit growth associated with economic growth, and (4) noninterest income.

15. The repricing of loans and deposits depends on the "effective repricing maturity" of the stock of loans and deposits, which is sensitive to the prevalence of floating rates and the use of interest rate derivatives. These effective maturities are estimated using a model of bank interest income dynamics over 2005–18 (see Online Annex 4.1), which suggests that loans are repriced every three to six years and deposits every two to three years, on average, across the nine economies.[10] These estimated maturities, along with forecasts of interest rates, are used to

[8]For data availability reasons, the simulation uses December 2018 as the starting point. The simulated values for 2019 use the realized growth rates and interest rate data. For the rest of the simulation period, growth forecasts correspond to those of the April 2020 *World Economic Outlook*. Interest rates correspond to effective rates until the first quarter of 2020 and to forward market rates for the 1-month, 3-month and 10-year benchmark bonds of each of the sample countries prevailing at April 6, 2020.

[9]The simulation was also conducted using consensus forecasts for growth, inflation, and interest rates released April 9–14, 2020, obtaining similar results to those described below.

[10]Effective maturities are estimated by looking at the historical relationship between average yields (on bank assets and liabilities), short-term rates, and the slope of the yield curve. Effective maturities are estimated at the country level and are assumed to be constant for all banks domiciled in that country (see Online Annex 4.1 for more details). These effective maturities implicitly account for the amount of fixed and floating rate assets and liabilities, as well as the degree of hedging against interest rate risk. Effective maturities of deposits are longer than

simulate the evolution of yields on loans and the cost of funding—the main two components of net interest margins—for the average bank in each economy. In doing so, it is assumed that deposit rates have a floor at zero because negative rates have so far been applied only to part of banks' deposit bases.[11] While the model of interest income dynamics cannot be separately estimated for global systemically important banks because of data availability issues, the simulation incorporates a lower sensitivity of net income to interest rate movements for these banks. This observation is in line with other econometric evidence indicating that net interest margins of global systemically important banks are less sensitive to declines in interest rates than other banks.[12]

16. The evolution of loan-loss provisions and the fee income component of noninterest income are modeled as a function of economic growth, short-term interest rates, and the term spread, based on econometric results. These models capture the historical relationships between these variables and, as such, they may not fully incorporate the impact of the unprecedented COVID-19 shock and the implications of recent bold and sizable policy measures, adding uncertainty to the estimates.[13] For example, as noted in Chapter 1, bank resilience may not be as severely impacted in the current episode as in the past, given that the historical relationship between economic growth and credit losses may be weaker in light of the large amounts of fiscal and other support measures being provided.

17. Credit growth is derived from a Bayesian vector autoregression model used to estimate effective repricing maturities, ensuring consistency between the estimates. This model captures the downside pressure on credit growth resulting from the deterioration in the near-term economic outlook and the compensating effect of declining interest rates, but does not explicitly (other than what is incorporated in market interest rates) account for the consequences of other recent policy actions aimed at supporting flow of credit to the economy.

18. Potential gains on securities' investments (the other main components of noninterest income) are kept constant relative to assets because of lack of data on banks' securities' portfolios. The near-term impact of this omission is difficult to assess but, in the medium term, is likely to overstate simulated profits because, as rates remain at low levels in the simulation and eventually move up, there are likely to be few gains on securities. As is usual in simulation

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contractual maturities as they incorporate the stickiness of deposits (particularly those in checking or sight accounts with overnight contractual maturities) with respect to changes in interest rates.

[11]Relaxing this assumption and allowing the deposit rate to fall to a minimum of –50 basis points does not significantly change the results.

[12]See Online Annex 4.1. This is likely because these more sophisticated banks, with deeper treasury and balance sheet management capacities, may use interest rate swaps to hedge against changes in interest rates.

[13]In principle, the near-term consequences for provision expenses may be ambiguous as the magnitude of the shock may lead to greater provisioning while the flexibility provided by the regulatory and accounting response may allow banks to smooth them through the cycle. In addition, fiscal measures aimed at supporting households and firms that would otherwise default may alter historical patterns. Furthermore, government loan guarantees may reduce the need for provisioning for years to come as some of these guarantees covers a relatively long horizon. Fresh estimates of provision expenses released by major US banks for 2020 suggest that, on balance, provision expenses may be larger in the near term than those modelled from historical patterns. An important part of these increases in provisions is related to credit cards, which may in turn reflect uncertainty and record high unemployment in recent weeks. However, some banks have also reported increases in non-fee income associated with the expanded trading activity in light of the sharp rise in volatility seen in recent months.

exercises, the composition of bank balance sheets is assumed to remain unchanged. This rules out endogenous changes in asset and liability composition, which would require a fully-fledged model of bank behavior.

19. The simulated path of interest rates is shown in Figure 4.3, panel 2. At the start of the simulation, new loans are issued at lower rates than those of maturing loans, while funding costs remain relatively unchanged, resulting in a continued reduction in net interest margins (this is a continuation of phase 2 previously discussed). Then, in phase 3, deposit rates fall further until they hit the zero lower bound, reflecting easing of monetary policy.[14] In phase 4, there is another round of net interest margin compression as interest rates on loans continue to fall, while deposit rates remain around zero. Finally, in the last phase, interest rates on loans start to increase gradually, as do deposit rates in some countries.

20. Based on historical relationships, the sharp economic contraction in 2020 will lead to higher provision expenses (Figure 4.3, panel 3). As discussed above, the actual change in provisions in the current conjuncture may differ importantly from historical patterns, adding uncertainty to this trajectory.[15] Over the rest of the simulation, provisioning declines as economic growth recovers. Nonetheless, the important message from the simulation is that the medium-term dynamics of profitability are dominated by further compression in net interest income.

21. Overall, these simulations suggest that bank profitability will likely remain under pressure over the next five years. Across country groups, even after the contraction in profitability in 2020-21 fades, most banks in the simulation see a reduction in return on assets by 2025 relative to their recent, already-low levels (Figure 4.3, panel 4). While the low interest-rate environment puts pressure on net interest margins across all regions, banks in low-interest-rate economies tend to benefit less from the future economic recovery than others because provisioning and net interest margins are already very low by historical standards and rates are not expected to rise by much. In the large euro area economies, the simulation foresees a cut-back in provisions and a small increase in noninterest income in the medium term that enables a fraction of banks (by assets) to increase profits relative to 2018 levels. Nonetheless, return on assets in 2025 remains below current levels for most banks in the region. Banks in the North Atlantic economies are also not immune from profitability pressures, largely driven by net interest margin compression.

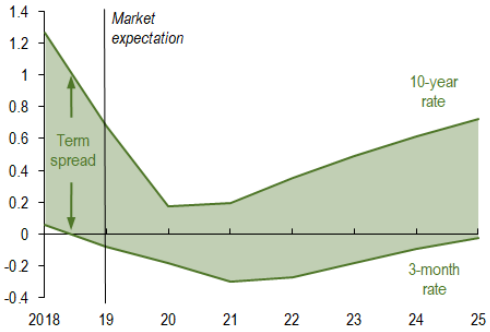
[14]As discussed above, this simulation does not explicitly incorporate the consequences of the direct measures aimed to the banking sector that may result in lower cost of funding in the near term, but the quick decline in the cost of deposits obtained from the model is consistent with this mechanism.

[15]For instance, loan loss guarantees would have a dampening effect on provisions in the near term and flatten the decline in provision expenses in the medium term. The use of regulatory flexibility could have a similar effect. At the same time, earnings management by banks may have the opposite effect on the trajectory of provisions.

Figure 4.3. Bank Profitability Simulation Results

In the simulation, interest rates and term spreads are assumed to remain at low levels ...

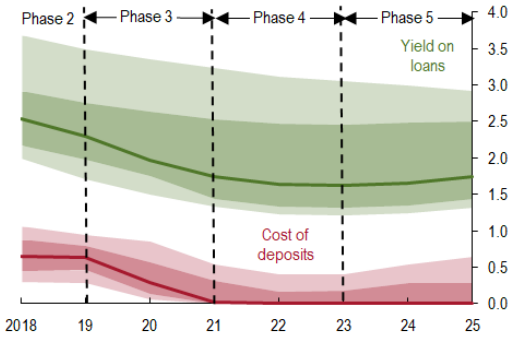
1. Median Interest Rate Assumptions across Economies (Percent)



Lower net interest income is partly offset by lower provisions ...

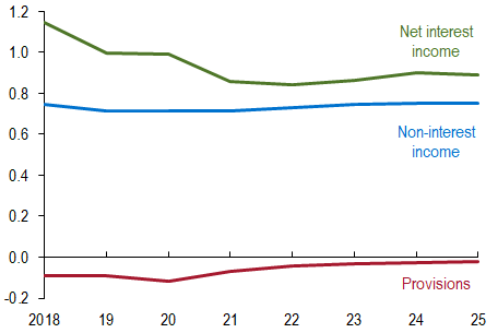
... and this passes through to interest rates on bank loans and deposits.

2. Simulated Path of Bank Interest Rates (Percent)



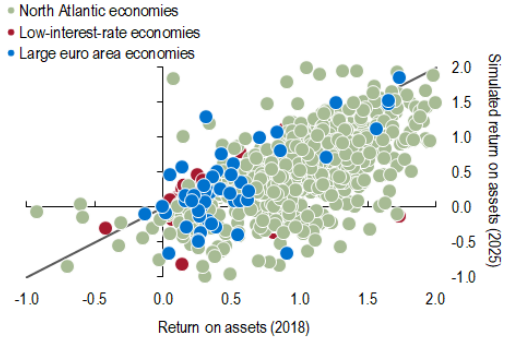
... but overall profitability falls in most of the banks in the sample.

3. Simulated Median Profitability across Economies (Percent of assets)



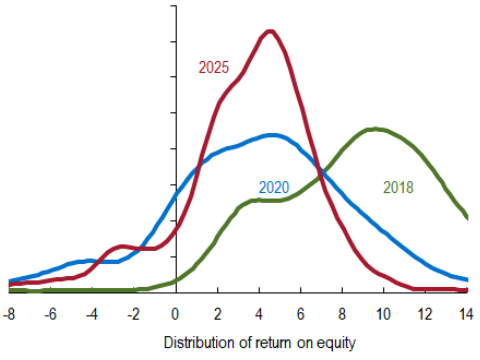
Return on equity falls materially across the banks in the sample ...

4. Return on Assets, 2018 and Scenario Estimates for 2025 (Percent)

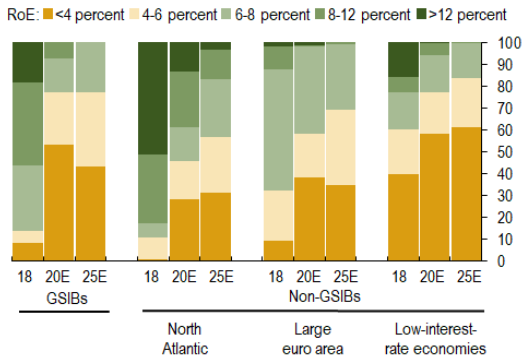


... though profits are weakest in the large euro area and low interest rate economies.

5. Return on Equity Distributions (Percent)



6. Simulated Return on Equity, by Region (Percent of sample assets)



Sources: Bloomberg Finance L.P.; Fitch Connect; S&P Market Intelligence; SNL Financial; and IMF staff calculations.
Note: Results are based on the nine advanced economies covered in this chapter. In panel 2, the shaded areas show the 10th-90th percentiles of the interest rates across the nine economies, while the dark shading shows the 25th-75th percentiles, and the line shows the median. E = estimated; GSIBs = global systematically important banks; Large euro area economies = France, Germany, Italy; Low-interest-rate economies = Japan, Sweden, Switzerland; North Atlantic economies = Canada, United Kingdom, United States; ROE = return on equity.

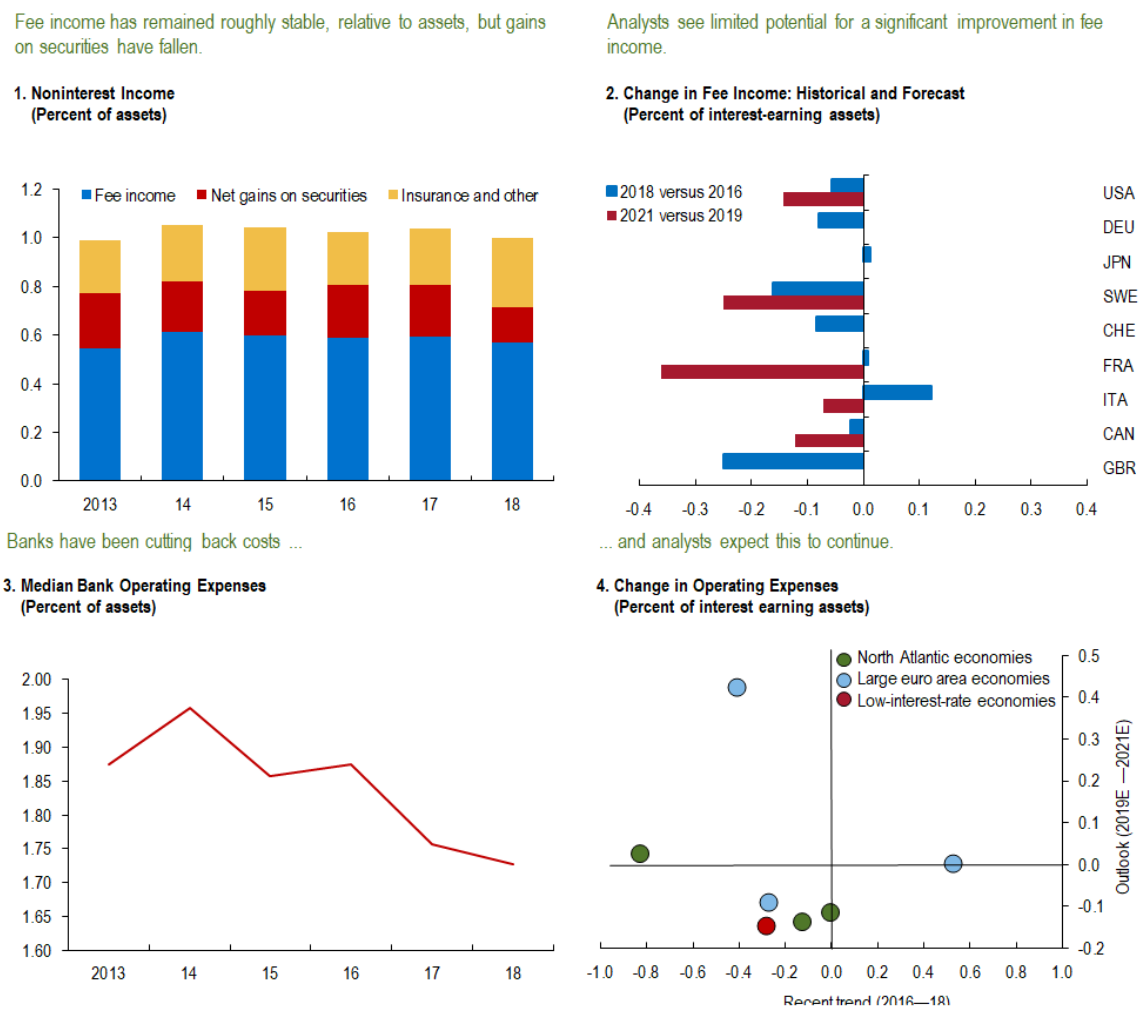
22. Declining profits compromise the ability of banks to generate a return on equity commensurate with estimates of the cost of equity. The simulated distribution of return on equity in 2025 is markedly to the left of the one observed in 2018 and not very different from the distribution simulated for 2020, indicating that profitability pressures persist well beyond the immediate impact of the deterioration in the economic outlook (Figure 4.3, panel 5). In addition, a large fraction of banks in the sample generates a return on equity below 8 percent—the lower end of the current estimates for the cost of equity previously discussed. Profitability challenges at global systemically important banks are set to continue beyond the near term, with simulated return on equity in 2025 somewhat better than in 2020, but still deteriorating relative to 2018 (Figure 4.3, panel 6). A similar pattern is observed outside of the group of global systemically important banks, where most of the banks still have weak return on equity in 2025, especially in large euro are and low interest rates economies.

Substantial Action Will Be Needed to Fill the Earnings Shortfall

23. The sharp economic downturn resulting from COVID-19 will likely hurt bank earnings through mark-to-market and credit losses (see Chapter 1). However, banks' earnings challenges emerged prior to the recent COVID-19 episode, and will extend to at least 2025, well beyond the immediate effects of the current situation. Banks' capacity to mitigate these continuing, structural profitability pressures from low interest rates will therefore depend on their ability to further increase noninterest income or cut operating costs in an environment of increasing competition from Fintech and nonbank financial intermediaries.

24. Noninterest income includes two broad components: fees and gains on securities. As discussed, gains on securities holdings will likely decline further when interest rates stabilize, so an improvement of noninterest income must derive largely from generating more fee income. However, fees appear to offer little additional potential upside to profitability. From 2013 to 2018, fee income (relative to assets) was fairly flat across advanced economy banks, on aggregate (Figure 4.4, panel 1). There were, however, some differences across economies. While fee income fell in Canada, Germany, Sweden, the United Kingdom, and the United States over 2016–18, it rose (albeit to different degrees) in France, Italy, and Japan (blue bars in Figure 4.4, panel 2). In addition, significant fee income pools appear structurally mature (capital markets sales and trading revenue have shrunk steadily over the past decade) or subject to technology-based market erosion (payments and transaction banking). Analysts are therefore forecasting falling fee income relative to assets (red bars in Figure 4.4, panel 2).

Figure 4.4. Key Mitigants of Declining Profitability: Noninterest Earnings Levers



Sources: S&P Market Intelligence; SNL Financial; and IMF staff calculations.
Note: The figure is drawn using the nine advanced economies covered in this chapter. In panel 4, data for 2019E to 2021E are estimated. 2021 estimates for Swiss and Japanese banks, and 2021 fee income estimates for UK banks, are unavailable.

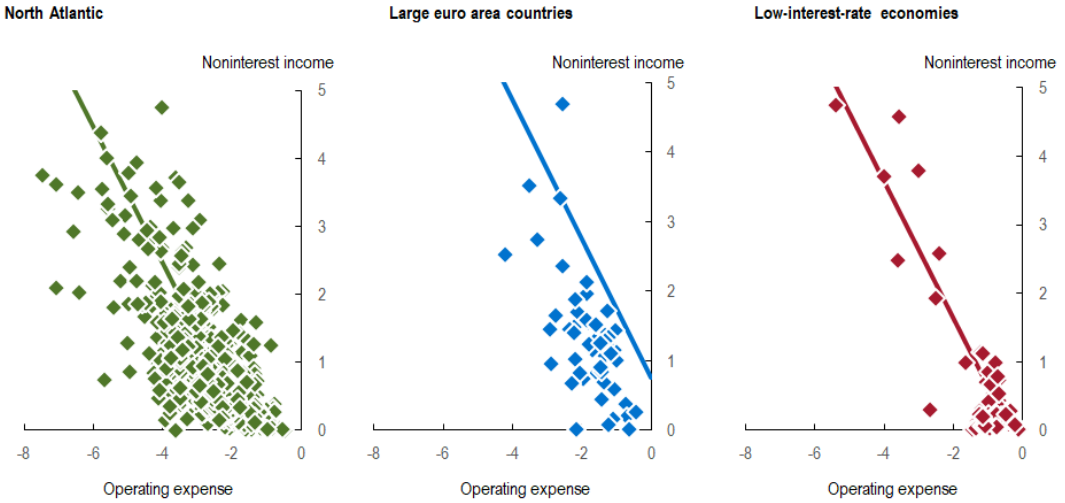
25. Banks can, in principle, support profits by cutting operating expenses, for example through more efficient technology. From 2013 to 2018, cost savings have delivered about a 15 basis point improvement to median return on assets (Figure 4.4, panel 3). Analysts expect cost-to-assets ratios to continue to decline in some countries, generally in the order of another 5–25 basis points of assets by 2021 (Figure 4.4, panel 4).[16]

[16]This resembles a discussion of European banks' profitability outlook in the April 2017 GFSR, though this section deploys a more nuanced, dynamic model of the responses of net interest margin responses to changes in the policy rate environment.

Figure 4.5. Changes to Costs and Noninterest Income to Restore Profitability

Large increases in noninterest income and substantial cuts to costs may be needed.

1. Cost and Noninterest Income: Bank Actual Positions and Combinations Needed to Generate 8 Percent Return on Equity (Percent of assets, 2025)



Sources: S&P Global Market Intelligence; SNL Financial; and IMF staff estimates.
Note: Lines represent combination of cost and noninterest income relative to assets required to generate 8 percent return on equity, assuming that all other earnings drivers (interest income, loan-loss provisions, tax rate and so on, relative to assets and capital structure (equity relative to assets) are at industry-average levels. Other combinations are possible, but any significant deviation from this assumption requires even more challenging performance improvement on one or the other earnings driver.

26. Given that fee income and cost improvement are the two major levers banks can use to mitigate downward pressure on bank return on equity, the crucial question is: are they likely to be sufficient? Assuming profits evolve as projected in the simulation presented earlier, what combinations of cost reduction and additional fee income improvement would be required for banks in each country to generate a return on equity in line with the cost of equity? To address this question, Figure 4.5, panel 1, compares noninterest income and operating costs (both relative to assets) for a sample of banks across the three country groups against the combinations of cost and fee income that would be required for an "average" bank in that group to deliver return on equity of 8 percent (Figure 4.5, panel 1). In the North Atlantic, a proportion of banks is expected to generate adequate returns by 2025 and, for the rest, there is a range of feasible cost and revenue improvements that would generate them. However, the improvements that would be required for banks in large euro area countries and low-interest-rate economies are particularly challenging. In the former, virtually all banks would need to improve both cost and noninterest income, sometimes significantly. For instance, for some banks cutting costs to zero would not suffice in absence of an increase in noninterest income. In low-interest-rate economies, many banks show little scope for further cost improvement—costs are already quite low—and would require noninterest income rising from very low current levels.

27. Banks may also mitigate margin pressures by hedging against declining rates, typically using interest rate swaps. The much larger overall swap books of the largest banks (relative to

total assets) suggests that they are more heavily engaged in hedging (Figure 4.6, panel 1).[17] Moreover, available data for the United States suggests that smaller banks are more sensitive to a decline in rates than larger banks (Figure 4.6, panel 2). The econometric analysis discussed above corroborates this finding, and this is consistent with other studies that find small banks to be less resistant than larger domestic peers to margin and earnings compression in a negative interest rate environment (Nucera and others 2017; Molyneux, Reghezza and Xie 2019). Finally, US banks' net interest income has become more sensitive to changes in policy rates in recent years, with risk increasingly skewed to the downside, perhaps reflecting the increasing difficulty of mitigating net interest margin pressures as deposit rates approach zero (Figure 4.6, panel 3).

Banks May Take Excessive Risk in the Medium-Term once the Economy Begins to Recover

28. Recent policy measures taken by monetary and financial authorities aim to help banks use their risk bearing capacity to mitigate the economic consequences of the COVID-19 outbreak, maintaining the flow of credit to borrowers and supporting economic growth. However, once the current crisis recedes, medium-term profitability pressures may induce banks to increase credit, maturity, liquidity, or trading risks aggressively enough to sow the seeds of future problems.

29. There is some evidence that, before the onset of the COVID-19 pandemic, banks had taken more risk in response to a prolonged period of very low interest rates. First, banks in some countries had modestly shifted their exposures from short-term instruments and marketable securities toward less liquid loans, driving up loans as a percentage of total assets and taking additional liquidity risk (Demiralp, Eisenschmidt, and Vlassopoulos 2019). Second, banks had looked to increase the maturity risk of their loans to increase yields. From 2013 to 2018, estimated average loan maturity across reporting banks lengthened, particularly in countries where low interest rates exacerbated pressures on net interest margins (Figure 4.6, panel 4).[18]

30. The econometric analysis discussed earlier confirms that banks operating in a negative rate environment have tended to increase the maturity of their loans, in contrast to their behavior in normal times (Figure 4.6, panel 5). This is consistent with findings in the literature documenting banks expanding their mortgage loan portfolio (Basten and Mariathasan 2018). Finally, though difficult to discern from bank disclosure, studies of credit registers and syndicated loan data suggest that banks may respond to low interest rates by shifting the composition of their loan portfolios toward riskier borrowers (Bottero and others 2019b;

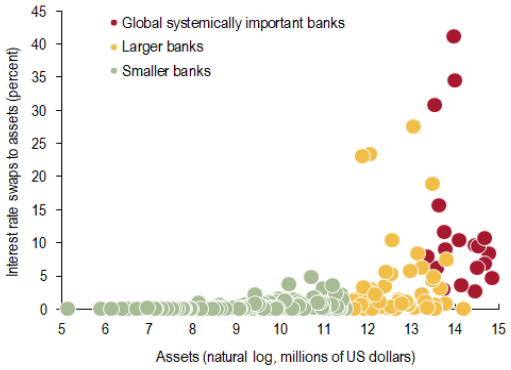
[17]Available data only reveal aggregate interest rate swap contracts in notional terms. Disclosures do not provide sufficient data to reveal the specific interest rate positioning or the degree of hedging against specific interest rate risk scenarios.

[18]Some banks report loans by maturity interval (less than 3 months, 3–12 months, and so forth). Average maturity is estimated based on the mid-point of each interval and an estimate of average maturity of the final bucket (typically, greater than 5 years).

Figure 4.6. Bank Hedging and Risk Taking

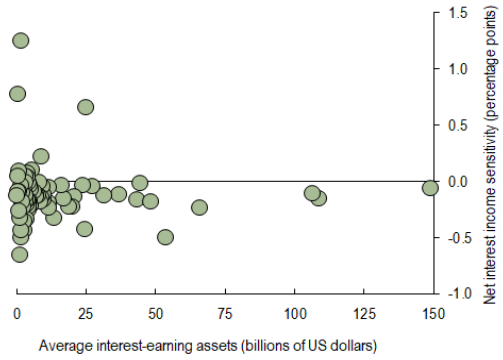
Larger banks tend to take larger interest rate swap positions ...

1. Interest Rate Swaps Notional Value Outstanding and Total Assets (As of 2018)



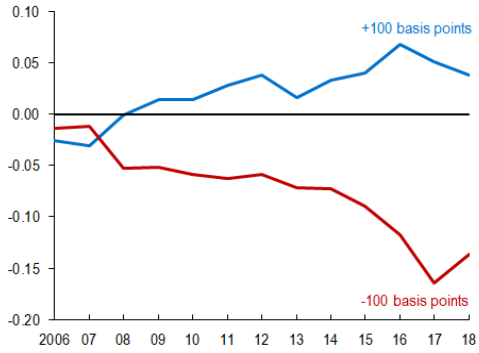
... which probably underlies their lower interest rate risk.

2. United States: Net Interest Income Sensitivity and Average Interest-Earning Assets



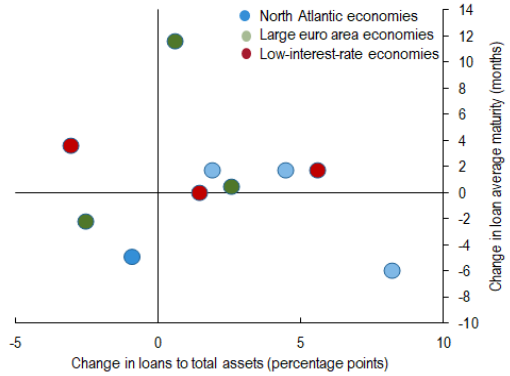
Banks' net interest margin sensitivity to changes in policy rate has increased and become increasingly skewed downward ...

3. United States: Median Net Interest Margin Sensitivity to a Change in the Base Rate (Percent)



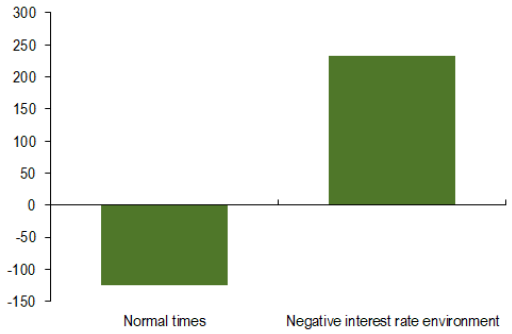
... and in several low interest rate economies, by increasing loan maturities ...

4. Changes in Loans to Assets and in Estimated Average Loan Maturity (2013–18 average)



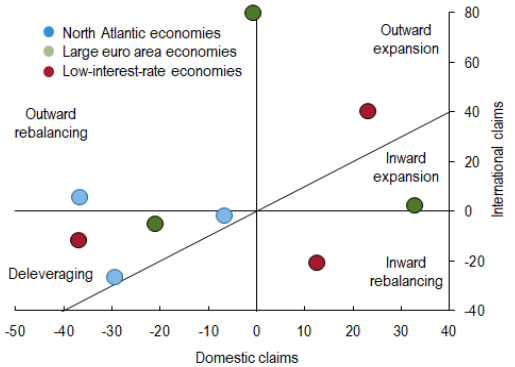
... in contrast to their behavior in normal times ...

5. Impact of a 100 Basis Point Decline in the Short-Term Rate on the Maturity of Bank Loans



... in some cases, by expanding their international loan portfolio.

6. Change in Banking Systems' Domestic and International Claims, 2013:Q4–2019:Q4 (Percent)



Sources: Bank for International Settlements; Bloomberg Finance L.P; Fitch Connect; Haver Analytics; S&P Market Intelligence; SNL Financial; and IMF staff calculations.
Note: In panel 1, small banks are those with less than $100 billion of total assets. In panels 2 and 3, reported interest rate shocks vary in size. The analysis linearly interpolates net interest income effects to a 100 basis point shock. In panel 4, portfolio maturity is estimated from bank financial reports. This is distinct from the "effective maturity" measure employed in this chapter to gauge banks' net interest margin response to changes in "front-book" rates. Panel 5 shows the impact on the ratio of long-term bank loans to short-term loans for the nine advanced economy banking systems covered in this chapter. In panel 6, domestic claims have been adjusted for movements in local exchange rates against the dollar.

Heider, Saidi, and Schepens 2019). However, others have found that the increased origination of riskier syndicated loans by banks is rapidly ceded to nonbank financial intermediaries, thus passing down credit risk to other parts of the financial system (as discussed in Chapter 2 and by Aramonte, Lee, and Stebunovs 2019).

31. Third, some banks have increased their overseas exposures, potentially raising their currency and liquidity risks.[19] This is most evident in Canada and Japan, though some other banking systems have rebalanced their claims toward foreign lending (Figure 4.6, panel 6). Data from Japan, where individual banks publicly report their overseas exposures, suggest that this tactic is available only to large banks with extensive international subsidiary and branch footprints.

Policy Discussion

32. The sharp downturn in economic activity resulting from the COVID-19 outbreak will put significant pressure on bank profitability in the near term, as already reflected in banks' equity prices and discussed in Chapter 1. The high levels of capital and liquidity buffers built since the global financial crisis, together with the decisive policy actions taken by policymakers to maintain the flow of credit to households and firms and to sustain the economy, will certainly help banks navigate these challenging times. However, this episode will test banks' resilience. It is thus crucial that policymakers rapidly employ a combination of policies that maintain the balance between preserving financial stability, maintaining the soundness of financial institutions, and supporting economic activity. These include an adequate provision of liquidity by central banks; and clear supervisory guidance on the prudent renegotiation of loan terms, the use of the flexibility embedded in existing regulatory frameworks to account for expected credit losses, and the use of existing buffers to absorb costs (see Chapter 1 for a detailed discussion).

33. Beyond the near term, the findings of this chapter highlight the medium-term profitability challenges that banks will likely face in an environment of persistently low interest rates for years to come. While such difficulties are anticipated to be compounded by increasing competition from FinTech and other nonbank financial intermediaries, there are steps that authorities can take to address medium-term bank profitability concerns and ensure an adequate flow of credit to the economy.

34. Financial sector authorities should incorporate in their decisions and risk assessment the potential impact that the low-interest-rate environment has on banks. Supervisory capital planning and stress testing should include lower-for-longer scenarios, and the strength of business models in such an environment should be evaluated. Supervisors should also remain vigilant to prevent an excessive buildup of risks through the arbitrage of existing regulations that could reduce the resilience of the banking sector.

[19]For a comprehensive discussion of the link between foreign lending and liquidity risks in foreign currency, see Chapter 5 of the October 2019 GFSR.

35. If banks do start taking excessive risks once the current COVID-19 emergency is resolved, macroprudential policy tools should be deployed to address emerging vulnerabilities. For instance, the countercyclical capital buffer could be used in time to enhance the resilience of the banking system as systemic risk builds up during a period of loose financial conditions. Borrower-based measures could also be used to limit rapid growth of mortgage portfolios should banks aggressively shift to these types of loans to sustain margins. For banking systems that expand their foreign operations to enhance profitability, macroprudential authorities could ensure that foreign exposures remain adequately diversified and monitor liquidity mismatches in banks' foreign currency balance sheets (see Chapter 3 of the October 2019 GFSR).

36. Monetary policy, which has supported economic growth since the onset of the global financial crisis and has been the first line of defense during the COVID-19 pandemic, should remain data dependent and be set to meet central banks' macroeconomic targets. Policy tools helping to offset some of adverse effects of negative interest rates, such as tiering schemes aimed at limiting the application of negative rates to a portion of the banks' reserves held with the central bank, should stay in place while policy rates are negative (see Box 4.2).

37. In an environment of difficult policy trade-offs and constraints, authorities should also explore actions aimed at removing structural impediments still present in banking systems to support resilient institutions that can provide an adequate flow of credit to the economy. For example, authorities should assess the benefits of domestic and cross-border bank consolidation while also taking steps to ensure adequate competition and addressing potential too-big-too fail issues. Policymakers at all levels should encourage banks to take a broad range of measures to improve operating efficiencies, including branch reduction where warranted, upgrades of information technology systems, and process outsourcing.

38. These cost reduction efforts need to be balanced against other important policy concerns, especially in the current environment of heightened uncertainty about the economic outlook. For instance, authorities should ensure broad access to financial services and financial inclusion for households and small and medium-sized enterprises; technology upgrades should guarantee adequate data protection and privacy; efforts to expand non-fee income should ensure financial consumers are adequately informed and protected; and the potential consequences for local communities and employment should be properly assessed.

Box 4.1. The Experience with Negative Interest Rate Policies

Since 2014 several central banks, mostly in Europe, have set their policy rates below zero for extended periods. Policymakers turned to negative interest rate policies when the room to deliver monetary stimulus by conventional means had been exhausted. In the euro area, Japan, Sweden, and Switzerland, short-term interest rates were already at, or close to, zero. Cyclical headwinds, and, in Switzerland, an overvalued currency, meant that monetary stimulus was needed to support demand and inflation.[1] With persistently low neutral interest rates, central banks had less room to maneuver in positive interest rate territory than in previous cycles.

As with conventional monetary policy, negative rates can be expected to be transmitted to the broader economy through various channels. Lower rates reduce the cost of capital for businesses, raise the attractiveness of current consumption over saving, and strengthen demand for domestically produced goods by weakening the exchange rate. They may also support credit growth by relaxing balance sheet constraints for both borrowers and lenders. These channels remain active when rates fall into mildly negative territory, although their strength may change.

The impact of negative interest rate policies has been most visible in money market rates. Across jurisdictions, they have tracked policy rates closely as the latter moved below zero (Eisenschmidt and Smets 2019). Longer-term yields have fallen too, especially following the initial rounds of cuts that took rates below zero, likely reflecting coincident changes in asset purchase programs and forward guidance (public communication by the central bank about the likely future path of monetary policy and its objectives and intentions).

Deposit rates and lending rates have also fallen. In jurisdictions where central banks have cut interest rates multiple times into negative territory—the euro area and Sweden—these rates have slowly fallen following each round of easing (Figure 4.1.1).[2] The fall in deposit rates has been more pronounced for corporate deposits, which is in line with the notion that, compared to retail depositors, it is costlier for corporate depositors to switch into cash (CGFS 2019). There is also evidence that these cuts have helped to lower lending rates in the euro area and Switzerland, even if it is difficult to measure their effect because of many confounding factors (for example, the simultaneous announcement of Targeted Longer-Term Refinancing Operations).[3]

The evidence to date on the macroeconomic effects of negative interest rate policies remains sparse. This is partly because it is challenging to separate the effects of negative interest rate policies from those of other concurrent unconventional monetary policy measures. Still, for the euro area, negative interest rate policies seem to have had small but positive effects in inflation and growth (Rostagno and others 2019. In addition, negative interest rate policies may have supported the Japanese economy through the exchange rate channel (Honda and Inoue 2019).

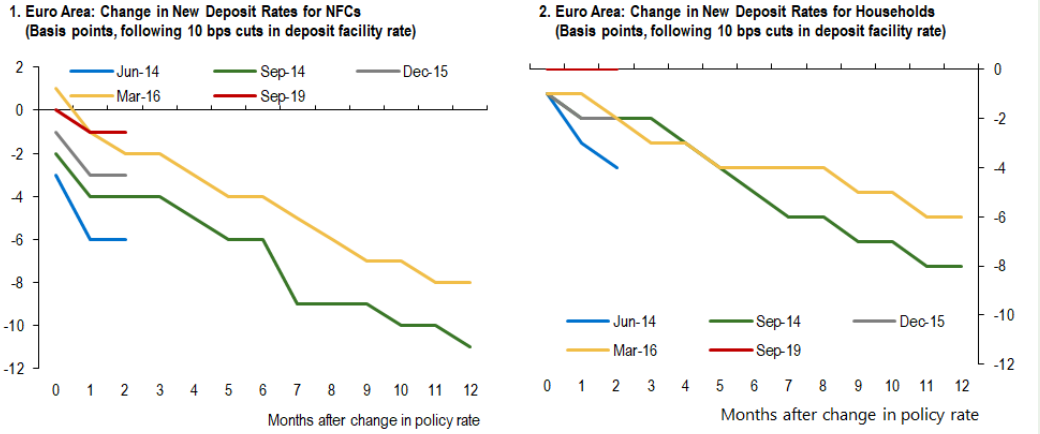
Taken as a whole, the available evidence indicates that negative rates have lowered market rates, supported asset values and credit provision, reduced deposit and lending rates, and therefore likely provided support for growth and inflation. However, there is a limit to how negative rates can go—the effective lower bound. Were rates to become deeply negative, investors could make a wholesale move into cash, bank profits could decline, and the positive impacts observed on bank lending could be reversed (Brunnermeier and Koby 2018).

Box 4.1. The Experience with Negative Interest Rate Policies (concluded)

Figure 4.1.1. Euro Area and Sweden: Change in Bank Interest Rates

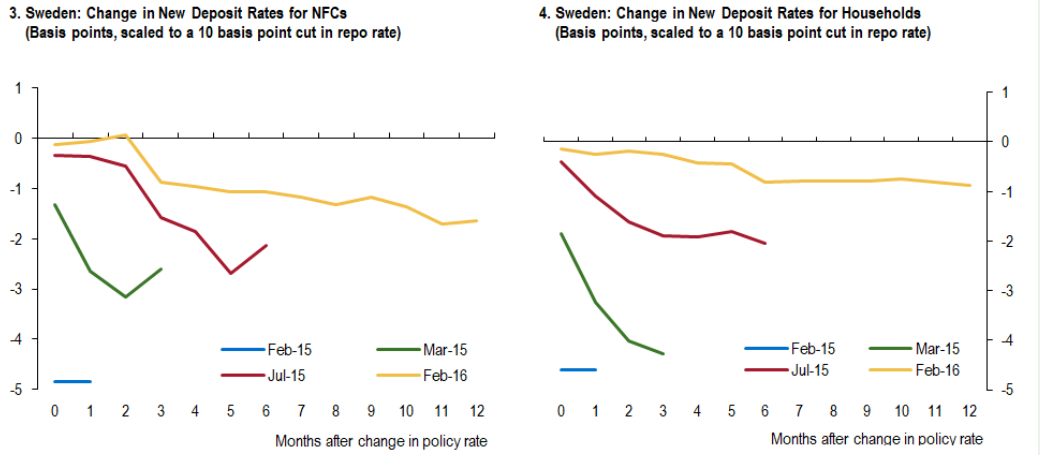
After policy rate cuts, euro area corporate deposit rates have fallen, but pass-through has diminished over time.

Euro area retail deposit rates have also fallen, but less so.



In Sweden, corporate deposit rates have also fallen, with diminishing pass-through ...

... and Swedish retail deposit rates show the same behavior.



Source: European Central Bank; and IMF staff calculations.
Notes: The charts show the change in new short-term deposit rates for households and corporations up to 12 months following each of the 10 basis point cuts that the European Central Bank has made in its main deposit rate since June 2014 (panels 1 and 2) and the three rate cuts made by Swedish Riksbank since February 2015 (panels 3 and 4). Shorter lines reflecting shorter periods between rate cuts.

The author of this box is Roland Meeks.

[1]Denmark operates a currency peg with the euro and introduced negative rates to mitigate upward pressure on the krone.

[2]Deposit rates also adjust sluggishly to changes in policy rates when rates were positive (Andries and Billon 2016).

[3]For example, negative interest rate policies have lowered loan rates and gave a boost to lending by Italian and Swiss banks (Bottero and others 2019a and Basten and Mariathasan 2018, respectively).

Box 4.2. Experiences with Tiering of Reserve Remunerations

Several central banks have introduced tiered reserve systems to help counter the negative effects of low rates on banks' profitability.[1] Jurisdictions with some form of tiering system include Denmark, the euro area, Japan, Norway, Sweden, and Switzerland (Table 2.2.1).

Table 2.2.1. Selected Central Bank Deposit Tiering Schemes

Economy	Description	Exemption Threshold	Interest Rate Applied to Nonexempted Reserves (Percent)	Date Tiering Implemented	Date Negative Rates Implemented
Euro area	Bank deposits below the exemption threshold pay 0 percent interest. Reserves above the threshold pay the deposit rate.	Six times the minimum reserve requirement.	-0.50	Nov., 2019	Jun., 2014
Japan	Three-tier system at 0.1 percent rate for the basic balance, 0.0 percent rate for the macro add-on balance, and -0.1 percent rate for the policy rate balance.	Amount of reserves charged the policy rate varies in line with the Bank of Japan's monetary base target.	-0.10	Feb., 2016	Jan., 2016
Switzerland	Negative interest are charged on the portion of banks' sight deposit at the central bank exceeding the exemption threshold.	Twenty-five times the minimum reserve requirement (revised up from 20 times exemption in Nov. 2019)	-0.75	Jan., 2015	Dec., 2014

Sources: National central banks; and IMF staff estimates.

Tiering delivers two benefits to banks. First, banks are exempted from paying interest (or receiving a less negative rate) on a portion of the reserves they maintain at the central bank. Second, banks have scope to arbitrage the difference between the negative rate and the exempted rate by trading liquidity (possibly across countries).[2]

The introduction of the two-tier system by the European Central Bank at the end of 2019 is estimated to generate total savings for euro area banks of about €4.7 billion relative to a counterfactual scenario where tiering is not introduced (Table 2.2.2). In Switzerland, savings from tiering is estimated at about $0.7 billion. While this help banks, these savings, equivalent to a few basis points of return on assets, are unlikely to fully offset the impact of low interest rates on profitability.

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[1] Although deposit tiering is present is various jurisdictions, not all central banks introduced the tiering policy to alleviate the impact of negative rates on bank profitability. For instance, deposit tiering was part of central banks' monetary policy frameworks in Denmark and Norway before the introduction of negative policy rates (Jobst and Lin 2016).

[2] For example, a German bank with excess reserves that is charged the deposit facility rate of –0.50 percent could find an Italian bank with few reserves and offer to pay, say, –0.30 percent to the Italian lender for holding such liquidity. Both lenders would gain: the German by lowering the cost of its deposits, and the Italian by accruing a positive return. The benefits from such activities are estimated to be smaller than those from the introduction of tiering schemes.

Box 4.2. Experiences with Tiering of Reserve Remunerations (concluded)

Table 2.2.2. European Central Bank Tiering Scheme: end-2019

Economy	Minimum Reserve Requirement (MRR)	Bank Deposits with Eurosystem	Exempted Reserves (MRR + Multiple)	**Cost Savings for Banks**	Impact on Banks' Return on Assets
	(Billions of euro)				(Percentage points)
Euro area	135	1,818	942	**4.7**	0.01
Germany	37	562	261	**1.3**	0.02
France	27	526	186	**0.9**	0.01
Italy	18	102	128	**0.4**	0.01

Sources: European Central Bank; national central banks; and IMF staff estimates.

The author of this box is Juan Solé.

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ONLINE ANNEX 4.1. TEHNICAL NOTE[1]

1. This annex accompanies Chapter 4 of the April 2020 Global Financial Stability Report and provides additional details on the analytical work supporting the chapter. This work consists of three separate but related parts that are discussed in turn in the different sections of this annex. Section A explains the econometric exercise used to analyze the main drivers of changes in bank profitability that have occurred to date. Section B describes the methodology used to estimate the effective repricing maturities of banks' loans and deposits and how to use them to simulate the paths of banks' yields on loans and costs of deposits for a given future path of economic growth and inflation. Section C explains how these simulated paths are combined with bank level information to conduct a forward-looking assessment of banks' profitability. In addition, Section D describes the method for estimating the market -implied cost of equity for banks that is used in Chapter 4.

2. The chapter discusses trends and challenges to profitability for banks from nine advanced economies—the Group of 7 economies (Canada, France, Germany, Italy, Japan, the United Kingdom and the United States) plus two economies which have or have had negative central bank policy rates (Sweden and Switzerland). While all three parts of the analytical work cover these 9 countries, the actual number of banks used in the various parts vary because of the different data requirements involved in each type of exercise. Each of the sections below explain the criterial used to select the sample of banks in detail, but in all cases the goal was to maximize bank coverage.

A. Econometric Analysis of Bank Profitability[2]

Data

3. The analysis relies on financial statements of banks from the nine economies studied throughout the chapter. Bank-level balance sheet and income statement data come from Fitch-Connect[3]. Macroeconomic data on GDP growth, inflation, forecasts, and interest rates (three-month rate and terms spread) come from the World Bank World Development Indicators and Consensus Economics. The analysis is based on an unbalanced sample of banks covering the period from 2000 to 2018. The exact number of banks included varies across exercises depending on the data availability for the included balance sheet items. For the higher-level items, which are more broadly available, it includes 11,802 banks.

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[1] This is an annex to Chapter 4 of the April 2020 *Global Financial Stability Report.* © 2020 International Monetary Fund.

[2] This section was prepared Yizhi Xu.

[3] The bank-level statements are consolidated at the country. Such design allows us to pick up the impact on domestic parent banks.

Econometric Model

4. The econometric model builds on previous work by Borio and others (2017), Claessens and others (2018), and Altavilla and others (2018) and considers the following empirical specification to study the relationship between the interest rate environment and banks' net interest margin (NIM) controlling for macroeconomic conditions:

$$NIM_{i,c,t} = \beta_0 + \beta_1 NIM_{i,c,t-1} + \beta_2 Bank_{c,t-1} + \beta_3 Macro_{c,t} + \beta_4 ST3M_{c,t} + \beta_5 TermSpread_{c,t} + \beta_6 ST3M_{c,t} \times Negative_{c,t} + \beta_7 TermSpread_{c,t} \times Low_{c,t} + \beta_8 Negative_{c,t} + \beta_9 Low_{c,t} + \beta_{10} GFC_t + \beta_{11} EDC_t + \gamma_c + \varepsilon_{i,c,t} \quad (1)$$

where $ST3M_{c,t}$ is the annual average 3-month government bonds yield (short-term rate) in country c, $TermSpread_{c,t}$ is 10-year to 3-month government bonds spread, $Negative_{c,t}$ is a dummy that equals 1 if the short-term rate is less than zero, $Low_{c,t}$ is a dummy that equals 1 if the 10-year to 3-month spread is less than 1 percentage point (the 10th percentile of the empirical distribution of spreads in the sample), GFC_t and EDC_t are dummies for the Global Financial Crisis (2008-2009) and the Euro Area Debt Crisis (2010-2012), respectively. $Bank_{c,t-1}$ and $Macro_{c,t}$ are bank controls (capital ratio, deposit-to-liability ratio, security-to-asset ratio) and macro controls (real GDP growth, inflation rate, and 1-year ahead GDP growth and inflation rate forecast). γ_c are country fixed effects. All standard errors are clustered at the bank-level.

5. This specification permits studying the effect of changes in short term rates on banks' net interest income and test whether the elasticities differ between "normal" times and periods with negative short-term rates (or low spreads) depending on the values of $\beta_4, \beta_5, \beta_6, \beta_7$. For instance, positive values for β_4 and β_5 indicate that a decline in the short-term rate or term-spread reduces bank profitability, and that this decline is larger when short term rates are negative or term spreads are compressed if β_6 and β_7 are also positive. As Annex Table 4.1.1 shows, in the negative rate or low spreads environment, decreasing short-term rates or term spreads is associated with significant declines in bank net interest margin. Such pattern is persistent without controlling the lagged NIM or with time fixed effects.

6. In addition to the analysis on bank profitability, the same specification was used to analyze the relationship between the interest rate environment and the ratio of loan-loss provisions to total assets and loan maturity ratio (the difference in amount between 5-year or longer maturity loans and 3-month or shorter maturity loans over gross loans) that are also reported in the chapter. The results of these regressions are reported in Table 4.1.2. It appears that squeezing term spreads in a low spreads environment is associated with further declines in bank provisions, while decreasing short-term rates in a negative rate environment is associated with additional increases in loan maturities and fee income ratio.

Online Annex 4.1. Table 4.1.1.
Relation Between Interest Rates and Bank NIM

VARIABLES	(1)	(2)	(3)	(4)
Dependent Variable (Lag)	0.581***	0.581***		
	(0.013)	(0.014)		
Deposit/Liability (Lag)	0.000	0.001	0.000	0.002*
	(0.000)	(0.001)	(0.001)	(0.001)
Capital Ratio (Lag)	-0.009***	-0.009***	-0.000	-0.000
	(0.002)	(0.002)	(0.003)	(0.003)
Security/Assets (Lag)	0.001**	0.001***	-0.005***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)
Real GDP Growth	-0.000	-0.024***	-0.001	-0.022***
	(0.001)	(0.002)	(0.001)	(0.002)
Inflation Rate	-0.004***	-0.005*	0.012***	0.006*
	(0.002)	(0.003)	(0.002)	(0.004)
Real GDP Growth Forecast	0.043***	0.057***	0.059***	0.052***
	(0.002)	(0.004)	(0.003)	(0.005)
Inflation Rate Forecast	0.023***	0.012***	-0.022***	0.003
	(0.003)	(0.005)	(0.004)	(0.007)
ST3M	0.063***	0.008**	0.147***	-0.002
	(0.003)	(0.004)	(0.005)	(0.006)
Term Spread	0.043***	-0.016***	0.078***	-0.071***
	(0.003)	(0.004)	(0.006)	(0.006)
ST3MxNegative	0.054***	0.187***	0.122***	0.282***
	(0.010)	(0.011)	(0.015)	(0.016)
Term Spread x Low	0.170***	0.166***	0.290***	0.270***
	(0.007)	(0.009)	(0.009)	(0.011)
Negative	-0.025***	-0.035***	-0.050***	-0.099***
	(0.005)	(0.006)	(0.009)	(0.009)
Low	-0.136***	-0.112***	-0.294***	-0.208***
	(0.007)	(0.008)	(0.008)	(0.010)
GFC	-0.011*		-0.009	
	(0.006)		(0.008)	
EDC	0.041***		0.065***	
	(0.004)		(0.005)	
Observations	156,940	156,940	156,968	156,968
R-squared	0.882	0.883	0.820	0.823
Bank FE	Yes	Yes	Yes	Yes
Time FE	Crises	Yes	Crises	Yes

Source: IMF staff.

Note: This table reports the association between bank NIM and interest rates. The dependent variable is bank NIM expressed as a fraction of bank total assets. ST3M is the short-term rate proxied by 3-month government bond yields. Term spread is the 10-year minus 3-month spread. Negative and Low are dummies indicating whether ST3M is below zero and whether the term spread is below 1.25 percentage points respectively. The specification also includes macro and bank-level controls, and GFC (2008-2009) and Euro Area Debt Crisis (2010-2012) dummies. Column (1) and (3) report specifications with crises dummies, and Column (2) and (4) report specifications with year fixed effects. Column (1)(2) include lagged NIM, while Column (3)(4) do not. All errors are clustered at the bank-level. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Online Annex 4.1. Table 4.1.2.
Relation Between Interest Rates and Other Bank Variables

VARIABLES	(1) NIM	(2) Provision/Assets	(3) Loan Maturity Ratio
Dependent Variable (Lag)	0.581***	0.329***	0.586***
	(0.013)	(0.008)	(0.020)
Deposit/Liability (Lag)	0.000	-0.002***	0.030
	(0.000)	(0.000)	(0.033)
Capital Ratio (Lag)	-0.009***	0.001	-0.027
	(0.002)	(0.001)	(0.056)
Security/Assets (Lag)	0.001**	-0.000	0.044**
	(0.000)	(0.000)	(0.019)
Real GDP Growth	-0.000	-0.012***	-0.334***
	(0.001)	(0.001)	(0.087)
Inflation Rate	-0.004***	-0.047***	0.255
	(0.002)	(0.002)	(0.369)
Real GDP Growth Forecast	0.043***	-0.051***	1.983***
	(0.002)	(0.002)	(0.295)
Inflation Rate Forecast	0.023***	-0.030***	-2.461***
	(0.003)	(0.004)	(0.642)
ST3M	0.063***	0.059***	0.823***
	(0.003)	(0.002)	(0.172)
Term Spread	0.043***	0.098***	-5.300***
	(0.003)	(0.003)	(0.396)
ST3MxNegative	0.054***	-0.107***	-4.429***
	(0.010)	(0.014)	(0.533)
Term Spread x Low	0.170***	0.065***	12.338***
	(0.007)	(0.007)	(1.351)
Negative	-0.025***	-0.026***	-1.514***
	(0.005)	(0.009)	(0.431)
Low	-0.136***	0.020***	-11.752***
	(0.007)	(0.007)	(1.039)
GFC	-0.011*	0.118***	4.055***
	(0.006)	(0.008)	(0.541)
EDC	0.041***	0.059***	5.053***
	(0.004)	(0.005)	(0.453)
Observations	156,940	152,320	26,618
R-squared	0.882	0.459	0.940
Bank FE	Yes	Yes	Yes
Time FE	Crises	Crises	Crises

Source: IMF staff.

Note: This table reports the association between other bank variables and interest rates. ST3M is the short-term rate proxied by 3-month government bond yields. Term spread is the 10-year minus 3-month spread. Negative and Low are dummies indicating whether ST3M is below zero and whether the term spread is below 1.25 percentage points respectively. The specification also includes macro and bank-level controls, and GFC (2008-2009) and Euro Area Debt Crisis (2010-2012) dummies. The dependent variables are NIM for Column (1), loan loss provisions to assets ratio for Column (2), and loan maturity ratio (more than 5-year maturity minus less than 3-month maturity) for Column (3). All errors are clustered at the bank-level. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Online Annex 4.1. Table 4.1.3.
Elasticities of Changes in Provisions and Fee Income Ratio

VARIABLES	(1) Provisions/Assets (Growth in Percent)	(2) Fee Income/Assets (Change in Percentage Points)
Dependent Variable (Lag)	-0.112***	-0.104***
	(0.003)	(0.026)
Deposit/Liability (Lag)	-0.004***	-0.001
	(0.001)	(0.001)
Capital Ratio (Lag)	0.005	-0.007***
	(0.005)	(0.002)
Security/Assets (Lag)	-0.001	-0.000
	(0.002)	(0.000)
Real GDP Growth	-0.035***	0.006***
	(0.007)	(0.001)
Inflation Rate	-0.079***	-0.002
	(0.011)	(0.002)
ST3M	0.188***	0.007***
	(0.013)	(0.003)
Term Spread	0.127***	0.014***
	(0.014)	(0.003)
ST3MxNegative	-0.361***	-0.011
	(0.124)	(0.013)
Term Spread x Low	0.466***	0.028***
	(0.053)	(0.009)
Negative	-0.030	0.020**
	(0.061)	(0.008)
Low	-0.290***	-0.031***
	(0.045)	(0.008)
GFC	0.880***	-0.048***
	(0.042)	(0.008)
EDC	0.039*	-0.020***
	(0.022)	(0.003)
Observations	113,590	109,842
R-squared	0.125	0.107
Bank FE	Yes	Yes
Time FE	Crises	Crises

Source: IMF staff.
Note: This table reports the elasticities of changes in loan loss provisions and fee income (relative to assets) with respect to changes in the interest rate environment and economic activity (real GDP growth and inflation rate). ST3M is the short-term rate proxied by 3-month government bond yields. Term spread is the 10-year minus 3-month spread. Negative and Low are dummies indicating whether ST3M is below zero and whether the term spread is below 1.25 percentage points respectively. The specification also includes macro and bank-level controls, and GFC (2008-2009) and Euro Area Debt Crisis (2010-2012) dummies. The dependent variables are change in provisions to assets ratio in percent in Column (1), and growth in fee income to assets ratio in percent in Column (3). All errors are clustered at the bank-level. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

7. Finally, similar econometric analysis is used to support some aspects of the forward-looking simulation (described in Section b and c). For example, the elasticity of growth in loan

loss provisions and fee income (relative to assets) with respect to changes in the interest rate environment and economic activity (real GDP growth and inflation rate) is used to project the path of bank provisions in the simulation (Table 4.1.3). Differences in the sensitivity of Global Systemically Important Banks' (GSIBs) interest income to loans ratio to changes in interest rates, relative to the sensitivity of smaller banks is also used to calibrate the relative sensitivity of yields to short term rates of these two group of banks in the simulation (Table 4.1.4). Based on the estimates in Table 2.4, the sensitivity of GSIBs' net interest margin to the short-term rate is around 40 percent less than that of non-GSIBs.

Online Annex 4.1. Table 4.1.4.
Difference in Sensitivities between GSIBs and Non-GSIBs

VARIABLES	Interest Income/Loans
Dependent Variable (Lag)	0.545***
	(0.034)
Deposit/Liability (Lag)	0.000
	(0.004)
Capital Ratio (Lag)	-0.024
	(0.017)
Security/Assets (Lag)	0.004
	(0.002)
Real GDP Growth	0.035***
	(0.010)
Inflation Rate	0.021*
	(0.011)
Real GDP Growth Forecast	-0.152***
	(0.023)
Inflation Rate Forecast	-0.134***
	(0.016)
ST3M	0.459***
	(0.031)
Term Spread	0.217***
	(0.026)
ST3MxGSIBs	-0.183***
	(0.039)
Term Spread x GSIBs	-0.188***
	(0.043)
GFC	0.083*
	(0.044)
EDC	0.148***
	(0.037)
Observations	100,327
R-squared	0.782
Bank FE	Yes
Time FE	Crises

Source: IMF staff.
Note: This table reports the difference between the sensitivity of GSIBs' interest income to loans ratio to interest rates and that of non-GSIBs. ST3M is the short-term rate proxied by 3-month government bond yields. Term spread is the 10-year minus 3-month spread. GSIBs is a dummy indicating whether a bank belongs to FSB's list of Global Systemically Important Financial Institutions. The specification also includes macro and bank-level controls, and GFC (2008-2009) and Euro Area Debt Crisis (2010-2012) dummies. All errors are clustered at the bank-level. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Decomposition of Bank Net Interest Margin into Contributing Factors

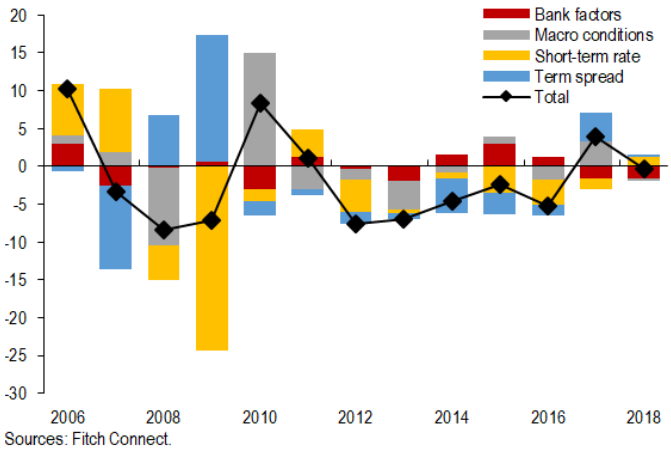
8. The historical decomposition of the contribution of different factors (the short-term rate, term-spread, other macro conditions, and bank-specific characteristics) to variations in NIM is complicated by the presence of the lagged dependent variable in the econometric model described in equation (1). To sort out this issue, the contributions from the above-mentioned 5 groups of factors are computed from the difference in estimated NIM paths under two difference scenarios. The first scenario, thereafter "flexible" path, takes into account of the changes in various factors included in the econometric specification after the initial year (labeled t_0), whereas the second scenario with a "rigid" path assumes that all these factors remain at their initial levels for the rest of the period.

9. A few calculations show that the difference in the two paths correspond to:

$$\Delta NIM_t \equiv NIM_t^{Flexible} - NIM_t^{Rigid} = \sum_{j=0}^{t-t_0} \alpha^j \beta'(X_{t-j} - X_{t_0}) \quad (2)$$

10. Figure 4.1.1 shows the estimations of different contributing factors (i.e. short-term rate, term-spread, other macro conditions, and bank specific characteristics). In this decomposition, the bank fixed effects are grouped with other bank characteristics into "bank factors" and the crises dummies are grouped with other macro conditions. The role of short-term rates and term spreads includes the respective variables and their interactions with the dummies for negative rates and low term spreads, as well as the direct effect of those dummies.

Online Annex 4.1. Figure 4.1.1.
Decomposition of Bank Net Interest Margins
(Basis points)



Sources: Fitch Connect.
Note: The decomposition is based on estimated elasticities from 9 economies and a sample of realized contributing factors from 6 countries (three large European countries and three low interest rate countries). The numbers represent percentage changes in a representative bank's net interest margin.

B. Estimation of Bank Interest Rates and Credit Growth[4]

11. This section describes the estimation of two key inputs that are used in the forward-looking simulation of bank profitability: (1) bank interest rates on assets and liabilities; and (2) bank credit growth.

12. The estimation was carried out for each of the nine countries using annual bank-level unbalanced panel data available during the period of 2005 to 2018. The sample contains 1,390 banks in total. The set of banks is smaller than that used in the econometric exercise because the methodology requires banks to separately report interest income for loans and for other interest-earning assets, and interest expense separately for deposits and other interest-bearing liabilities. Data are obtained from Fitch Connect and partially complemented with data from SNL. Data on market yields are zero coupon yield curve for each currency were downloaded from Bloomberg, Thomson Reuters, and partially complemented with dataset in Wright (2011). Estimation is carried out using country-level pools of sample banks.

Modelling Yields on Loans and Cost of Deposits

13. The chapter uses a parametric model to estimate the effective repricing maturities of banks' interest earning assets and liabilities and the elasticity of the yields of those assets and liabilities to benchmark interest rates based on their historical relationship. Once the parameters of the model have been estimated, the trajectories of banks' interest income and cost of deposits can be simulated forward, conditional on the market expected forward interest rate path and the macroeconomic environment projected by the *World Economic Outlook*.

14. In many jurisdictions, bank financial statements report only the yield on the current portfolio—so called "back-book" yield. However, the "front-book" yield (the interest charged on loans that are repriced or on new loans, henceforth "new loans") of bank i at time t can be estimated by assuming that it corresponds to a weighted average of the interest rates charged for new loans of different maturities indexed by s, $Y_{i,t}(s)$

$$Yield\ on\ Loans_{i,t}^{FrontBook} = \sum_{s=1}^{N} w_{i,t}(s) \times Y_{i,t}(s) \quad (3)$$

where the weights $w(s)$ correspond to the share of new loans of maturity s in the overall portfolio of new loans and are assumed constant across banks and time.

15. Under the additional assumption that spread between interest rates $Y_{i,t}(s)$ and benchmark market rates of the same maturity $MarketYield_t(s)$ is an affine function of the benchmark rate, front book yields can be written as

$$Yield\ on\ Loans_{i,t}^{FrontBook} = \alpha_i + (1+\beta)\sum_{s=1}^{N} w(s) Market\ Yield_t(s) + e_t^{Loans} \quad (4)$$

[4] This section was prepared by Tomohiro Tsuruga.

16. Since the back-book yield is the accumulation of interest paid by loans underwritten in the past but not yet matured, it corresponds to:

$$Yield\ on\ Loans_t = \frac{\sum_{s=0}^{N}\sum_{k\geq s}^{N} w(k)\left(New\ Loans_{t-s}(k) \times Y_{i,t-s}(k)\right)}{Loans_t} \quad (5)$$

where $New\ Loans_{t-s}(k)$ is the amount of loans underwritten at time $t-s$ in maturity bucket k with interest rate $Y_{i,t-s}$.

17. Finally, assuming that the fraction of new loans is constant and noted by ϕ and that the asset size is constant $Loans_t = Loans$, changes in the back-book yield can be written as:

$$\Delta Yield\ on\ Loans_{i,t} = \tilde{\beta}\sum_{s=0}^{N} w(s)\left(MarketYield_t(s) - MarketYield_{t-s}(t-s)\right) + u_t^{Loans} \quad (6)$$

where $u_t^{Loans} \sim N(0, \sigma_{Loans}^2)$ and $\tilde{\beta} = \phi(1+\beta)$ is the overall sensitivity of the back-book yield to the current market yield, which is a product of the fraction of new loans and the sensitivity of the margin spread to the market yield.

18. The common maturity structure of banks in a given country w is assumed to follow a log-normal distribution with parameters (μ, σ), which can be adequately integrated to obtain an approximation of the weight of each 1-year maturity buckets used in the estimation[5].

19. Under the previous assumptions, the relationship between the changes in the observed back book yields and benchmark market rates depends on four parameters: $\tilde{\beta}, \mu, \sigma, \sigma_{Loans}$. These parameters were estimated by Markov Chain Monte-Carlo method. The Bayesian posterior mean is computed by drawing a number of sample parameters Θ from the posterior distribution. This procedure was carried out by using Hamiltonian Monte-Carlo (HMC) algorithm (number of chains = 4, number of samples = 1,000, burn in period = 500).

20. An analogous procedure is applied to estimate the parameters relating the cost of deposits to benchmark market interest rates, and to simulate trajectories for the cost of deposits.

21. The parameters can also be used to compute the implied average effective repricing maturity for the front book, which under these assumptions corresponds to $\exp(\mu + \sigma^2/2)$. Furthermore, the assumption that the front-book maturity structure $w(s)$ is constant in time implies that the back-book effective repricing maturity distribution $\boldsymbol{\phi_t} = (\phi_1\ \phi_2 \cdots \phi_{N-1}\ \phi_N)_t$ converges to a steady state "ergodic" distribution that is characterized by

$$\boldsymbol{\phi} = \mathbf{P}\boldsymbol{\phi}$$

where the transition matrix **P** is:

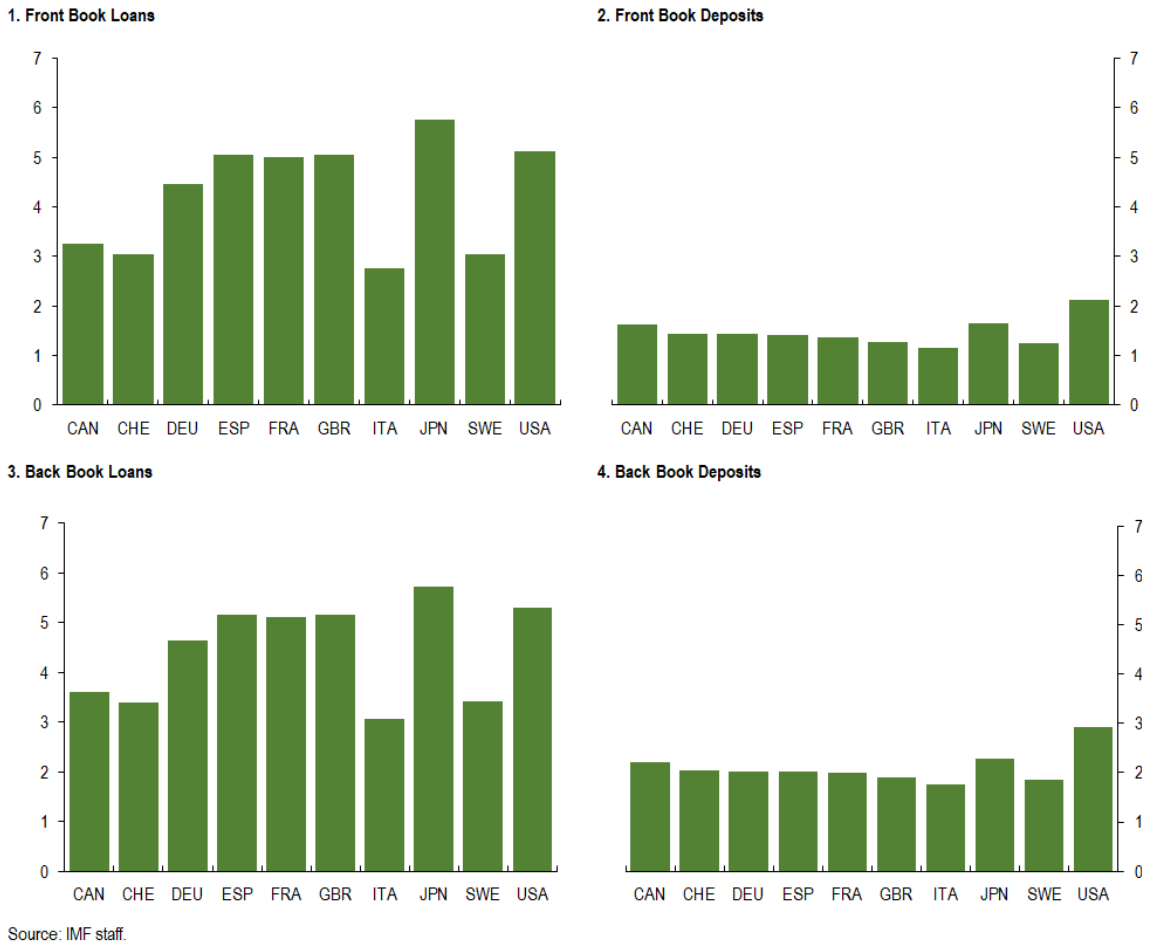
[5] In order for this approximation to be precise, *N* must be sufficiently large to describe bank portfolio maturity structure. Due to data limitation, in this exercise we suppose *N* to be 15 years (60 quarters).

$$\mathbf{P} = \begin{bmatrix} w(1) & 1 & 0 & \cdots & 0 & 0 \\ w(2) & 0 & 1 & \ddots & 0 & 0 \\ \vdots & \vdots & \ddots & \ddots & \ddots & \vdots \\ \vdots & \vdots & \vdots & \ddots & \ddots & \vdots \\ w(N-1) & 0 & 0 & \ddots & 0 & 1 \\ w(N) & 0 & 0 & \cdots & 0 & 0 \end{bmatrix}$$

which are the formulae used to compute the effective repricing maturities reported in the chapter and presented in Figure 4.1.2.

Online Annex 4.1. Figure 4.1.2. Implied Maturity of Loans and Deposits

(Years)



Source: IMF staff.

Modelling and Simulating Yield on Other Assets and Expenses on Other Liabilities

22. For income on other assets and expenses for other liabilities, the repricing mechanism may not apply. This is because these items include various transactions such as securities, repos,

central bank reserves, etc. where banks can either purchase or sell those assets. Thus, only the front-book is considered for those items in this exercise:

$$\Delta Yield\ on\ Other\ Assets_t = \tilde{\beta}^{OA} \sum_{s=0}^{\infty} w^{A}(s)\Delta MarketYield_t(s) \quad (7)$$

$$\Delta \text{Cost of } Other\ Liabilities_t = \tilde{\beta}^{OL} \sum_{s=0}^{\infty} w^{OL}(s)\Delta MarketYield_t(s) \quad (8)$$

Under similar functional form assumptions, the underlying parameters of the maturity structures and elasticities can be recovered applying Markov Chain Monte-Carlo to the historical relationship between these income components and benchmark market rates and used to conduct forward looking simulations of their paths.

Estimating Trajectories of Benchmark Market Rates at Different Maturities

23. The simulation of banks yields on assets and cost of liabilities requires benchmark market rates for all maturity buckets considered. Market interest rates for other tenors are estimated using a latent dynamic three-factor model following Diebold and Li (2006).

24. The measurement equation is constructed as:

$$\begin{pmatrix} MarketYield_t(T_1) \\ MarketYield_t(T_2) \\ \vdots \\ MarketYield_t(T_N) \end{pmatrix} = \begin{pmatrix} 1 & T_1 & (T_1)^2 \\ 1 & T_2 & (T_2)^2 \\ \vdots & \vdots & \vdots \\ 1 & T_N & (T_N)^2 \end{pmatrix} \begin{pmatrix} Level_t \\ Slope_t \\ Curve_t \end{pmatrix} + \begin{pmatrix} \epsilon_t^1 \\ \epsilon_t^2 \\ \vdots \\ \epsilon_t^{30} \end{pmatrix} \quad (9)$$

for $t = 1,2,\dots,T$, where $Level$, $Slope$, and $Curve$ are latent level, slope, and curvature factor, respectively. T_s $(s = 1,\cdots,N)$ represent the years of maturity of the corresponding benchmark market rate with maturity bucket *s*. We set $T_1 = 0$ and $T_s = T_{s-1} + 0.25$ (years) for all *s*>0, so that $MarketYield_t(1)$ equals to $Level_t$, which corresponds to the overnight riskless rate. The method of simulating these latent factors are explained later.

25. The system equation is a BVAR system (lag = 2) with macroeconomic variables, following Diebold and Li (2006) and Diebold, Rudebusch, and Aruoba (2006), as follows:

$$\boldsymbol{F}_t = \mathbf{B_1}\boldsymbol{F}_{t-1} + \mathbf{B_2}\boldsymbol{F}_{t-2} + \boldsymbol{u}_t \quad (10)$$

where factors $\boldsymbol{F}$ consists of level, slope, curvature factors as well as (HP filtered) series of (log) GDP, CPI, and total credit to the non-financial sector from banks as a share of GDP.[6]

26. The model was estimated using quarterly time series data from 1991Q1 to 2019Q2[7]. Estimation is carried out for each currency following the 2-step procedure of Diebold and Li

[6] Quarterly data of GDP, CPI inflation, Bank Credit to nonfinancial sector per GDP are downloaded and constructed from Organization for Economic Co-operation and Development and Bank for International Settlement. All variables are HP filtered ($\lambda = 1600$).

[7] For Euro Area the sample period is 1999Q1 to 2019Q2. The estimation was carried out using the whole sample period including the zero and negative rate periods. One caveat of this method is that these estimates can be biased if these countries have already been bounded by the effective lower bound (ELB).

(2006), although in the second step the VAR system is estimated via Bayesian methods as in Arias, Rubio-Ramírez, and Waggoner (2018).[8]

27. The fitness of the first step of the model to data is shown below (Table 4.1.5).

Online Annex 4.1. Table 4.1.5. Implied Maturity of Loans and Deposits

	CAD	CHF	EUR	GBP	JPY	SEK	USD
Fit (%)	98.6	98.3	97.5	98.8	98.8	94.2	98.0

Source: IMF staff.

28. Once the model has been estimated, the parameters can be used to simulate trajectories for conditional forecast of bank credit-to-GDP that are consistent with the forecasted trajectories for GDP, CPI, and interest rates.

Scenario Building

The estimated path of the whole yield curve is specified by the dynamic factor model. According to the observation equation (9), the overnight short-term rate corresponds to the $Level$ factor. We set the path for the level factor according to the market forward rate. Given the level factor set by the forward rate, we assume 10 years tenor to follow the 10 years forward rate, and set $Curve_t$ to be in the long-run mean. This way, the path for the $Level_t$ and $Slope_t$ are pinned down. Regarding the macroeconomic variables, expected path for GDP growth and CPI inflation are set in line with the *World Economic Outlook*. The path of other tenors and other macroeconomic variables are specified by a conditional forecast based on the dynamic factor model. To forecast the conditional path of credit growth, the BVAR system was used. The assumptions are summarized in the Table 4.1.6 and the trajectories of these variables are shown in Figure 4.1.3.

Online Annex 4.1. Table 4.1.6. Scenario Assumptions

Category	**Yield Curve**			**Macroeconomic Variables**		
Item	Short-term rate	10 years spread	Other tenors	GDP growth	CPI inflation	Bank credit-to-GDP
Assumption	Implied forward rate	WEO	Dynamic Factor Model	WEO	WEO	Dynamic Factor Model

[8] As a prior distribution for Bayesian estimation, uninformative Normal-Inverse-Wishart prior is used. The closest-to-median impulse model is chosen as the baseline model (number of lags = 2, number of draws = 100, number of transformations per draw = 100).

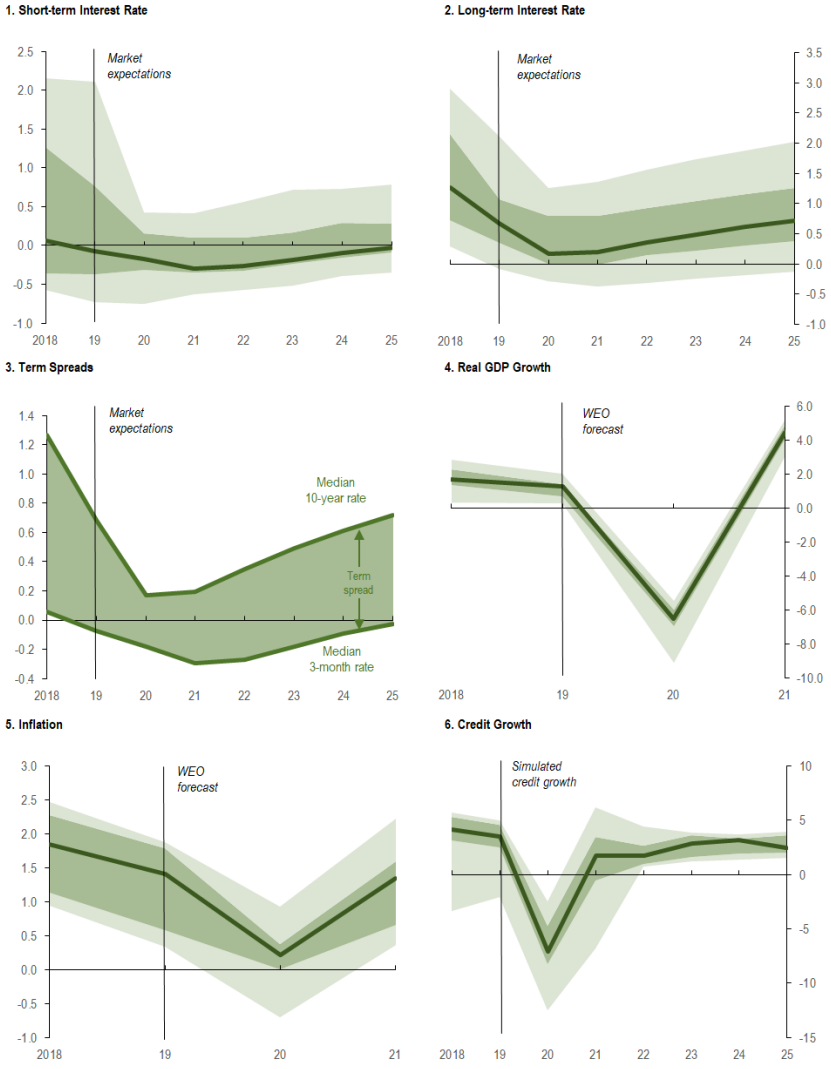
Simulating future yields on loans and cost of deposits

29. Once the parameters of the model are estimated, equation (6-10) can be used to simulate the yield on assets and costs for liabilities for given future trajectory of benchmark market rates. However, in simulating these trajectories, the model incorporates an effective lower bound of interest rates on deposits as this reflects the cost of the entire retail and corporate deposit base, as follows:

$$\underline{Cost\ of\ Deposits_t} = max(Cost\ of\ Deposits_t, 0) \quad (11)$$

Online Annex 4.1. Figure 4.1.3. Simulation Scenario

(Percent)



Source: Bloomberg Financ L.P; Thomson Reuters; and IMF staff calculations.
Note: The decomposition is based on estimated elasticities from 10 economies and a sample of realized contributing factors from Eurozone countries. The numbers represent percentage changes in a representative bank's net interest margin. The trajectories for WEO forecasts are truncated up to the last period that is publicly available.

C. Forward-Looking Simulation of Bank Profitability[9]

30. The simulated paths for banks' yields on loans and other interest earning assets, cost of deposits and other expenses, as well as the macro consistent trajectories for GDP and credit growth are used to simulate bank profitability, using a bottom-up model that projects the income statements and selected balance sheet items for a sample of banks from 2019 through 2025.

31. The analysis is carried out on a sample of about 900 banks headquartered in nine countries, including three North Atlantic countries (Canada, United Kingdom and United States) that represent 47 percent of the sample by assets, three large euro area countries (France, Germany and Italy) that represent 27 percent of the sample, and three other countries employing negative policy rates (Japan, Sweden and Switzerland) that represent 26 percent of the sample. The sample size is constrained by the modeling requirement that a bank separately reports its interest income on loans and on other interest-earning assets, and its interest expense on deposits and on other liabilities.

Balance Sheet

32. The growth of banks' balance sheet is anchored to loan growth. Banks' *gross loans* are assumed to follow the BVAR-based simulated credit growth (as described in Section B of this annex). The model projects assets assuming each bank's *loan-to-assets ratio* remains constant at its 2018 level. Asset and loan growth are subject to the constraint that each bank's *Tier1 ratio* remains above 8 percent and its *leverage ratio* above 3 percent. (there is an assumption that banks do not raise new capital during the simulation). *Risk weighted asset density* (risk weighted assets divided by total assets) is assumed to remain constant at the 2018 level.

33. Total interest earning assets are assumed to grow at the three-year average growth rate of total assets. Other interest earning assets are calculated as the difference between total interest earning assets and gross loans; and non-interest earning assets is the difference between total assets and total interest earning assets. Other elements of bank assets, such as insurance assets and fixed assets, are assumed to grow proportionally with total assets assuming constant ratio at 2018 level.

34. Similarly, *total interest bearing liabilities* grow proportionally with *total interest earning assets*, assuming constant ratio at 2018 level. *Customer deposit* is derived assuming constant *loan-to-deposit ratio* at 2018 level, with *non-deposit funding* being the residual of *total interest bearing liabilities* and *customer deposit*.

Income Statement

35. *Net interest income* is calculated by applying the bank yields and funding costs (that are estimated as explained in Section B of this annex) to the projected balance sheet. Specifically, *total interest income* is the sum of *interest income from loans* (*average gross loans* times *yield on loans*) and

[9] This section was prepared by John Caparusso and Yingyuan Chen.

interest income from other interest earning assets (*average other interest earning assets* times *yield on other interest earning assets*); and *total interest expense* is similarly derived.

36. *Loan loss provisions* and *net fee income* are calculated based on historical elasticities to macroeconomic factors (as discussed in Section A of this annex, Table 4.1.3).

37. Other key elements of revenue and expense items are projected assuming either trend-based or constant ratio to respective balance sheet item (Table 4.1.7).

38. A key goal of these assumptions is to establish a fairly neutral backdrop against which to highlight the income statement elements of particular interest for this analysis – net interest income and loan-loss provisions. Rather than attempting to forecast discontinuous shifts in business strategy, the chapter focuses on the magnitude of revenue or operating cost improvement that would be necessarily for a bank to reach sustainable profitability.

Online Annex 4.1. Table 4.1.7.
Summary of Income Statement Projection Assumptions

Income Statement Item	Projection assumption
1. Net interest income	Model-based, as described above
2. Fees and Commissions	3-year average ratio to average total assets
3. Dividend income	3-year average ratio to average other interest bearing liabilities
4. Trading & invt income	3-year average ratio to average other interest earning assets
5. Insurance income	Constant ratio to average insurance assets
6. Other operating income	Constant ratio to average total assets
7. Total non-interest income	Sum of 2 to 6
8. Total revenue	Sum of 1 and 7
9. Operating expense	Constant ratio to average total assets
10. Loan loss provision	Model-based (elasticities based on panel regression)
11. Other impairment charges	3-year average ratio to average total securities
12. Non-operating profit	3-year average ratio to average total assets
13. Pre-tax profit	8 less the sum of 9 to 12
14. Tax expense	Constant ratio to pretax profit
15. Profit transfer	Constant ratio to pretax profit
16. Net income	13 less the sum of 14 and 15
17. Total dividend	Constant ratio to net income
18. Retained earnings	16 less 17

Source: IMF staff.

D. Market-Implied Cost of Equity[10]

39. There are many ways to estimate a bank's cost of equity—the return that shareholders require to hold a bank's shares—but in Chapter 4 we use a market-implied estimate. This method is based on the price-to-book and return on equity valuation model in Wilcox (1984). The starting point is the Gordon Growth model from Gordon (1962):

$$P_t = \frac{DPS_{t+1}}{c-g} \qquad (1)$$

where P_t is today's share price, c is the cost of equity, $DPS = EPS \times d$ is expected dividends per share, EPS is earnings per share, d is the dividend payout ratio, $g = (1-d)r$ is the long-term growth rate of earnings, and r is return on equity.

40. Because $r = \frac{EPS.S}{BV.S}$, where BV is the book value of equity per share and S is the stock of shares outstanding, then the share price can be restated as:

$$P_t = \frac{r.BV.d}{c-g} \qquad (2)$$

41. The price-to-book ratio ($pb = \frac{P}{BV}$) can then be defined as a function of return on equity, the growth rate of earnings and the cost of equity in the price-to-book and return on equity model:

$$pb = \frac{r-g}{c-g} \qquad (3)$$

42. A simple re-arrangement, along with an assumption used by market analysts that the long-term growth of earnings (g) is approximately zero (see, for example, Ghose *et al*, 2020 and Patel *et al*, 2020), allows the cost of equity to be estimated from the ratio of expected return on equity and the price-to-book ratio:

$$c = \frac{r}{pb} \qquad (4)$$

43. This method implies that a bank's return on equity will be below its cost of equity when the price-to-book ratio is below one. This means that the price-to-book value can be thought of as an indicator of the difficulty that banks may have in raising new equity in the market. The further the price-to-book ratio falls below one, the harder it is likely to be for the bank to obtain new equity from investors.

44. Finally, because return on equity (r) is the product of return on assets (ρ) and leverage—the ratio of a bank's assets to the book value of equity ($\frac{A}{BV.S}$)—then this method can be used to show that the market-implied cost of equity is a function of profitability and market-adjusted leverage—the ratio of a bank's assets to its market capitalization ($M = P.S$):

$$c = \rho \frac{A}{M} \qquad (5)$$

[10] This section was prepared by Will Kerry.

The cost of equity therefore rises when the market-adjusted leverage increases, assuming a constant level of return on assets. Because market-adjusted leverage can be used an indicator of bank stress (Kerry, 2019) a rising cost of equity can be a sign of elevated investor concerns about a bank's health.

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