CHAPTER 2

A NEW LOOK AT GLOBAL BANKING VULNERABILITIES

Chapter 2 at a Glance

- We provide a fresh assessment of global banking vulnerabilities, emphasizing potential risks in the environment of still-elevated inflation and high interest rates. The assessment, based on publicly available data and uniform methods across regions, is meant to complement similar exercises conducted by authorities using detailed supervisory data.
- The analysis uses publicly available information and comprises (1) a global stress test that is enhanced to draw lessons from the March 2023 banking turmoil and (2) key risk indicators incorporating extensive market data and analyst forecasts for use in real-time surveillance of emerging banking vulnerabilities.
- The global stress test shows that the global banking system remains broadly resilient under the October 2023 *World Economic Outlook* baseline scenario. However, it uncovers many banks in advanced economies with the potential for significant capital losses, driven by marking to market securities and provisioning for loan losses.
- These results are consistent with the key risk indicators that currently flag banks in Europe and the United States as having the greatest levels of stress as of the end of March 2023.
- In an adverse scenario characterized by a severe stagflation, the global stress test identifies significant capital losses in a wide set of banks, including several systemically important institutions in China, Europe, and the United States.
- As of the end of December, the key risk indicators based on consensus analyst forecasts point to a substantial group of smaller banks at risk in the United States. Elsewhere, risks are concentrated in Asia, China, and Europe, where lower expected earnings and depressed price-to-book ratios point to future stress.

Policy Recommendations

- The chapter argues for sharpening analytical tools for risk assessments; closely monitoring relevant market metrics; and making stress tests more stringent and granular, including for smaller banks.
- It is also key to make supervisory practices more intrusive and to implement corrective actions in a more timely and effective manner.
- Furthermore, prudential standards for capital held against interest rate risk should be tightened.
- Banks should prepare to access central bank facilities, thereby substantially mitigating potential capital losses from selling held-to-maturity securities under stress.

Introduction

With inflation still high in many parts of the world, central banks may need to keep interest rates higher for longer than currently priced in markets, slowing economic momentum. Given the nature of their business models, banks are most immediately and directly affected by an environment of high interest rates. Higher interest rates can improve interest margins of some banks, especially those that can pass higher policy rates through to lending rates while keeping deposit funding costs low and retaining customers thanks to the value of their deposit franchises. However, extended periods of high rates can also be associated with more loan losses at banks as their corporate and household borrowers face heavier debt-servicing burdens and a less favorable economic backdrop. In addition, valuation losses on bonds due to high interest rates—especially those incurred if banks need to sell assets held at book value to meet

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liquidity needs—and increased competition to retain cheaper deposits and other core funding sources can be detrimental to bank profitability and viability.

The net impact on banks of a "higher for longer" interest rate environment is therefore uncertain. After more than two years of the current global cycle of rate increases, most banks continue to report solid earnings, strong capital, ample liquidity, and adequate provisions for loan losses. As detailed in Chapter 1 of this *Global Financial Stability Report*, deposit outflows from regional banks in the United States have stabilized since the March turmoil, and stock prices have somewhat recovered. Globally, banks have managed the situation relatively well. However, lending conditions are tightening, and loan demand is falling as both provision expenses and funding costs are rising, putting pressure on future profitability. These developments could adversely impact the financial condition of banks if a soft landing fails to materialize amid high inflation that requires central banks to hike policy rates or keep rates at high levels for longer.

The failure of a few large regional banks in the United States and the takeover of a global systemically important bank (G-SIB) with the support of the authorities in Switzerland in March of 2023 are a reminder of how fast-paced global increases in interest rates can affect the global banking system. The banking turmoil in March prompted authorities and market participants to investigate the changing nature of the stability of bank funding, notably deposits, and its sensitivity to rising rates; the interrelationships between bank funding and bank solvency; the efficacy of banking supervision and regulation; the importance of access to, and operational readiness for, central bank facilities; and the role of investors in amplifying stress in an era of high-speed technological change. Investors have focused on banks that have low market-to-book ratios, poor profitability, and concentrated lending business models. These recent failures demonstrated how a group of weak banks, even if not individually systemic, can pose financial stability risks. A systematic effort is needed—beyond assessing the health of the systemically important part of the global financial system, which is the usual focus of the *Global Financial Stability Report*—to identify at the global level a weak group of banks at risk of becoming more fragile in the present environment.

This chapter presents the IMF's assessment of banks vulnerable in the present environment. The assessment is meant as a multilateral surveillance tool using less granular publicly available data and common methods across countries. It is complementary to more granular stress tests conducted by bank supervisors and in IMF-World Bank Financial Sector Assessment Programs (FSAPs). First, it conducts an enhanced version of the IMF's global stress test to identify banks with potential fragility if the current high inflation–high interest rate environment worsens. The enhancements draw from lessons learned during the March 2023 banking turmoil and include refined assessments of various interest rate channels and interactions between liquidity and solvency, with and without access to central bank facilities. The chapter also expands the bank sample greatly, compared to the previous exercises, to nearly 900 banks across the world. It assesses bank resilience under both a baseline scenario of protracted higher interest rates and a severe but plausible adverse scenario in which the global economy enters a stagflationary period of heightened risks to banks. The exercise aims to provide timely first-cut surveillance results using publicly available worldwide data. It could differ from and should complement the analyses by national authorities and the FSAP using more detailed information and incorporating country specifics more comprehensively.

Although the global stress test offers an in-depth assessment of capital adequacy using detailed bank-level characteristics, delays in the release of balance sheet data inherently limit the timeliness of such an approach. This chapter also presents a second, complementary approach to produce a real-time monitor of forward-looking risks by incorporating short-term consensus analyst forecasts on future bank balance sheet, valuation, and profitability metrics for approximately 350 of the world's largest publicly traded individual banks. These metrics, or key risk indicators (KRIs), have been selected for their ability to predict financial stress of individual banks and acute stress events, such as large declines in stock prices or deposit outflows. Banks are flagged if they have outlier characteristics across multiple risk dimensions and hence at elevated risk of severe stress. As such outcomes are rare, the KRIs are not designed to predict bank failures with a high degree of certainty. Instead, they provide an important tool for tracking the overall level of stress in the global banking system over time, and for identifying banks meriting closer examination for signs of weakness. Given their reliance on high-level data, the KRIs should be viewed as a complement to, and not a substitute for, stress testing or other detailed risk analysis of individual banks. Even as early as the fourth quarter

of 2022, multiple KRIs flagged the three US regional banks and the Swiss G-SIB that failed during the March 2023 banking sector turmoil, demonstrating the forward-looking nature of the approach.

Although the methodologies of the two approaches are distinct, their results are similar. Banks that are flagged as outliers on multiple KRIs are more likely to experience large capital losses under the global stress test's adverse scenario. In addition, the two assessments point to similar risks at the current juncture. Under the baseline scenario, the global stress test results show that the global banking system remains broadly resilient, but many banks in advanced economies show significant capital losses, largely driven by mark-to-market losses on securities holdings in a higher-for-longer interest rate environment, as well as loan losses. In the United States, these losses are concentrated in regional banks, confirming the events of March 2023. This finding is consistent with the KRIs, which currently show the greatest levels of stress in the United States and Europe, in keeping with recent events and the subsequent downgrade of profitability forecasts and bank equity prices. Projections of KRIs to the end of December 2023 using analyst forecasts show that some small and regional US banks will remain under pressure, and risks are concentrated in banks in Asia, China, and Europe, as lower-than-expected earnings and depressed price-to-book ratios signal. In the adverse scenario, the global stress test shows that significant capital losses could spread to a much wider set of banks, including several systemically important ones in China, Europe, and the United States.

In addition to examining the global banking system, the chapter also assesses recent changes in depositor behavior, as well as evidence that investors tend to rapidly sour on banks with low price-to-book ratios and low profitability despite what appears to be adequate regulatory capital and liquidity. In other words, investors appear to weigh a forward-looking, economic view of bank viability more heavily than a static, balance sheet view.[1]

The chapter also outlines several policy recommendations, drawing on results from the global stress test and KRI analysis as well as insights from the IMF's in-depth analyses of banking systems conducted during recent assessments under the IMF's Financial Sector Assessment Program.

[1]Previous issues of the *Global Financial Stability Report* (see, for example, April 2010 and 2011, Chapter 1) noted that market pricing was a strong predictor of bank stress during the global financial crisis and used market valuation-based analyses to construct risk indicators and predict banking stress.

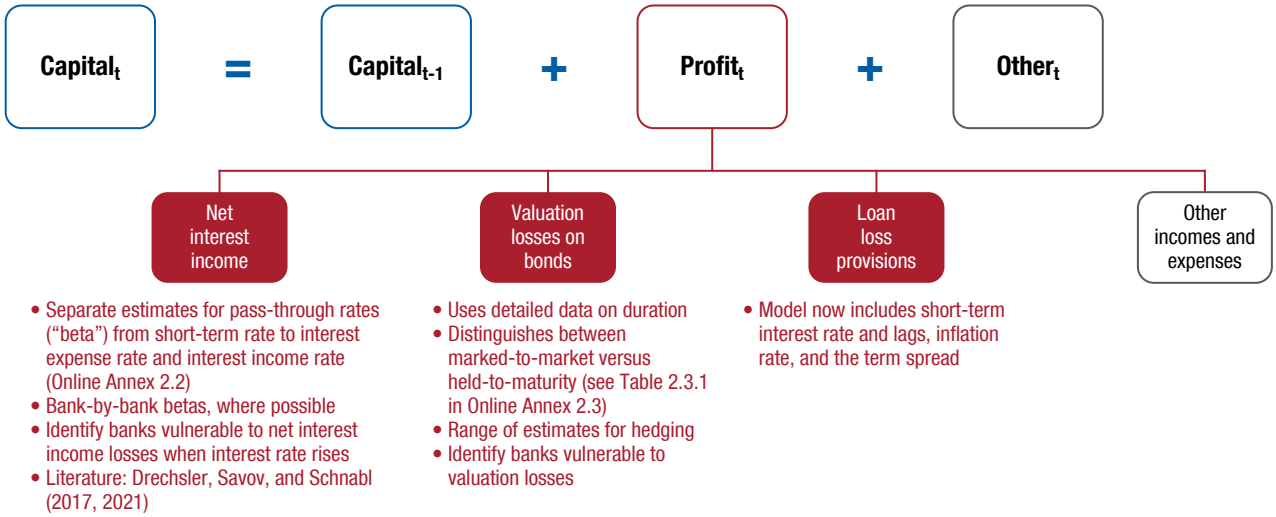
Using the Enhanced Global Stress to Identify Weak Banks

Stress testing is a forward-looking simulation tool often used to identify vulnerable banks under various macrofinancial scenarios. In the version used in this chapter, it projects banks' income and capital through the medium term, in both a baseline and an adverse scenario, using each bank's balance sheet and profit and loss data at the stress test's starting point. It also uses statistical methods to model banks' behaviors through the macrofinancial cycle over the test's projection horizon. Macrofinancial stress testing has been one of the central risk assessment approaches in the Financial Sector Assessment Program since its inception in 1999. Many countries have also adopted stress testing as a key supervisory tool. Past issues of the *Global Financial Stability Report* and other research have presented results from the global stress test (for example, Ding and others 2022; October 2022 *Global Financial Stability Report,* Chapter 1). Covering 260 banks globally using publicly available data, the previous global stress test showed that no banking system would breach the Basel minimum capital level—Common Equity Tier 1 (CET1) capital ratio of 4.5 percent—although almost 30 percent of emerging market economy banks would do so. Following sharp increases in policy rates, 2022 provides a new starting point of the stress tests with an opportunity to include additional insights on interest rate channels.

In view of the recent bank turmoil and the current high-for-long interest environment, this chapter modifies the global stress test in several ways to identify potentially weak banks. First, it expands the sample to nearly 900 banks across 29 countries (Online Annex 2.1). Second, it modifies the methods to project the main sources of banks' net income—net interest income, fees and commissions, valuation gains or losses on fixed-income securities, and loan loss provisions—to bring out the effect of higher-for-longer interest rates on bank capital (Figure 2.1; Online Annexes 2.2 and 2.3). Third, in a bank run in which banks lose a certain share of deposits, it adds a new liquidity-to-solvency channel to the adverse macrofinancial scenario to assess the additional effect of such a run on capital (see the

Figure 2.1. Enhancement to Global Stress Test: Interest Rate Channels

Solvency channel: Direct effect of macrofinancial scenarios on banks' net income, which has an effect on retained earnings and hence, capital. The enhanced global stress test has new "satellite models": a series of econometric models that link macro scenarios to banks' income sources, including net interest income, valuation losses on bonds, and loan loss provisions. The models sum the impacts from each of these channels for the overall effect on regulatory capital. The changes to the global stress test are shown in red (see Online Annexes 2.1 through 2.3):



Liquidity-to-solvency channel: Additional capital impact for all banks, conditional on a rate of withdrawal ("run") of liabilities including deposit and margin calls, over and above the macrofinancial adverse scenario. This is based on a simulation conditional on a deposit run of 25 percent at the end of 2023 (see the "Vulnerabilities to Interactions between Liquidity and Solvency" section); banks would need to pledge securities held to maturity with the central bank at penalty rates of 150 basis points above the adverse-scenario short-term rates, under the assumption that central bank facilities are available (see Online Annex 2.4). The penalty rate usually ranges from 100 to 300 basis points above policy rates and could sometimes be zero in certain systemic stress scenarios.

Source: IMF staff compilation.

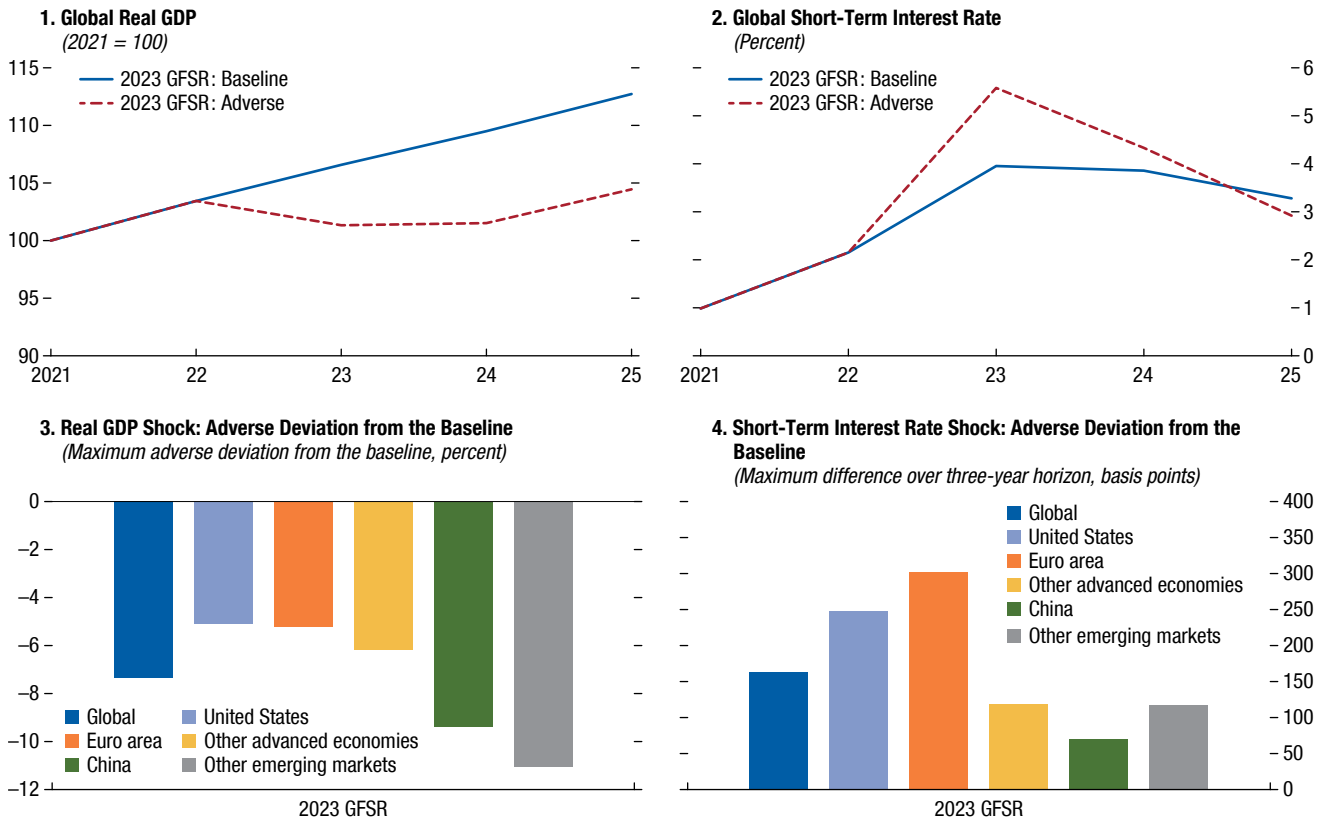
discussion later in the chapter, as well as Figure 2.1 and Online Annex 2.4).[2]

Furthermore, the analysis also identifies potentially weak banks conservatively using a change in the capital ratio in addition to a capital ratio threshold. A bank is "weak" if either (1) its CET1 ratio falls below 7 percent—the Basel minimum of 4.5 percent plus a capital conservation buffer of 2.5 percent—plus buffers for G-SIBs where applicable, or (2) its CET1 ratio at its lowest point over the stress test horizon (2023–25) represents a decrease of more than 5 percentage points from the stress test's starting point of 2022, excluding banks that are highly capitalized (with more than a 30 percent CET1 ratio). This way, banks are identified to be weak because they either breach the minimum threshold or are cyclically very sensitive to the scenarios.

The liquidity-to-solvency channel is built on an illustrative "reverse stress test" approach because it is empirically hard to relate deposit runs to bank balance sheets or pin down depositor behavior. Moreover, such behavior could differ depending on characteristics such as retail versus institutional deposits, demand versus term deposits, and deposit insurance coverage, but our data do not offer such details. The reverse stress tests apply several hypothetical deposit run-off rates to all deposit for identifying breaking points without discussing how likely they are. The business models of commercial banks rely greatly on maturity transformation, and any bank—no matter how liquid it is—would fail if it experienced a massive run (Box 2.1). The global stress test assumes that liquidity stress will affect capital differently, depending on the run rate of deposits and the presence or absence of central bank facilities (see Online Annex 2.7). Some previous solvency stress tests have incorporated the effect of liquidity on funding costs, as in assessments under the Financial Sector Assessment Program (Schmitz, Sigmund, and Valderrama 2017;

[2]Apart from a smaller sample of banks, the previous version of the global stress test excluded the Chinese banking system and had 2021 as the starting point. Moreover, the baseline scenario had a smaller interest rate rise and higher GDP growth, and the adverse stagflationary scenario featured smaller inflation and interest rate shocks, compared to the version presented in this chapter. The global stress test using publicly available data and common methods is meant to serve as a multilateral surveillance tool, complementary to supervisory or FSAP stress tests that use more granular bank-by-bank data.

Figure 2.2. Macrofinancial Scenarios



Sources: IMF, *World Economic Outlook*; Vitek 2018; and IMF staff calculations.
Note: Panels 3 and 4 show the maximum difference between adverse and baseline over the three-year stress-testing horizon. GFSR = *Global Financial Stability Report*.

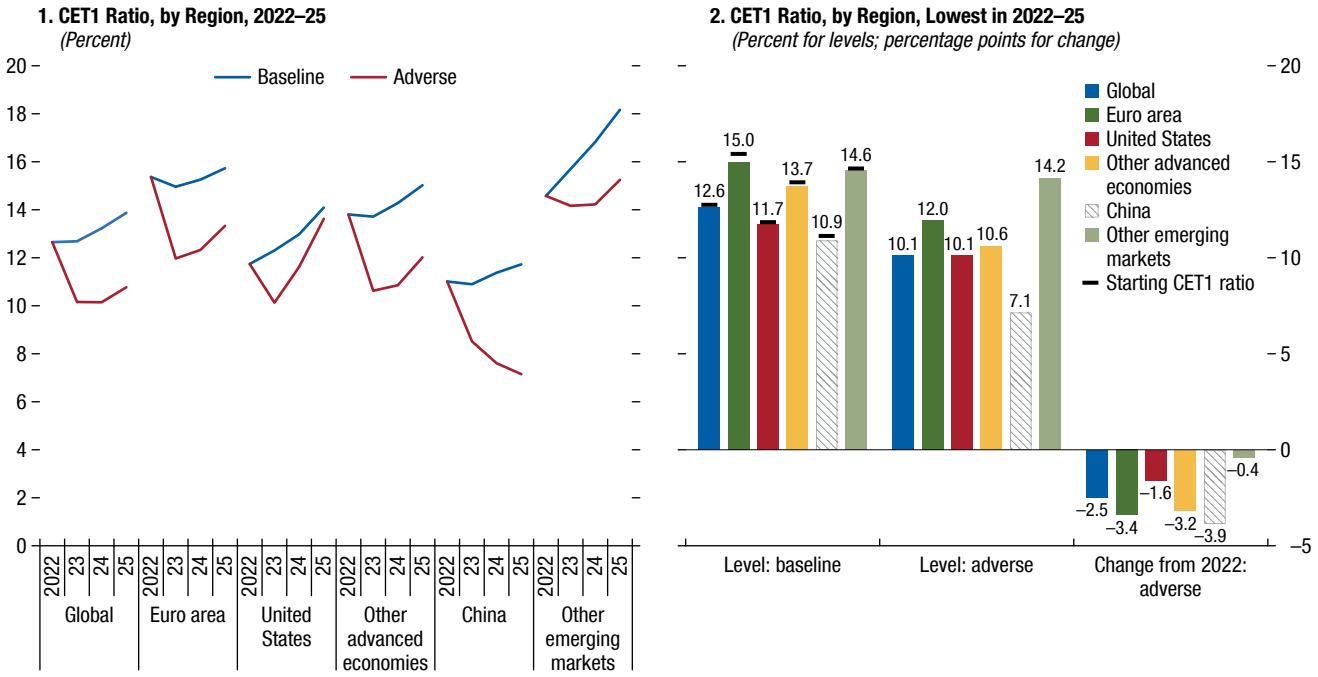
Adrian, Morsink, and Schumacher 2020) and in previous issues of the *Global Financial Stability Report* (such as Chapter 3 of the October 2013 issue), but rarely do they include an effect on capital through bank runs (exceptions are Wong and Hui 2009 and Cont, Kotlicki, and Valderrama 2020, and outside of stress tests, Copestake, Kirti, and Liu, forthcoming).

Macrofinancial Scenarios

The baseline macrofinancial scenario used in the chapter features continued gradual global growth in the baseline, following the October 2023 *World Economic Outlook*, and the adverse scenario incorporates severe stagflation. The baseline assumes that long-term inflation expectations are well anchored, monetary tightening continues but peaks, and term premiums fall across regions. In contrast, the adverse scenario—derived from a structural macrofinancial model for 33 countries (Vitek 2018; Online Annex 2.1)—assumes that inflation is more persistent, driven primarily by supply shocks, and generates stronger monetary tightening. Term premiums increase more in emerging market economies than in advanced economies. The global economy contracts by about 2 percent in the first year of the scenario (2023), with recessions across regions, including in China. The peak global policy rate shock, over the baseline, is about 160 basis points (Figure 2.2).

The two scenarios accommodate different regional dynamics (Online Annex 2.1). In both, inflationary dynamics are more subdued in China than in other economies. The euro area and the United States, in contrast, experience stronger monetary policy tightening compared with emerging markets in both scenarios. However, emerging markets experience steeper shocks to real GDP compared with those in advanced economies, owing to spillovers from policy tightening and recessions in the latter group (Figure 2.2). The adverse scenario for China features a very large but plausible correction in the housing market as well as supply shocks from labor productivity, markups, and oil prices, which are common across regions. Hence, the GDP growth shock for China is significantly larger than that used in other

Figure 2.3. Global Stress Test Results



Sources: Bloomberg Finance L.P.; Capital IQ; Fitch Analytics; Vitek 2018; October 2023 *World Economic Outlook*; and IMF staff estimates.
Note: CET1 = Common Equity Tier 1.

regions on a historically scaled basis, but comparable when scaled to deviations from the baseline (see Online Annex 2.1). Sensitivity analyses around the China adverse scenario are shown in Online Annex 2.1.

The adverse scenario further assumes bank runs at the end of 2023 resulting in liquidity-to-solvency interaction channels. This interaction is based on a simulation exercise added on to the effect on capital from the macrofinancial adverse stagflationary scenario. It is assumed that banks experience a run on customer deposits at the end of 2023 (the first year of the stress horizon), for which they pledge so-called held-to-maturity securities with the central bank, after selling their available-for-sale and held-for-trading portfolios. When central bank facilities are available (such as normal-time standing facilities or emergency liquidity assistance), the simulation assumes that banks can pledge securities with the central bank at a moderate penalty rate—taken as 150 basis points above policy rate, although it usually ranges between 100 and 300 basis points—for a year. Thus, banks will incur higher interest expenses, squeezing their net interest income and retained earnings, but they will not need to sell held-to-maturity securities at distressed prices and realize capital losses. Separate simulation exercises show the effect on capital when such facilities are not available (see the "Vulnerabilities to Interactions between Liquidity and Solvency" section). Ad hoc policies and fines—such as raising tax rates on rising net interest income or imposing penalties for frauds—are not considered in the scenarios.

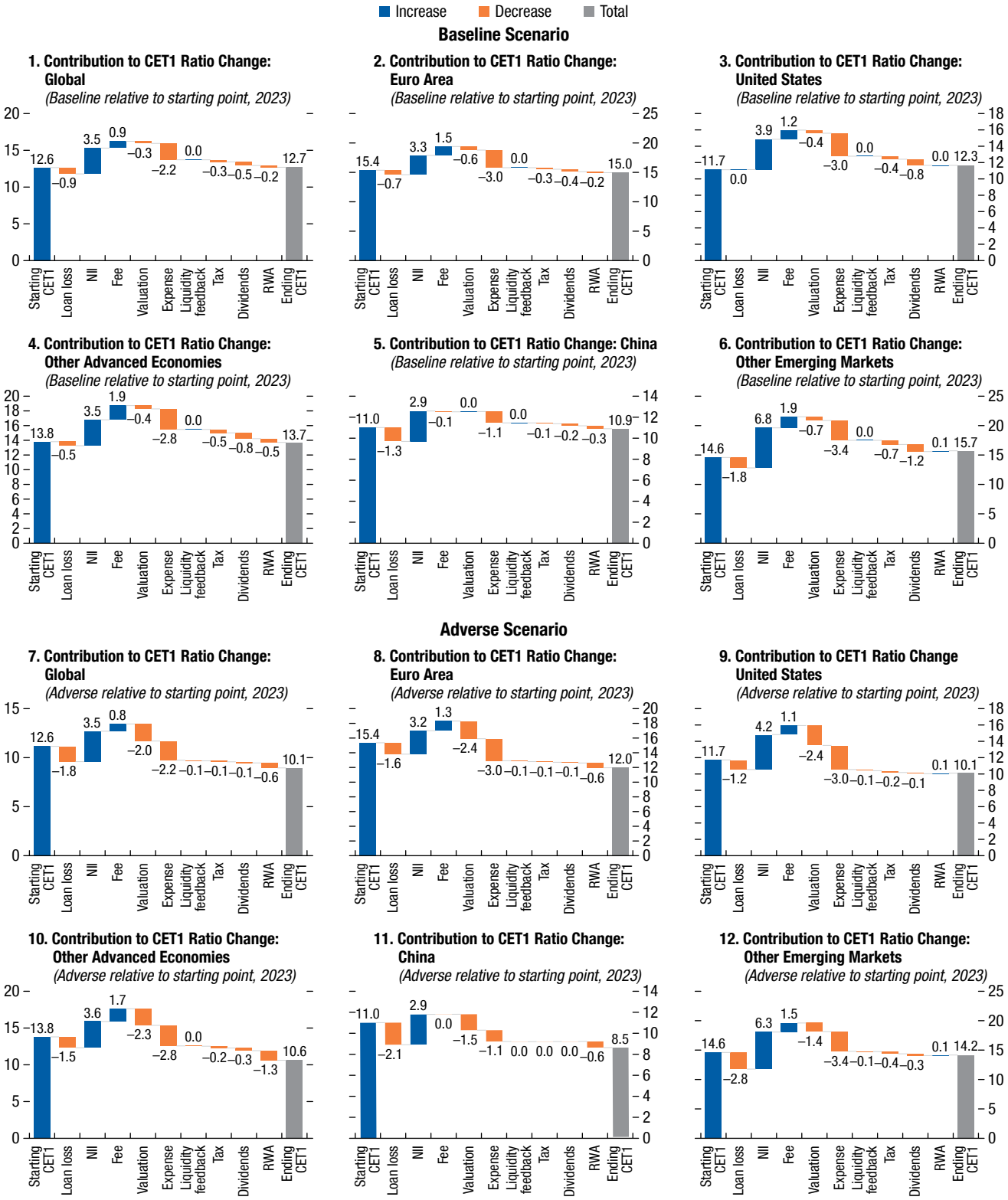
Overall Results

The global stress test results show that the global banking system remains broadly resilient in the baseline scenario. That scenario projects capital in the global banking system to remain high, at about 12.7 percent of risk-weighted assets, in 2023 when the policy rate shock peaks, and to continue to improve over the test's projection horizon (Figure 2.3). Most banks face higher loan loss provisions and valuation losses on their securities portfolios, and net interest income improves and counteracts losses in other areas. Although loan losses intensify through 2025, a reversal in valuation losses on securities and improvements in net interest income help increase capital over the stress test horizon on average.

In the adverse scenario, the capital ratio troughs in 2024 before improving to 10.8 percent in 2025, above the minimum threshold but below the starting point. Valuation losses dominate in 2023 compared with those in the baseline, contributing 1.7 percentage points to the decline in the CET1 ratio, and loan losses add nearly another percentage point (Figure 2.4). Higher loan losses

Figure 2.4. Stress Test Results: Capital Ratio in 2023 Relative to 2022

(Percentage points)



Sources: FitchSolutions, Fitch Connect; and IMF staff calculations.
Note: "Expenses" refers to operating costs, assumed to be constant over time and across scenarios as a share of risk-weighted assets. CET1 = Common Equity Tier 1; Loan loss = loan loss provisions; NII = net interest income; RWA = risk-weighted asset.

in the adverse scenario hold back improvements in net interest income from performing loans, despite higher interest margins over the baseline. The feedback from liquidity to solvency in the adverse scenario adds only 10 basis points to the capital decline overall, highlighting the relatively small cost of accessing central bank facilities during bank runs. As in the baseline, loan losses dominate in the medium term in the adverse scenario.

Regional differences in stress test results highlight the role of initial capital levels. In the adverse scenario, banks in emerging markets (other than the banking system in China, "Other emerging markets" in Figure 2.3) are particularly resilient in 2023, and over the medium term, they are helped by high initial capital ratios, robust economic growth, and sizable net interest income (Figures 2.3 and 2.4). Even in the trough year of the adverse scenario—when the capital ratio reaches the lowest point over the three years—other emerging markets see a decrease of only 40 basis points over 2022. In contrast, the banking system in China starts out with one of the lowest capital levels among the regions and ends up with the highest decline, 3.9 percentage points, and its CET1 ratio is slightly above the 7 percent minimum (Figure 2.3). Among advanced economies, the euro area experiences a relatively steep decline in capital ratio through the trough year—comparable to overall results for the European Banking Authority's (2023) stress tests for euro area banks—but ends up with a relatively high level, owing to a healthy starting point. The United States, despite a moderate level of initial capital, settles at a level similar to average global levels and average levels for other advanced economies; the modest decline over the adverse scenario for the United States is mainly due to gains on net interest income.

Reasons for the capital decline in the adverse scenario vary by region. When compared with those in the baseline scenario in 2023, valuation losses in the adverse scenario in that year dominate in advanced economies and in China, with loan losses the second-biggest contributor to the decline (Figure 2.4). Net interest income helps banking systems in the United States and in other advanced economies modestly in 2023, whereas it mildly hurts those in other regions. The adverse impact on capital in 2023 illustrates that valuation losses and loan losses would dominate any improvement in net interest income globally, even in regions in which net interest margins increase the most.

There are more weak banks in the advanced economies in the baseline, spreading to all regions in the adverse. Despite the benign outcome in the baseline, there are 55 banks with more than $5.5 trillion in assets that see their capital falling either below 7 percent or by more than 5 percentage points in 2023 (Figure 2.5). These include many banks in Europe, some G-SIBs (including Credit Suisse), and their subsidiaries, with their combined assets ranging from 5 to 10 percent of the total assets in each region (Figure 2.5). The weak banks are spread across countries and size in Europe and are concentrated in small banks in emerging markets and China. Under the adverse scenario, however, several banks in China and other emerging markets are flagged as weak, in addition to more banks in advanced economies including several G-SIBs, bringing the total number of weak banks to 215, accounting for 42 percent of global banking assets. If the criterion were limited to banks with capital falling below 7 percent, the share would still be sizeable at 36 percent of global bank assets, but the number and share of weak euro area banks would fall considerably. Sensitivity analyses around China's scenario suggests that if, for instance, the unemployment rate shock were halved in all three years, then the share of Chinese bank assets considered to be weak in the adverse scenario would fall from about 62 to 55 percent (Online Annex 2.1).

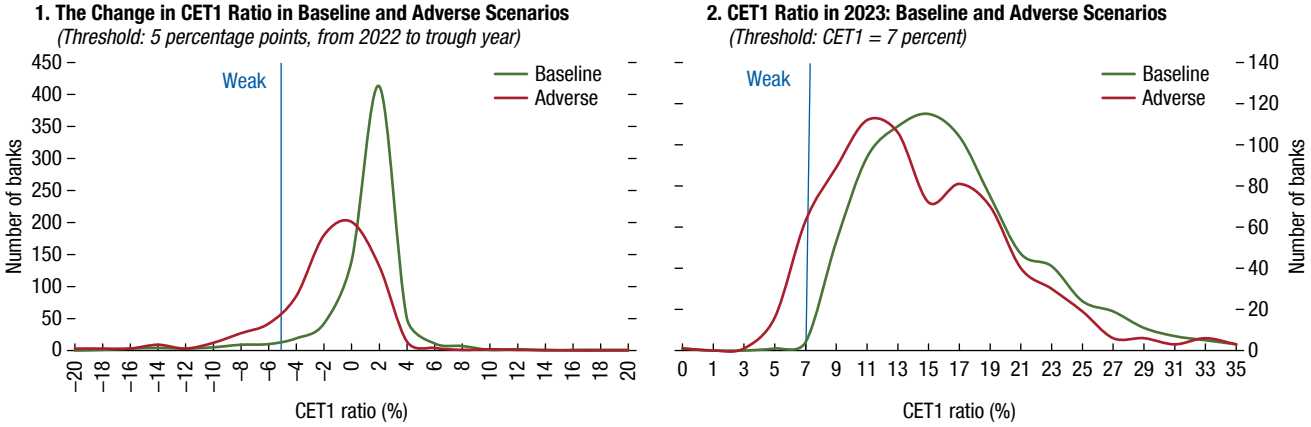
The interaction between liquidity and solvency makes a relatively small contribution to global and regional aggregates. However, in a 25 percent deposit run, the CET1 ratios of several banks in advanced economies would decline by almost one additional percentage point owing to higher expenses related to the use of central bank deposit facilities. These include at least two of the US banks that failed in March of 2023. Of course, the number of weak banks would quickly multiply if access to central bank facilities were not available in the event of deposit runs, as banks would need to sell held-to-maturity securities, taking marked-to-market losses, and deplete capital (see the "Vulnerabilities to Interactions between Liquidity and Solvency" section).

Characteristics of Weak Banks

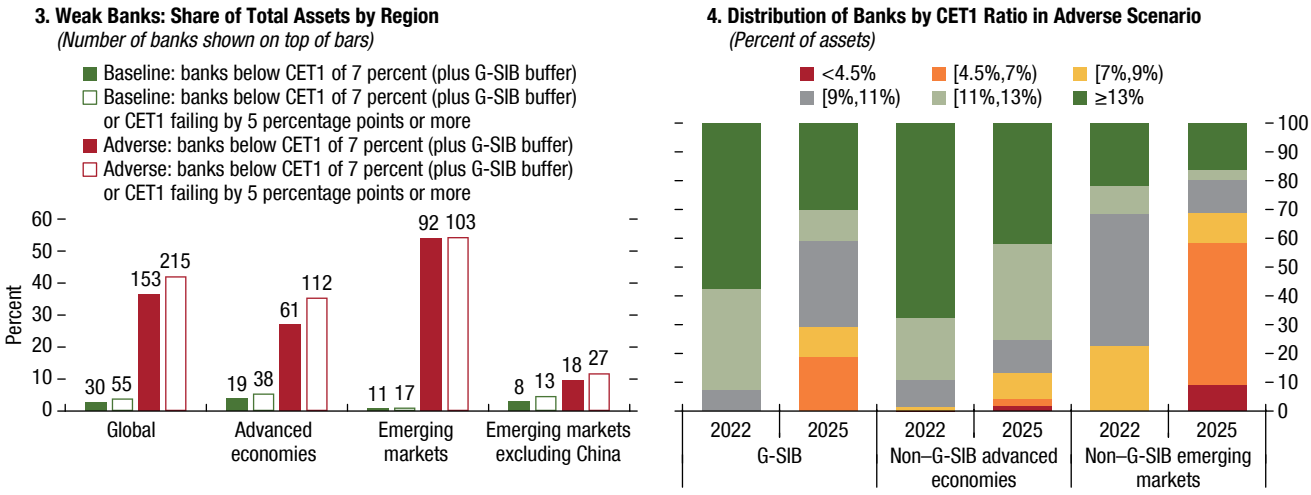
Banks that the global stress test has identified as weak share some common features. Comparison of different characteristics is presented as a spider chart (Figure 2.6), with the standardized average for weak banks (red) contrasted with those for non-weak banks (green). Larger values in the chart represent more risk. Across both the scenarios, weak banks on average are less profitable (red line for return on assets in Figure 2.6), have net interest margins that are adversely

Figure 2.5. Weak Banks, 2023

Banks that either fall below a minimum Tier 1 ratio (7 percent) or have a large (5 percentage points or greater) decline in their Tier 1 ratios are left of the vertical lines in panels 1 and 2, respectively, and are considered "weak."



Under the baseline scenario, 55 global banks representing 4 percent of global bank assets would be weak. Under the adverse scenario, 215 banks comprising 42 percent of global bank assets would be weak, mainly from advanced economies and China. A fifth of G-SIB assets would be weak by the end of the stress-testing horizon in 2025, and a considerable share of smaller banks would be weak, mainly from China.



Sources: Fitch Solutions, Fitch Connect; and IMF staff estimates.
Note: In panel 3, the number of banks are shown on top of the bars. CET1 = Common Equity Tier 1; G-SIB = global systemically important bank.

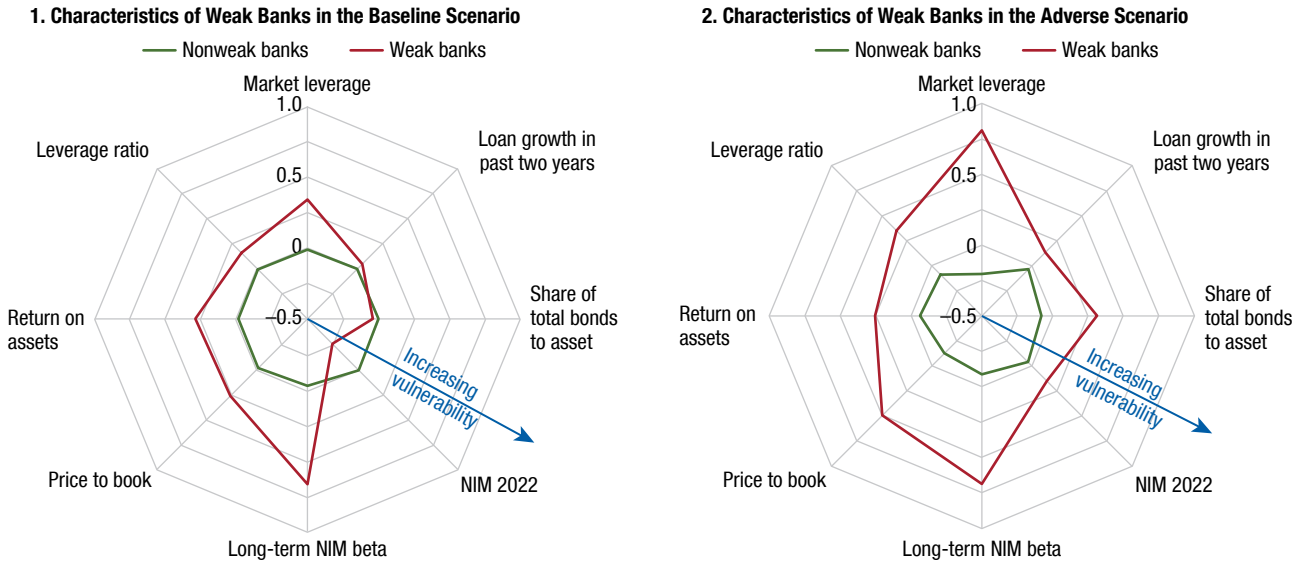
affected by higher interest rates (net interest margin [NIM] betas for weak banks are much lower than the nonweak banks), and have high loan growth in the preceding two years that enabled buildup of vulnerabilities (Figure 2.6). Moreover, they have relatively low price-to-book ratios, reflecting investor concerns about their prospects and, relatedly, very high market leverage.

In addition to the characteristics differentiating weak and non-weak banks in the baseline, there were other characteristics of banks that fare poorly in the adverse scenario. The weak banks in the latter case also had lower net interest margins in 2022, reflecting poor income generation capacity, weaker capitalization (reflected in their book leverage ratios), and a higher share of bonds in total assets. Low net interest margins and profitability together with slower pass-through of short-term rates to net interest income are major drivers for the difference between the euro area and US outcomes in the adverse scenario (see the "Vulnerabilities from Interest Margins" section and Online Annex 2.1).

In addition to those revealed by the overall results, several insights on bank-specific vulnerabilities arise from assessment of the global stress test's subcomponents of interest rate channels. These channels relate

Figure 2.6. Common Characteristics of Weak Banks across Scenarios

In the baseline scenario, weak banks had lower return on assets, high loan growth in the past, low price-to-book, low relative pass-through from policy rates to net interest income (NIM beta), and high market leverage compared to banks that are not flagged as weak. In the adverse scenario, in addition to the factors for weak banks in the baseline, low book leverage ratio and NIMs are distinguishing factors.



Sources: Bloomberg, L.P.; Fitch Solutions, Fitch Connect; and IMF staff estimates.
Note: Values in both panels are standardized; larger values along a given axis signify more risks along that characteristic. "Market leverage" refers to total assets/market capitalization; "leverage ratio" refers to Tier 1 capital/total assets; "Long-term NIM beta" refers to the differences between long-term income and expense betas (see Online Annex 2.2). The points in the figure represent the simple mean of the weak and the nonweak bank groups for each scenario, standardized by the mean and standard deviation of the whole sample. The "price-to-book ratio" and "market leverage" variables are calculated based on samples of 153 and 154 banks, respectively. "NIM beta" is based on a sample of 323 banks (see Online Annex 2.2). NIM = net interest margin.

to interest margins, bond valuations, loan losses, and liquidity-to-solvency interactions. In what follows, these components are discussed in detail. There are many other channels through which stress in one or a few banks could spread to other banks, to nonbanks and to the rest of the local or global economies, but these are not considered in the analyses.

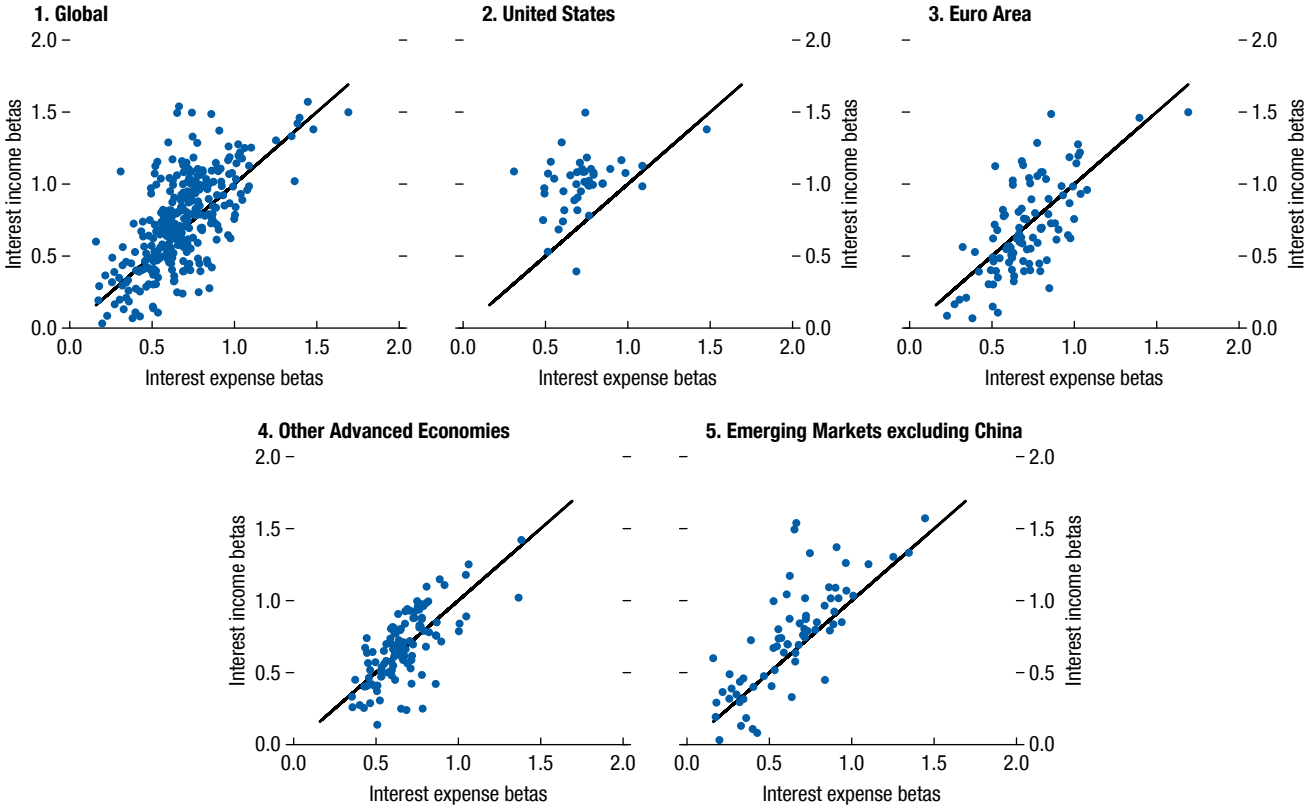
Vulnerabilities from Interest Margins

Not all banks would gain as a result of higher income from rising rates. When policy rates rise, banks whose expenses are more sensitive to rising short-term rates—that is, those that have higher "expense betas" relative to their "income betas"—stand to lose net interest income. Higher short-term rates pass through rapidly to funding costs in banks that are wholesale funded (Online Annex 2.2) or have customers moving to higher-return savings products (like certificates of deposit, bonds, or money market funds; see Online Annex 2.6). The pass-through to income, on the other hand, could be slow because of fixed-rate loans that take time to reprice or replace. The analysis here finds that the expense betas are small at first but increase over time, possibly because depositors seek higher returns within the same bank from other financial instruments like certificates of deposit. Figure 2.7 shows the long-term betas; banks below the 45-degree lines in the panels have greater sensitivity to interest rates on the expense side than on the income side, so they would be at greater risk of losing net interest income when interest rates are rising.

Globally, more than 40 percent of banks stand to lose net interest income, especially those in advanced economies outside the United States. US banks emerge as particularly strong in the current analysis because of their exceptionally high interest income betas. In contrast, banks in other advanced economies, especially euro area countries, tend to have

Figure 2.7. Long-Term Income and Expense Betas

The figure shows estimated long-term betas: rates of pass-through from a permanent increase in short-term rates to interest income and expense, two years after the initial increase. A beta value of 0.5 means borrowing interest rates rise by 50 basis points when short-term rates rise by 100 basis points.



Source: IMF staff estimates.
Note: See Online Annex 2.2. China is not included because empirical results on betas for individual Chinese banks or for the overall banking system were not robust; the net interest income was assumed to be constant as a percent of assets for the scenarios. The black line in the panels is the 45-degree line.

lower interest income betas. In emerging markets, the majority of banks have higher interest income betas than interest expense betas. Furthermore, interest rate margins in emerging markets, in excess of 5 percent in 2022, are much greater than those in advanced economies, in which they were only about 2 percent; the high margins help emerging markets absorb losses.

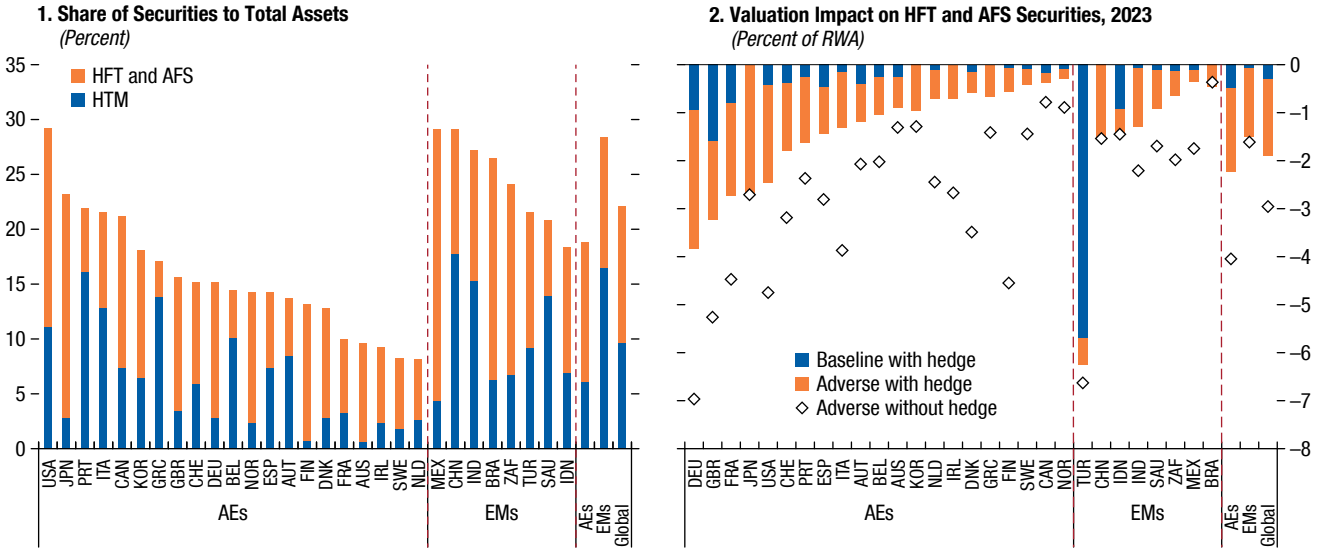
Vulnerabilities to Bond Valuation Losses

Almost one-quarter of global bank assets are invested in securities, with about half in held-to-maturity securities, amid notable cross-country differences (Figure 2.8, panel 1). Securities constitute from nearly 25 percent to about 30 percent of total bank assets in Brazil, China, India, Japan, Mexico, and the United States. In the sample used here, banks in emerging markets tend to have higher exposures to securities than those in advanced economies and keep more of their securities as held-to-maturity securities at book value, as opposed to those that are marked to market: held for trading and available for sale (Online Annex 2.3). About 40 percent of banks' positions are hedged on average (Online Annex 2.3). Even among advanced economies, non–internationally active banks in Japan and small and medium-sized banks in the United States can exclude from regulatory capital unrealized gains and losses from available-for-sale securities; this is referred to as the "available-for-sale filter" in Basel II. Online Annex Table 2.3.1 has further details.

Figure 2.8. Vulnerabilities to Bond Valuation Channel

Generally, banks in emerging markets hold more securities than those in advanced economies. Among advanced economies, exposures are higher in North America, Japan, Portugal, and Italy.

Valuation impacts are larger in advanced economies given higher rate shocks in the adverse scenario. But hedging could mitigate the loss by half.



Sources: Bank of Japan; Bloomberg Finance L.P.; European Banking Authority; FitchSolutions, Fitch Connect; and IMF staff estimates.
Note: Data for Japan exclude two specialized banks in both panels and assets such as equities and cash in panel 2. The IMF staff obtained several estimates of the hedge coverage ratio for each bank in panel 2. The staff used bank-reported ratio when available and, otherwise, used proxies estimated from comparing (1) the reported 2022 AFS valuation losses with model-based losses assuming all bond investments, including those held by foreign affiliates, are in home sovereign bonds, which could underestimate hedging in countries with lower interest rates than the global average (for example, Japan); or (2) the notional value of interest rate derivatives with interest-earning assets (see Online Annex 2.3). The analysis does not consider hedging counterparties and whether hedging is meaningful when banks are the counterparties (McPhail, Schnable, and Tuckman 2023). Data labels in the figure use International Organization for Standardization (ISO) country codes.
AEs = advanced economies; AFS = available for sale; EMs = emerging markets; HFT = held for trading; HTM = held to maturity; RWA = risk-weighted assets.

Banks' marked-to-market bond portfolios generally suffer moderate valuation losses in the baseline (Figure 2.8, panel 2). Overall, capital ratios could fall significantly for only about 2 percent of banks, which are thus deemed vulnerable to this risk propagation channel. These banks tend to have a higher share of held-for-trading and available-for-sale securities in their portfolios, with longer durations, and are subject to greater increases in their yield curves.

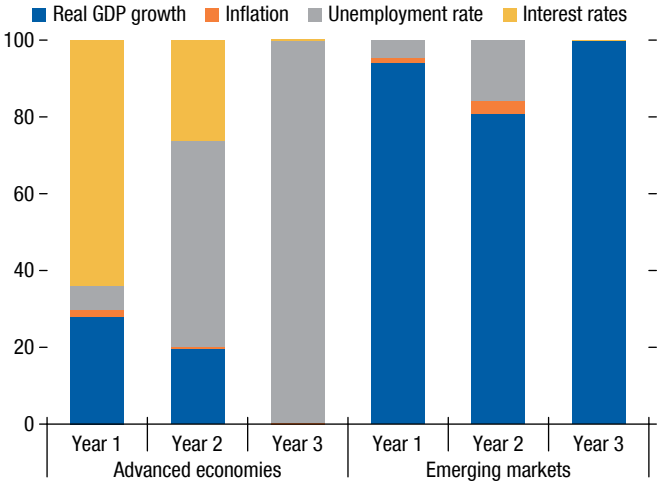
In the adverse scenario, which also considers part of banks' bond exposures to be hedged, valuation losses are significant. Although hedging mitigates the vulnerability, 11 percent of banks are vulnerable to significant declines in capital from this channel. If exposures are not considered to be hedged, however, about a quarter of the banks would be deemed vulnerable. German banks, among the most affected, have bonds with relatively longer durations and experience large policy rate shocks in the stagflationary scenario. Because of these same drivers—exposure, duration, and interest rate shocks—a higher share of banks in advanced economies than in emerging markets is also exposed to valuation losses.

Vulnerabilities to Loan Defaults

Increases in interest rates and declines in economic growth drive loan defaults (Figure 2.9). In the adverse scenario, loan loss provisions in banks in advanced economies rise initially because of increases in real interest rates; effects on unemployment rates start dominating later, as the interest rate shock wanes. In contrast, overall economic growth matters more for emerging markets. Banks in advanced economies tend to have higher shares of mortgage and consumer loans in total loans, whereas those in emerging markets tend to lend relatively more to firms. This could be the reason that the unemployment rate matters more for credit performance in banks in advanced economies, whereas GDP growth matters more for those in emerging markets.

Figure 2.9. Drivers of Loan Loss Provisions, 2023–25
(Percent)

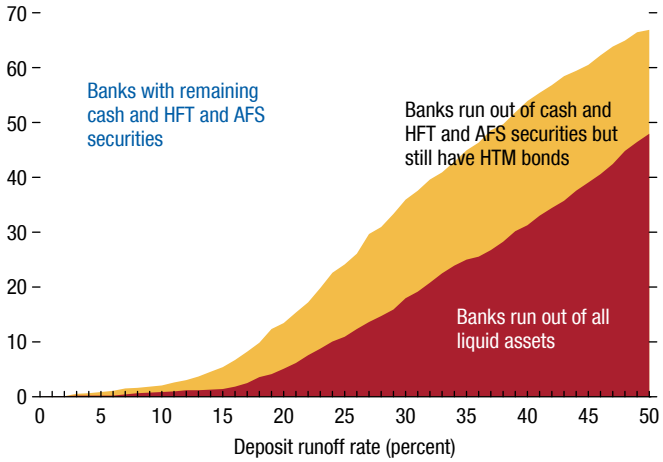
The bars show the contributions to adverse–baseline gaps of loan loss rates.



Sources: Fitch Solutions, Fitch Connect; IMF, *World Economic Outlook*; and IMF staff estimates.

Figure 2.10. Banks Vulnerable to Liquidity-to-Solvency Interaction
(Percent of total number of banks, with 2023 valuation shocks in the adverse scenario)

The liquidity-to-solvency interaction comes into play once banks run out of cash and HFT and AFS securities and start using HTM either for sales or repos.



Sources: Bloomberg Finance L.P.; European Banking Authority transparency exercise; Fitch Solutions, Fitch Connect; and IMF staff estimates.
Note: Figure depicts the share of the total number of banks with 2023 valuation shocks in the adverse scenario. AFS = available for sale; HFT = held for trading; HTM = held to maturity.

Vulnerabilities to Interactions between Liquidity and Solvency

Most banks have enough liquid assets to sustain deposit outflows of 10 percent without having to repo or sell held-to-maturity bonds (Figure 2.10). Banks in emerging markets can sustain slightly higher deposit outflows (20 percent) than those in advanced economies (5–10 percent) without needing to sell or pledge held-to-maturity securities (Online Annex 2.4). Overall, at outflows of 15–25 percent, an exponentially high share of banks would need to use held-to-maturity securities to address their liquidity needs. For a deposit runoff rate of 15 percent, the sale of held-to-maturity bonds would generate moderate losses across regions, when central bank facilities are not available (Figure 2.11, panel 1).[3] At 25 percent runoff, CET1 ratios would drop substantially in several banks, including Silicon Valley Bank and First Republic Bank, if central bank facilities are not available. These losses would multiply rapidly as deposit outflows increase from 25 to 35 percent, resonating analyses in Copestake, Kirti, and Liu (forthcoming).

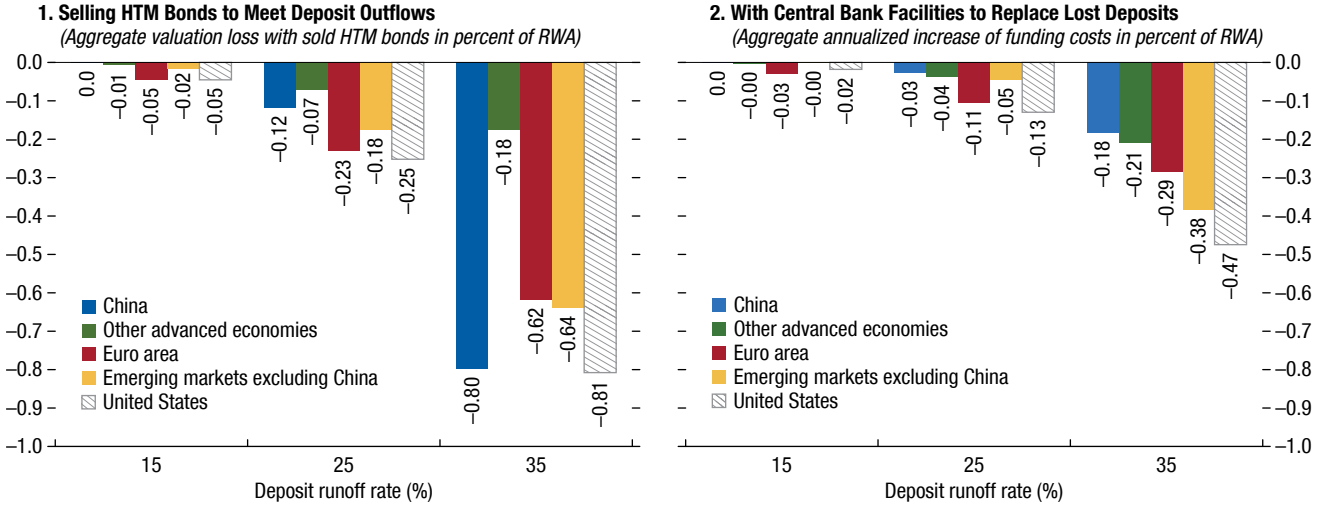
A bank run cannot be predicted well in advance, but if it happens, central bank facilities would help mitigate these losses noticeably across regions (Figure 2.11, panel 2). Under the assumption that banks can access central bank facilities, pledging held-to-maturity securities at 150 basis points over policy rates, capital losses across regions, at 25 percent deposit runs, are at most 13 basis points and take place through annualized increases in funding costs. However, results vary across banks within a region. Runoffs of 15 percent have a negligible effect on capital. At 25 percent, about 40 banks lose more than 1 percentage point CET1 ratio or more. If the cost of facilities doubles to 300 basis points, the number of banks in this scenario increases to 56. If a bank runs out of eligible collateral, the scenario assumes that central banks extend emergency liquidity assistance by expanding types of collateral accepted or, if needed, providing unsecured loans

[3]For reference, the regulatory liquidity coverage ratio assumes the following one-month runoff rates for deposits: insured retail demand deposits, 3–5 percent; less stable retail deposits, 10 percent; term deposits, 0 percent, except in the case of maturing contracts; small business deposits, 5–10 percent; and other nonfinancial firms and sovereigns, 20 percent if insured and 40 percent if not. The ratio is designed to replicate the liquidity stress observed during the global financial crisis and has higher runoff rates for wholesale funding than for customer deposits.

Figure 2.11. The Impact of Liquidity-to-Solvency Interactions on Bank Capital With and Without Central Bank Facilities: Adverse Scenario

When central bank facilities are not available, additional capital losses are contained at a regional level up to 25 basis points, with a runoff rate of 25 percent. However, several banks could lose more than 150 basis points in additional Tier 1 capital across regions because of the impact of HTM sales on capital (Online Annex 2.4).

When central bank facilities are available, additional capital losses are up to 13 basis points at a regional level at 25 percent deposit runoffs. Several banks could see losses of 75–100 basis points across regions owing to the additional cost of funding the facilities.



Sources: Bloomberg, L.P.; European Banking Authority transparency exercise; FitchSolutions, Fitch Connect; and IMF staff estimates.
Note: Figure uses end-of-2023 bond revaluation in the adverse scenario. Panel 2 shows the aggregate valuation loss with HTM bonds sold at the end of 2023, when liquidity stress hit banks, which results in valuation loss from interest rate changes in 2022 (actual) and 2023 (adverse scenario), if the book value of the HTM bonds is proxied by their valuation at the end of 2021. Once a bank runs out of securities, it is considered "failed" and incurs no additional losses (for example, through selling illiquid assets with massive haircuts). Panel 2 depicts the aggregate annualized increase in funding costs. It assumes that central banks charge 150 basis points on top of short-term interest rates under the adverse scenario. If a bank runs out of security collateral (all of which is assumed to be eligible for central bank repos at market values), the bank is presumed to obtain unsecured emergency liquidity assistance at the same interest rates. Moreover, it is assumed that central banks are able to provide liquidity in all currencies, having made swap arrangements with foreign central banks in advance. HTM = held to maturity; RWA = risk-weighted assets.

at the same interest rates, as is the practice in many central banks.[4] This exercise could be easily adapted to other situations, but the broad message stands—many banks are vulnerable at deposit run rates much below those recently observed (Box 2.1) if central bank facilities are not available.

Several caveats surround the analysis around the global stress test results. First, the adverse scenario, which is internally consistent across the 29 countries coordinated through the global dynamic stochastic general equilibrium model (Vitek 2018), is quite severe and corresponds to 3½ standard deviations from historical means of global GDP growth (Online Annex Table 2.1.5). The resulting number of weak banks is, therefore, large. The scenario is meant to be illustrative and other degrees of severity could be chosen by supervisors. However, given the experience with multiple global crises and heightened volatility since the global financial crisis, supervisors have in fact been moving to stronger assumptions in supervisory stress tests (see for example the severity of the scenarios in European Banking Authority 2023). Still, some sensitivity analyses around the severity of the scenario for the Chinese banking system (for which there is no historical precedent) is presented in Online Annex 2.1. Second, the analysis uses simplifying assumptions because of the absence of publicly available bank-level data on duration and hedging (Online Annexes 2.1 and 2.3). Supervisors, however, could have access to more detailed bank-level data and therefore avoid making such simplifying assumptions.

[4]It is assumed that a small number of banks found to be insolvent can still access the liquidity facilities, but it does not change the count of weak banks in the stress test results.

Using KRIs to Monitor Emerging Vulnerabilities

This section develops a forward-looking tool for monitoring vulnerabilities in publicly traded individual banks. The framework for the proposed tool, based on financial and aggregate consensus analyst forecasts data of KRIs, provides policymakers and practitioners with a methodology for identifying banks that are vulnerable to pressures related to solvency and liquidity and those generated by the market. Aggregate consensus analyst forecasts for the third and fourth quarters of 2023[5] are used to determine expectations for bank performance and the evolution of potential risk.[6] The framework comprises five fundamental dimensions of risk in banking that both bank supervisors and academics (in previous studies of bank stress) use. It then flags banks with outlier characteristics across a majority of key risk dimensions. The section then presents an econometric analysis to show the power of this method both in predicting previous stress events and in anticipating the potential capital shortfalls revealed by the global stress test.

Effective KRIs serve as an early warning system but have a forward-looking element; capturing this forward-looking element in such indicators, however, using public sources of data on bank balance sheets, as opposed to the real-time data available to bank supervisors, can often be challenging. To mitigate this issue, the framework used here incorporates consensus forecasts for relevant variables; it also uses market-based pricing indicators that embed information regarding expected profitability and downside risk. These forward-looking components enhance the framework's predictive capabilities and its utility as a policy instrument.

Data Summary

To enable development of a tool capable of analyzing a broad array of banks representing various geographic and economic regions, an extensive new data set encompassing more than 375 banks from 43 different jurisdictions has been compiled. The data set includes 28 of the 30 G-SIBs as identified by the Financial Stability Board.[7] The United States is overrepresented in terms of the number of banks covered due to greater data availability, but the balance improves considerably when regions are compared by total banking assets. Banks differ greatly in their structural characteristics across regions, which means that many of the KRIs used consider regional thresholds (Figure 2.12).

Selection and Calibration of KRIs

The KRIs used in this analysis are constructed by combining the CAMELS supervisory framework with market-based metrics. Bank supervisors use the CAMELS framework widely to assess the overall health of a bank and issue periodic supervisory ratings.[8] It includes six risk dimensions: capital adequacy, asset quality, management performance, earnings, liquidity, and sensitivity to market risk. In addition to the CAMELS framework, the analysis here uses the IMF's Financial Soundness Indicators, which were developed in collaboration with the international community to support the assessment of strengths and vulnerabilities of financial systems, and the quarterly Risk Dashboard metrics published by the European Banking Authority to identify core KRIs.[9] The analysis focuses on capital adequacy, asset quality, earnings, and liquidity because global quarterly data on sensitivity to market risk are scarce and have limited comparability and management performance cannot be observed directly through quantitative data. With market metrics added, this results in a total of five observable risk dimensions. These five key risk dimensions are measured using one or more key risk indicators, 12 in total (Table 2.1). These 12 indicators have been selected based on multiple criteria, including data coverage, literature review, best banking supervision practices, and econometric analysis (see Online Annex 2.5 for details on the

[5]Aggregate consensus analyst forecasts are also used for the second quarter of 2023, if second quarter of 2023 actual data were unavailable at time of data collection.

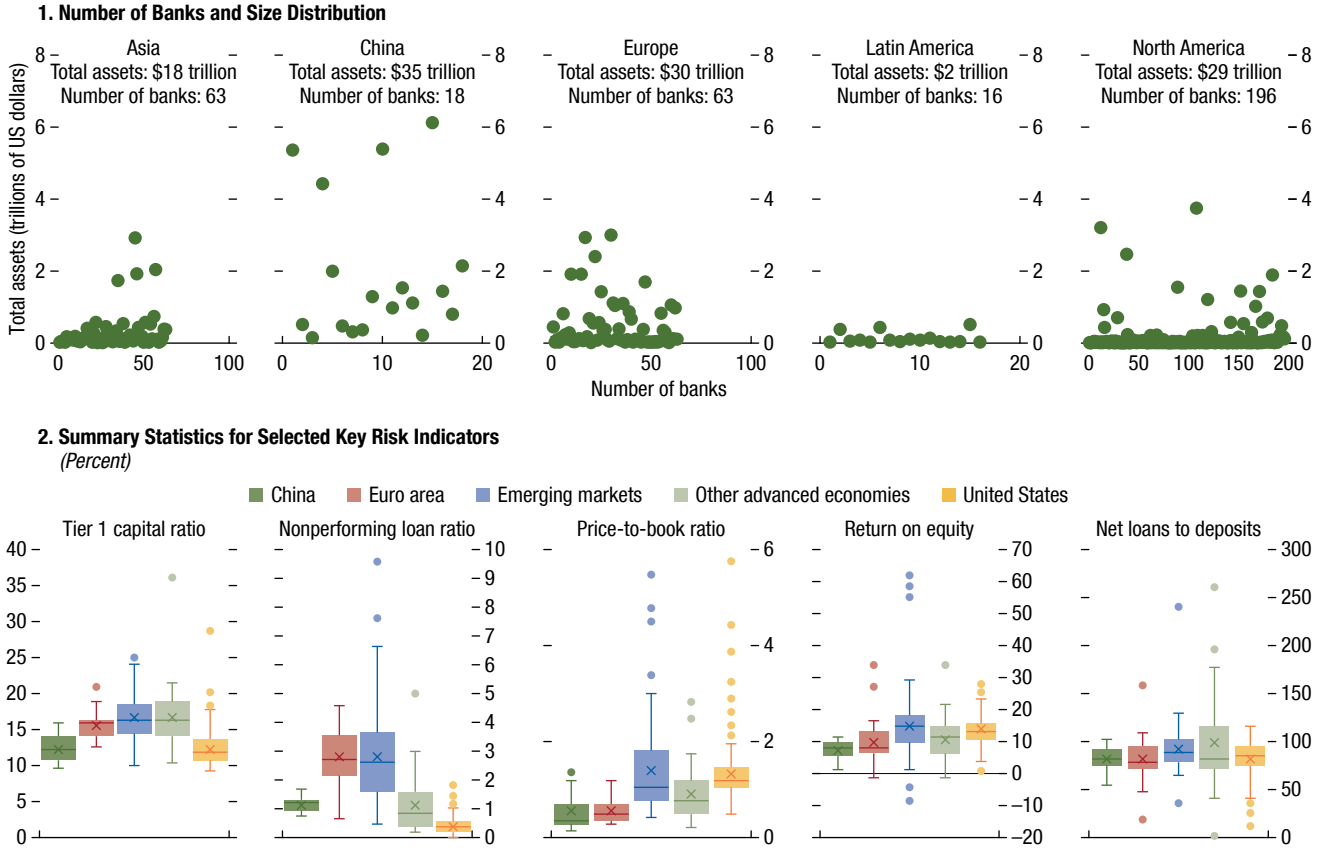
[6]The authors supplement their data with aggregate consensus forecasts of financial data and daily market pricing data from third-party proprietary sources. The third-party proprietary sources include Bloomberg Finance L.P., S&P Capital IQ, and Visible Alpha. The Visible Alpha data set includes standardized financial data and metrics that include company filings data, aggregate consensus, and revised aggregate consensus data that enable analysis across banks and geographies.

[7]Excludes one French G-SIB that is not publicly listed and one Swiss G-SIB that was acquired by another G-SIB in 2023. See Financial Stability Board 2022 List of Global Systemically Important Banks (https://www.fsb.org/wp-content/uploads/P211122.pdf).

[8]The original CAMELS framework has been adapted and/or expanded in many jurisdictions and relabeled to incorporate different risk metrics. Despite this, most supervisors continue to monitor traditional metrics related to the CAMELS framework.

[9]See IMF Financial Soundness Indicators (https://data.imf.org/?sk=51b096fa-2cd2-40c2-8d09-0699cc1764da) and European Banking Authority Risk Dashboard (https://www.eba.europa.eu/risk-analysis-and-data/risk-dashboard).

Figure 2.12. Regional Data Coverage and Summary Statistics



Sources: Bloomberg Finance L.P.; Visible Alpha; and IMF staff calculations.
Note: Panels 1 and 2 data are based on historical total assets as of 2023:Q2.

Table 2.1. Key Risk Indicators: CAMELS and Market Risk Metrics

Risk Dimension	Risks Measured or Gauged	Indicators (total: 12)
Capital adequacy	Solvency and loss absorption capacity	Ratios of equity to total assets (ETA) and Tier 1 capital to risk-weighted assets (Tier 1 capital ratio)
Asset quality	Likelihood of future credit losses	Ratio of nonperforming loans to total loans, coverage ratio, and quarterly loan growth
Earnings	Ability to increase and generate capital	Return on equity
Liquidity	Resilience to funding shocks and deposit outflows	Net loan-to-deposit ratio, ratio of total deposits to total liabilities, quarterly deposit growth
Market metrics	Overall market outlook, ability to maintain debt funding and raise equity	Dividend growth forecast, price-to-book (P/B) ratio, market leverage (Total Assets/Market Capitalization)

Source: IMF staff compilation.
Note: CAMELS = Capital, Asset Quality, Management, Earnings, Liquidity and Sensitivity to Market Risk,

construction of the data set, KRI selection, and calibration of KRI thresholds).

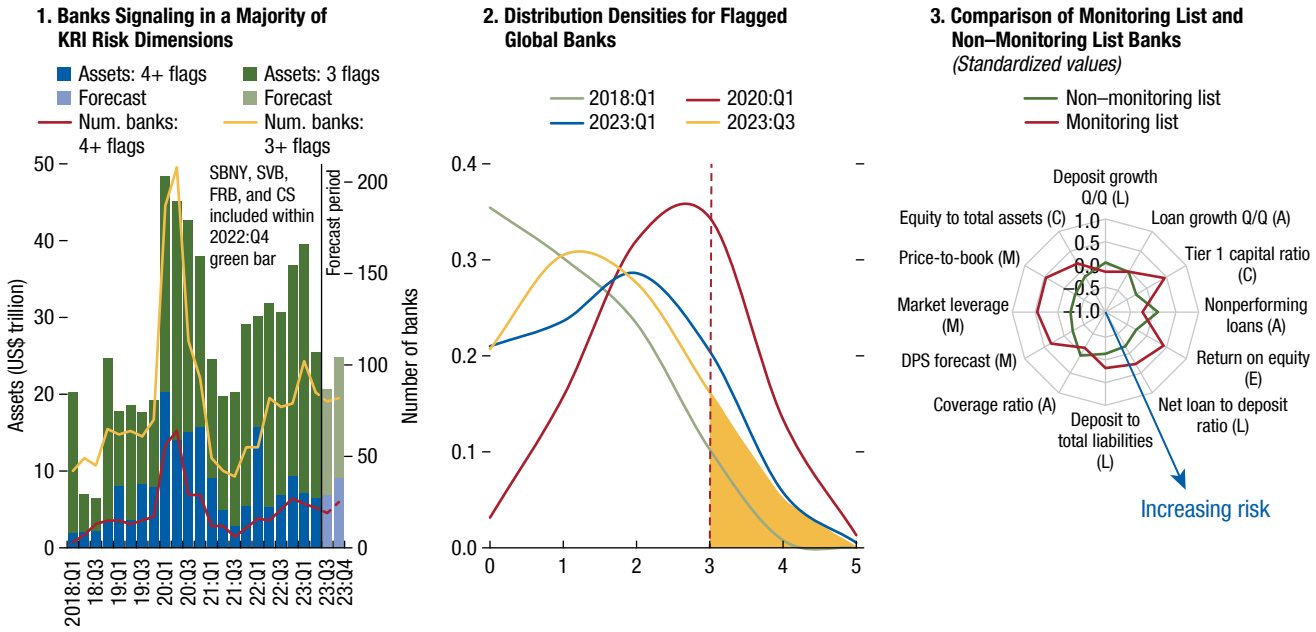
Using the KRIs, a monitoring list of potentially vulnerable banks is constructed in a two-stage process. First, for each of the risk indicators, banks' values are highlighted if they exceed defined thresholds. These thresholds have been calibrated to identify outliers among banks as well as temporal outliers while factoring in significant structural differences across regions and banking models (see Online Annex 2.5 for a discussion on how the thresholds were calculated). Second, banks are identified as potentially vulnerable within a particular risk dimension if one or more of the risk indicators in that dimension are highlighted as outliers. Finally, they are placed on the monitoring list, or "flagged," if they are identified as potentially vulnerable

Figure 2.13. Tracking Vulnerable Banks over Time Using Historical and Aggregate Forecast Data

The number of vulnerable banks on the global monitoring list remains elevated in 2023.

A weak group of global banks remains, as the number of banks flagged as vulnerable in three or more KRI risk dimensions remains elevated.

Low price-to-book ratios, low return on equity, and stretched loan-to-deposit ratios are key differentiations between monitoring list and non–monitoring list banks.



Sources: Bloomberg Finance L.P.; Visible Alpha; and IMF staff calculations.
Note: Panels 1 and 2 data include results based on historical data from the first quarter of 2018 to the second quarter of 2023, aggregate consensus forecasts for the second quarter of 2023 if actual data were not available, and aggregate consensus forecast data for the third and fourth quarters of 2023. Values in panel 3 are standardized by *z*-scores based on aggregate consensus forecast data as of the third quarter of 2023; larger values along a given axis signify more risks along that characteristic. See Online Appendix 1 for definitions of KRIs. A = assets; C = capital; CS = Credit Suisse; DPS = dividends per share; E = earnings; FRB = First Republic Bank; KRI = key risk indicator; L = liquidity; M = market; Q/Q = quarter over quarter; SBNY = Signature Bank; SVB = Silicon Valley Bank.

across a majority (that is, three or more) of the five risk dimensions, with heightened attention given to banks identified as potentially vulnerable along four or five risk dimensions. Importantly, analyst forecasts are used to track the evolution of the key risk metrics over the next two quarters as a measure of future risk.[10]

Two important econometric results demonstrate the value of the KRIs approach. First, the indicators are found to have predictive power in forecasting bank stress events (see Online Annex 2.5). Second, the stress test results and the KRIs are linked in a robust way, as the number of KRIs flagged is a quantitatively meaningful and statistically significant predictor of capital losses in the global stress tests adverse scenario (see "Similarities of Global Stress Test and KRI Frameworks").

KRI Results and Construction of Bank Monitoring List

The KRI framework finds that the number of banks flagged as vulnerable in three or more of the five risk dimensions spiked dramatically with the onset of the COVID-19 pandemic, fell sharply in 2021, and then, as interest rates rose, climbed to another peak just before the March 2023 bank turmoil (Figure 2.13, panel 1). Notably, the framework flagged as vulnerable along three risk dimensions in the fourth quarter of 2022 the four banks that ultimately failed in March: Credit Suisse, Silicon Valley Bank, and Signature Bank all breached the threshold in the market KRI dimension (along with the earnings and liquidity dimensions in the case

[10]Historical data from the first quarter of 2018 to the second quarter of 2023, aggregate consensus analysts forecasts for the second quarter of 2023 if actual data were not available, and aggregate consensus analysts forecasts for the third and fourth quarters of 2023 for all KRIs are used to determine expectations for bank performance and the evolution of potential risk. In addition, to supplement their analyses, the authors also use changes in consensus forecasts on dividends throughout the sample to gauge market sentiment related to the direction of risk. Dividend forecast comprises analyst expectations of future dividends at each point in time and is therefore a forward-looking metric.

of Credit Suisse, the capital adequacy and earnings dimensions in the case of Silicon Valley Bank, and the capital adequacy and liquidity dimensions in the case of Signature Bank), signaling that investors were becoming more concerned about these banks' prospects a quarter prior to their failure. In the case of First Republic, KRIs in the capital adequacy, asset quality, and earnings dimensions breached thresholds.

In the second quarter of 2023, 85 banks with $26 trillion in total assets were on the KRI monitoring list due to breaches of thresholds in at least three KRI risk dimensions. Many banks remain on the monitoring list for the remainder of 2023, as industry analysts project that pressures on earnings and liquidity will persist, likely as a result of economic uncertainty and higher-for-longer interest rates. Aggregate consensus analyst forecasts suggest that the number of banks flagged will decline slightly in the third quarter of 2023 to 80 with $21 trillion in assets, with the decline primarily reflecting an improvement in liquidity and earnings. However, the number of flagged banks picks up in the fourth quarter to 82 with $25 trillion in assets, driven by weaker earnings. Furthermore, in the fourth quarter, the number of banks flagged as vulnerable on four or more risk dimensions stands at 25, with $9 trillion in combined assets, with the elevated level reflecting lower price-to-book ratios and profitability challenges.

If one looks ahead at the fourth quarter of 2023, based on aggregate consensus forecast data, the number of banks flagged (area under the yellow graph line in Figure 2.13, panel 2) remains sizable, although it has shrunk since the onset of the pandemic (area under the red graph line) and the time of the March bank turmoil (area under the blue graph line).[11]

Figure 2.13, panel 3 compares risk characteristics of flagged and non-flagged banks, using standardized *z*-scores, with larger values denoting higher risk across all characteristics—for example, an outward movement along the Tier 1 capital ratio axis signifies less capital. Banks on the monitoring list (red line) score significantly worse than banks not on the monitoring list (green line) across nearly all categories, with the exception of the nonperforming loan ratio (a backward-looking indicator), coverage ratio, and quarterly deposit growth.

There are certain limitations to using analyst forecasts in the KRI framework. The consensus of analyst forecasts is presumably made under varying assumptions about the macro environment that are not revealed by the analysts. The KRI framework thus can offer only limited insights on how the monitoring list connects to expected macroeconomic developments. Not knowing the variation in the underlying assumptions made by analysts also reduces the KRI's congruence with the global stress test and suggests that these two tools should be used complementarily. That said, both aggregate consensus analyst forecasts and market variables can reflect impact on individual banks stemming from macrofinancial conditions, especially from severe tail events. For example, the monitoring list expanded sharply during the COVID-19 pandemic. Despite this, we cannot control for the divergence between predictions of the macro environment across aggregate consensus analyst forecasts going forward.

The regional distribution of banks on the monitoring list signaling in four dimensions calls attention to structural weaknesses within certain banking systems and highlights transitory stress periods (Figure 2.14, panel 1). The list of potentially vulnerable banks includes large banks in most countries, and smaller and regional banks in the United States.[12]

- In Europe, banks with low ratios of equity to total assets, low profitability, low price-to-book ratios, and higher dependency on noncore deposit funding are flagged by the KRIs. The group of flagged banks includes some of the largest banks in Europe, with estimated combined total assets of more than $8 trillion by the end of the year. Higher funding costs will remain a challenge for profitability (Figure 2.13, panel 2). The forecast-based KRIs show that European banks are expected to comprise 30 percent of the monitoring list on a total asset basis by the fourth quarter of 2023.
- In Asia, nearly all banks have low ratios of equity to total assets and face pressures on profitability resulting from rising funding costs and lower fee income. However, net interest margin compression has been smaller, reflecting in part that policy rate changes have been smaller in magnitude compared to Europe and North America. The group of flagged banks,

[11]Price-to-book and market leverage metrics for the third quarter of 2023 and the fourth quarter of 2023 used market data as of September 8, 2023, and not end-of-quarter data as for the rest of the periods.

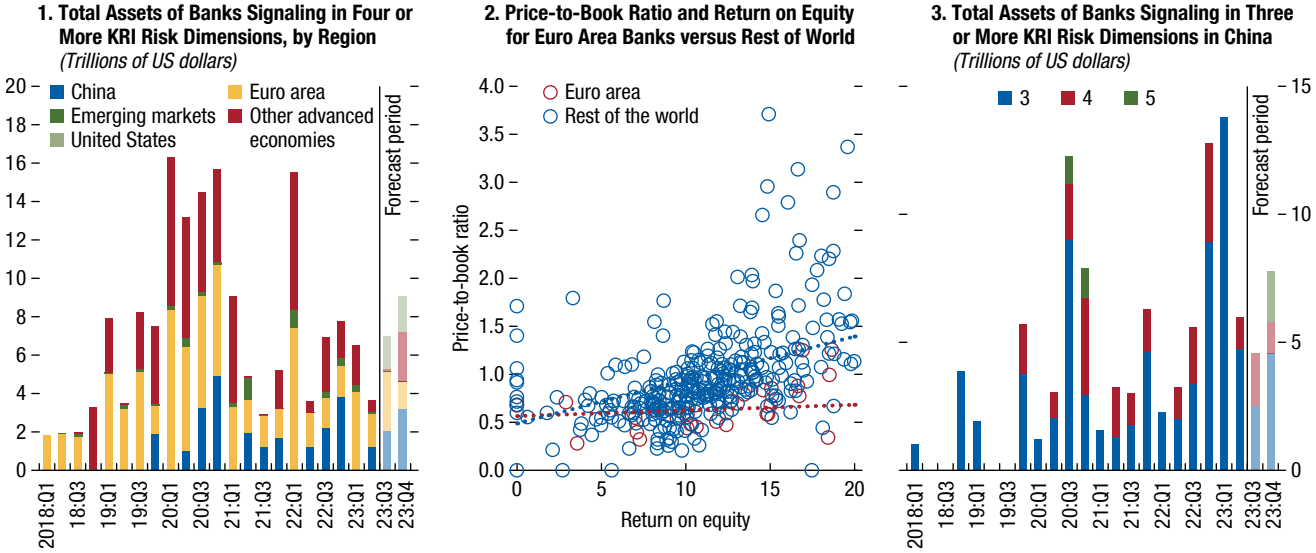
[12]Based on the Bankers Almanac Rankings by country as of August 31, 2023.

Figure 2.14. Highlighted Results from Key Risk Indicators

Regional distribution highlights structural weaknesses in the euro area, a weak tail of US banks and a geographical shift toward China throughout 2023.

Price-to-book ratios have deteriorated in banks across the globe, but the problem is more acute in the euro area.

In China, total assets of banks increasing from three to four vulnerability flags are elevated, despite aggregate vulnerabilities' falling.



Sources: Bloomberg Finance L.P.; Visible Alpha; and IMF staff calculations.
Note: Panels 1 and 3 are based on historical data from the first quarter of 2018 to the second quarter of 2023, aggregate consensus data for the second quarter of 2023 if actual data were not available, and aggregate consensus data from the third and fourth quarters of 2023. In panel 2, "Price-to-book ratio" refers to the ratio of the market price of equity to the book value of equity, and "Return on equity" to net income as a percentage of total equity as of the first quarter of 2023.

based on fourth-quarter forecasts, has combined total assets of more than $1 trillion. KRIs signal market leverage is elevated for a handful of banks in the region; price-to-book ratios are low; and profitability is expected to deteriorate by lower net interest income, higher noninterest expenses, and higher provision expenses. Consensus forecasts predict that profitability will decline as banks are also challenged by rising noninterest expenses and loan loss provision expenses. Asian banks will rise to 10 percent of monitoring list assets in the fourth quarter.

- In China, banks with lower capital ratios, low profitability, and low price-to-book ratios are flagged as vulnerable by the corresponding core KRIs. For the second half of 2023, consensus forecasts call for lower profitability arising from compression of net interest margins, as a result of the decline in the prime rate for loans and lower noninterest income. The number of flagged banks is projected to increase and rise to $4.6 trillion in assets by the fourth quarter, representing 31 percent of monitoring list total assets (Figure 2.14, panel 3).
- In Latin America, banks with low ratios of equity to total assets, higher loan-to-deposit ratios due to their higher reliance on noncore deposit funding, and low price-to-book ratios signal vulnerabilities. Fourth-quarter flagged banks include a few large banks in several countries with estimated combined total assets of more than $900 billion. Profitability is expected to improve by the third quarter of 2023, but consensus forecasts expect equity-to-total-assets and price-to-book ratios to remain low. The number of potentially vulnerable banks is projected to decline in the fourth quarter, representing just 4 percent of total assets in the monitoring list assets.
- In North America, banks face profitability challenges from rising funding costs and lower generation of fee income. Flagged banks include a few large banks and many US regional banks, with estimated combined total assets of more than $6 trillion. Small banks—specifically, those with total assets of $10 billion or less—have low profitability, stretched net loan-to-deposit ratios, and low price-to-book ratios. Medium-sized banks—those with total assets between $10 and $100 billion—are also struggling with profitability, stretched net loan-to-deposit ratios, low price-to-book ratios, and high market leverage.

Table 2.2. Key Risk Indicator Global Volatility Heat Map

Bank stress has been building gradually since as far back as March 2022.

Category	Capital		Asset Quality			Earnings	Liquidity			Market		
Variable	Equity to Total Assets	Tier 1 Capital Ratio	NPLs	Loan Growth (QoQ)	Coverage Ratio	Return on Equity	Deposit Growth (QoQ)	Net Loans to Deposits	Deposits to Liabilities	Price to Book	Dividend Growth Forecasts	Market Leverage
Threshold	Below 1st Quartile by Region	Below 12%	Above 8%	Above 3rd Quartile by Region	Below 1st Quartile by Region or Below Supervisory Threshold	Below 1st Quartile by Region	Below –5%	Above 3rd Quartile by Region	Below 1st Quartile by Region	Below 1 SD of Bank Average and/or Below 1st Quartile by Region	Below 0%	Above 90th Percentile by Region
Mar. 2018	65	90	12	38	19	67	6	92	43	32		5
June 18	60	92	9	30	21	66	44	99	43	40	8	5
Sep. 18	54	86	8	21	22	56	17	102	45	38	12	9
Dec. 18	45	81	8	30	25	86	10	101	40	74	30	20
Mar. 19	54	87	10	32	25	80	10	101	47	57	33	15
June 19	57	97	10	29	25	76	8	108	50	53	43	14
Sep. 19	56	89	9	23	22	80	25	102	48	62	48	14
Dec. 19	48	86	10	37	24	122	7	103	47	42	57	12
Mar. 20	76	104	9	35	20	239	43	97	48	315	89	89
June 20	86	96	10	141	14	224	6	73	44	293	174	85
Sep. 20	84	82	10	40	12	146	8	72	46	316	134	108
Dec. 20	80	82	7	50	11	135	10	66	44	159	64	42
Mar. 21	94	67	7	34	12	71	21	55	46	68	36	24
June 21	83	67	6	27	13	67	15	54	43	71	52	20
Sep. 21	90	69	5	22	12	73	21	49	45	73	46	19
Dec. 21	85	76	4	51	13	92	24	52	43	64	50	18
Mar. 22	118	88	4	53	13	82	21	55	42	53	53	19
June 22	140	98	3	74	7	63	68	64	41	86	64	35
Sep. 22	147	102	3	48	8	51	81	77	41	107	59	42
Dec. 22	127	101	1	90	6	63	29	86	41	81	69	34
Mar. 23	123	96	1	44	7	70	28	87	38	175	88	62
June 23	112	99	1	15	10	74	29	77	37	192	94	76
Sep. 23	105	85	1	6	10	82	16	79	36	169	86	59
Dec. 23	102	84	1	11	9	112	3	79	35	169	30	59

Sources: Bloomberg Finance L.P.; Visible Alpha; and IMF staff calculations.
Note: The heat map shows the number of banks flagged on each core key risk indicator and CAMELS component. The colors reflect ranking of low to high values across all metrics through the sample period. The count is based on historical data from the first quarter of 2018 to the second quarter of 2023, aggregate consensus forecasts for the second quarter 2023 if actual data were not available, and aggregate consensus forecast data for the third and fourth quarters of 2023.
CAMELS = Capital adequacy, Asset quality, Management performance, Earnings, Liquidity and Sensitivity to market risk; NPLs = nonperforming loans; QoQ = quarter over quarter; SD = standard deviation.

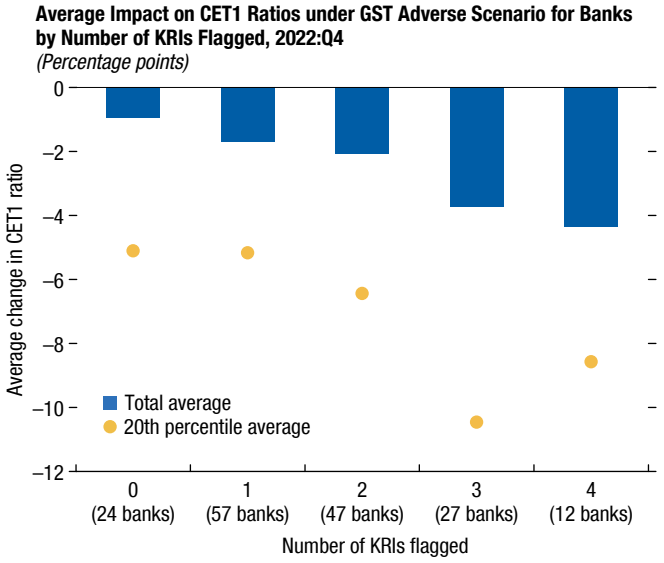
With funding costs rising, consensus forecasts expect compression of net interest margins in small and medium-sized banks to continue for the remainder of the year. Large banks—those with total assets of more than $100 billion—have low profitability, low price-to-book ratios, and high market leverage. Consensus forecasts call for their profitability to decline by the end of the year due to net interest margin compression and rising provision expenses. The number of banks is projected to increase in the fourth quarter and represent 25 percent of total monitoring list assets. Further analysis reveals that among North American banks on the monitoring list that have been flagged as vulnerable on four risk indicator dimensions, market-driven indicators such as market leverage and changes in forecasted dividend per share appear to also signal stress for those with high concentrations of commercial real estate in total loans.

A heat map (Table 2.2) compares visually the number of banks flagged as vulnerable on three or more risk dimensions included in the monitoring

list, quarter by quarter, based on historical KRI data from the first quarter of 2018 to the second quarter of 2023, aggregate consensus data for the second quarter of 2023 if actual data were not available, and aggregate consensus forecast data for the third and fourth quarters of 2023. It highlights three main observations. First, the period from the first to second quarter of 2020 shows the largest concentration of vulnerable banks, appropriately reflecting the stress related to the COVID-19 pandemic, with more than 200 banks in the monitoring list. This period represents the peak period of risk in the banking system over the time horizon of this chapter's analysis. Second, the heat map shows a gradual run-up in the number of vulnerable banks in early 2022, mainly in Europe and corresponding to the invasion of Ukraine in the first quarter of that year. Third, capital adequacy, earnings, and market KRIs capture an increasing number of banks ahead of the banking turmoil in the first quarter of 2023. The indicators suggest that liquidity stress, a key concern earlier in the year, began increasing as early as June 2022. This is evidenced by the growing number of banks experiencing deposit outflows, higher ratios of loans to deposits, and lower shares of deposits in total liabilities.

Figure 2.15. Congruence of Global Stress Test and Key Risk Indicators

Banks with higher key risk indicators register a larger negative capital impact in the global stress test.



Sources: Bloomberg Finance L.P.; Fitch Solutions, Fitch Connect; Visible Alpha; and IMF staff calculations.
Note: CET1 = Common Equity Tier 1; GST = global stress test; KRI = key risk indicator.

Similarities of Global Stress Test and KRI Frameworks

The global stress test and KRI framework complement one another in identifying banks that are still showing weakness. The global stress test finds banks struggling to stay solvent under stagflationary scenarios and suggests that many banks will suffer significant capital losses, largely driven by mark-to-market losses on securities holdings, in a higher-for-longer interest rate environment. In the United States, these losses are concentrated in smaller, regional banks, confirming what was observed in March of 2023. The KRI framework identifies banks that analysts expect to be weak in the coming quarters for various reasons, such as lower expected capital in the case of some Chinese banks, further declines in price-to-book ratios in the case of some European banks, and declining liquidity in the case of some other banks in advanced economies.

The two frameworks appear to have a high degree of congruence. Among the 168 banks that are in the samples for both the global stress test and KRI framework exercise, banks that are flagged as vulnerable on a higher number of dimensions of the KRIs have larger Tier 1 ratio declines, on average, under the global stress test's adverse scenario. For example, among the 47 banks that were flagged as vulnerable on two KRI dimensions as of the fourth quarter of 2022—the starting point of the global stress test exercise—the Tier 1 ratio declines about 2 percentage points, on average, under the adverse scenario in the global stress test; for the 12 banks that were flagged as vulnerable on four KRI dimensions, the average Tier 1 impact increases almost –4 percentage points. The two frameworks also effectively track the weaker tail of the distribution—among banks with three or four flagged KRIs, the worst quintile (in terms of the performance in the stress test) had an average decline of Tier 1 capital ratio of more than 8 percentage points (Figure 2.15).

A cross-bank regression analysis of adverse impacts on Tier 1 capital in the adverse scenario of the global stress test in the fourth quarter of 2022 confirms that this relationship is strong; the analysis yields a highly statistically significant regression coefficient of about –0.7, suggesting that every increase of one flag among the KRI dimensions is associated with a fall of 0.7 percentage point in the Tier 1 capital ratio in the global stress test.

It should be noted that the KRI framework is designed to identify banks meriting closer examination for signs of weakness, but as actual bank failures are quite rare, it will by construction have a high level of type I errors. This model should be seen as complementary to traditional distance-to-default models, which are often not well suited to the idiosyncratic nature of bank failures (Chan-Lau and Sy 2006).

Policy Recommendations

The sizable group of weak banks identified in this chapter—coupled with the risk of contagion to healthy institutions through investors' forward-looking assessment of vulnerabilities—highlights the urgent need to strengthen the resilience of the banking sector. Supervisors should enhance banks' capital level to ensure all banks maintain adequate capital ratios under stress scenarios. The results also highlight the need to reinvigorate supervision and risk assessments, including through enhanced stress testing (see Adrian and others 2023; Dordevic and others 2021). Timely and consistent implementation of international standards—as well as strengthening of regulations and crisis management frameworks—is also of paramount importance.

Enhancing Risk Assessments

As the enhanced global stress test shows, expanding the sample of banks subjected to stress tests and enhancing methodologies—by, for example, incorporating interactions between funding and solvency and deposit stability—would provide sharper insights on weaknesses in the banking sector. As the "desktop" analysis also demonstrates, interest rate sensitivity of the balance sheet and hedging choices considerably influence stress test outcomes at the bank level. For instance, net interest income may appear to be insensitive to interest rates at the level of the banking system even as several individual banks may be vulnerable within the system. Making the adverse scenario more severe while choosing a plausible narrative would further help in uncovering vulnerabilities.

Although supervisory techniques have improved over time, for example, incorporating market-based metrics in their assessment and becoming more forward looking, more needs to be done. The KRIs framework shows that banks that failed during March 2023 had sharply deteriorating balance sheet and price metrics. Supervisors could further leverage more timely and granular data to achieve even better accuracy and comprehensiveness in their risk assessments, provided that they narrow gaps in data coverage and granularity (Figure 2.16, panel 1).

The March 2023 banking turmoil has provided a powerful reminder that markets can shift rapidly from a balance sheet view to a mark-to-market view of risks, in which a bank's viability is assessed based on the market value of its assets, irrespective of their accounting or regulatory values. Such a shift can cause share prices of banks to drop sharply as investors lose confidence in banks' earnings prospects and, eventually, can trigger destabilizing deposit outflows. Bank assets—and therefore equity—are inherently difficult to value because they may not be easily tradable. As accounting approaches cannot be relied on to provide timely economic valuations, it is key for supervisors to closely monitor market metrics as well and to be particularly cautious in regard to banks that exhibit persistent price-to-book ratios below 1.

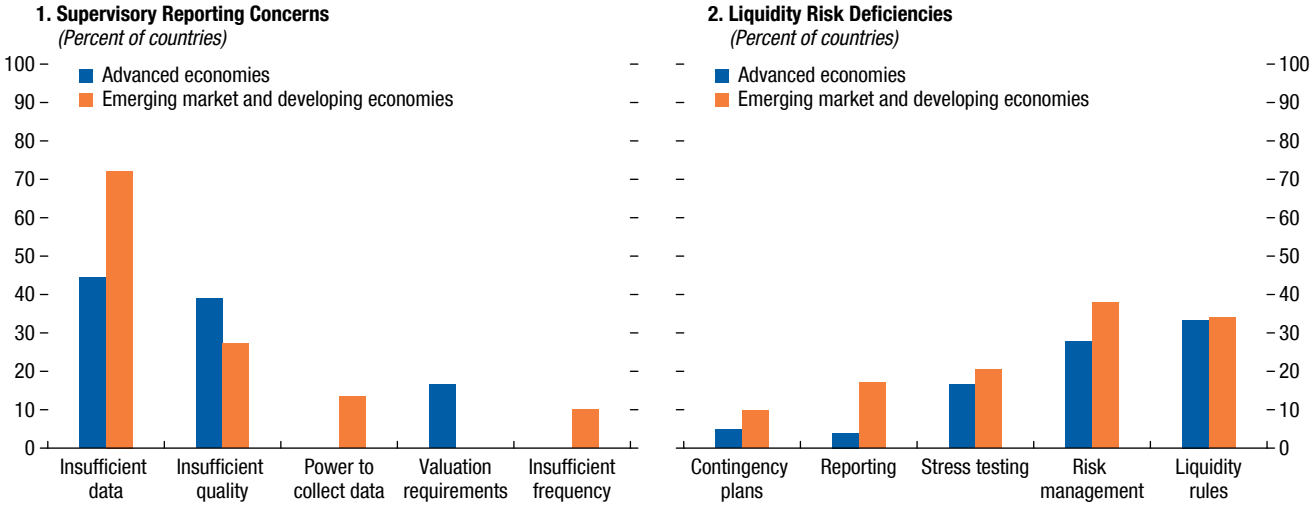
Sharpening Supervision and Regulation

Identifying vulnerable banks is just the first step. An effective prudential framework requires supervisors with both the ability and the willingness to address safety and soundness concerns promptly. However, in many countries, supervisors operate in conditions that are not conducive to effectively carrying out their responsibilities, and some even lack the necessary powers. The Financial Sector Assessment Program's assessments indicate that more than half of the jurisdictions still do not have independent bank supervisors with a clear mandate to effect financial stability, with sound internal governance, or with resources appropriate to their assigned responsibilities. The ongoing structural evolution of the financial sector, as evidenced, for example, by the growth of nonbank financial intermediation, the digitalization of finance, and climate change, adds to supervisory challenges and makes these weaknesses even more relevant. Additional efforts are also needed to make supervisory practices more intrusive, to make corrective actions more timely and conclusive, and to improve legal protection of supervisors.

Figure 2.16. Weaknesses in Bank Supervision Identified in Financial System Stability Assessments

Comprehensive and high-quality data reporting is improving in almost all jurisdictions, but gaps in coverage and granularity need to be addressed.

Some jurisdictions need to emphasize management of liquidity risk further and design better rules regarding quantitative liquidity.



Source: Dordevic and others 2021.
Note: Statistics are based on 47 assessments of Basel Core Principles conducted between 2012 and 2019.

An analysis of the enhanced global stress test results highlights interest rate and liquidity risks as issues of substantial concern. The Financial Sector Assessment Program's assessments show that quantitative and qualitative liquidity requirements can be further improved in several jurisdictions (Figure 2.16, panel 2). Despite broad success in implementing the Basel liquidity standards, recent assessments have found that nearly one-fifth of jurisdictions have weak supervisory and regulatory practices with respect to liquidity. Most of these weaknesses arise from requirements that fail to address liquidity needs in foreign currency, define liquid assets inappropriately, or are not imposed on a consolidated level. The assessments also reveal that several jurisdictions do not require banks to maintain capital against the risk of losses arising from movements of interest rates that affect assets that are not expected to be traded in the short term (that is, interest rate risk in the banking book), and more than a quarter have material deficiencies in terms of monitoring and controlling this risk (Dordevic and others 2021). Supervisory failure to determine whether banks have sound strategies, policies, and processes in place to manage liquidity and interest risk is also common. Supervisors and regulators should therefore implement prudential rules ensuring that banks hold appropriate capital against interest rate risk and guard against hidden losses that could materialize abruptly in the event of liquidity shocks.

Full, timely, and consistent implementation of internationally agreed-upon standards remains an important first step for enhancing prudential frameworks. However, despite repeated calls from the Group of Twenty, some major jurisdictions have delayed implementing the remaining elements of Basel III or have introduced deviations from it, which could undermine the effectiveness of the standard-setting process and increase regulatory fragmentation.

The March 2023 banking turmoil also suggests potential areas for improving the international framework, such as whether specific features of the current Basel III liquidity standards performed as intended. The current Pillar 2 approach for interest rate risk in the banking book also looks insufficient given that its implementation has led to variations of supervisory and regulatory practices, and in some jurisdictions, the risk is not adequately addressed. Moreover, although Basel III was developed to be applied to internationally active banks, the recent banking turmoil has shown that distress among relatively small banks can have broader systemic implications and cross-border contagion effects. The ongoing review of the Basel Core

Principles for Effective Banking Supervision offers a good opportunity to remind the international community that although the diversity of institutions requires a proportional approach to regulation, all segments of the banking sector should be subject to rigorous prudential standards (see Bank for International Settlements 2023). In particular, all banks should be required to comply with capital and liquidity standards that are broadly compatible with the Basel framework, which represents only minimum requirements. In many cases, countries and banks will need to impose higher standards than the framework implies to cover all material risks.

Fortifying Crisis Management Frameworks

The global stress test shows that in the absence of central bank liquidity facilities, interactions between solvency and liquidity triggered by adverse shocks could lead to distress among a considerable number of banks. Enhancements of commercial banks' preparedness to use eligible collateral and access central bank facilities and improved communication by authorities on the availability and usage of these facilities, including information on, for example, acceptable collateral and haircuts, are key in stemming systemic risks. The institutional arrangements for emergency liquidity provision vary widely in transparency, accessibility, collateral requirements, and time limits. All banks should be required to periodically test their access to central bank instruments. This is a common supervisory requirement in many jurisdictions. Central banks should set up their emergency liquidity assistance frameworks in normal times, anticipating that they would have to intervene in a crisis, and they should abide by a broad set of principles concerning collateralization, conditions, and state guarantees.

The March 2023 bank failures have also highlighted the need for further progress in several aspects of the too-big-to-fail reform agenda. These include the importance of effective backstops for public sector liquidity among resolution authorities and deposit insurers and authorities' preparedness to operationalize a range of resolution options and their strategies for communicating those options, as well as the role of deposit insurance in resolution in a world where digital innovation can accelerate deposit runs. The Financial Sector Assessment Program's assessments have highlighted that in many countries deposit insurers face significant weaknesses in their funding arrangements, such as, for example, weaknesses regarding backstop arrangements for funding liquidity. In addition, authorities should recognize that it is not just the largest banks whose failures can prove systemic and whose resolutions should be adequately planned for.

Box 2.1. Experience of Past Bank Runs

The March 2023 bank runs in Switzerland and the United States were unusually large and fast (see Figure 2.1.1, panel 1), with their speed and size facilitated by rapid online deposit withdrawals and the rapid spread of worries among important groups of depositors via social media and other digital channels. This has rightly prompted consideration of possible policy lessons, but the most recent runs also have important similarities with previous bank runs.

Although the runs were not as severe and fast as the run on Silicon Valley Bank, banks have experienced rapid online runs before. The 2007 deposit run on the UK bank Northern Rock took place mostly via the internet: The bank lost almost 60 percent of its retail deposits in 2007, including 20 percent over just five days (between September 13 and 17). In 2008, the UK internet banking branch of the Icelandic bank Landsbanki also suffered a rapid run amid the broader Icelandic banking crisis (Kobrin 2021).

Earlier advances in banks' use of technology triggered similar concerns about speeding up deposit withdrawals in a crisis. For example, the US Federal Deposit Insurance Corporation's official history describes that organization's rescue of Continental Illinois National Bank and Trust in 1984—the episode from which the phrase "too big to fail" originates—as resulting from a "high-speed electronic bank run" (Federal Deposit Insurance Corporation 1997).

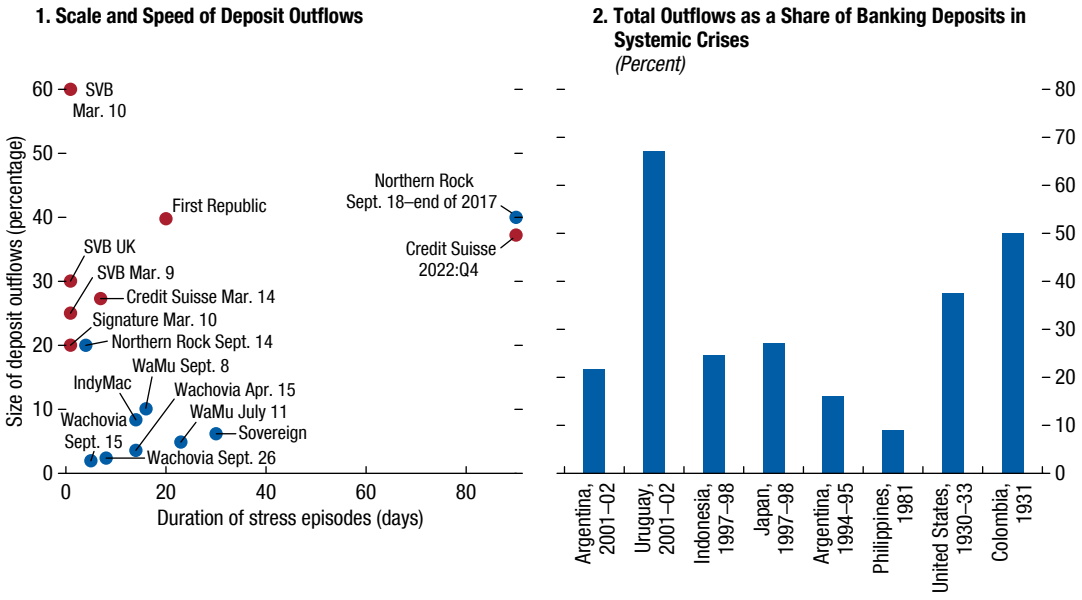
The capacity for concerns to spread rapidly within a concentrated or closely connected group of depositors has long been recognized as a potential contributor to bank runs. One of the first major bank failures of the Great Depression was the 1931 failure of Bank of the United States, whose customer base, concentrated among New York City's foreign-born population, also facilitated the rapid spread of the bank run.

Some crises that have affected the entire financial sector have matched the scale of the 2023 bank runs (Figure 2.1.1, panel 2).

Figure 2.1.1. Case Studies of Bank Runs

Recent bank runs have been unusually large and fast, but banks have experienced rapid online runs before.

Some systemic banking crises have also involved massive total deposit outflows.



Sources: Ennis and Keister 2009; Federal Deposit Insurance Corporation 1997; Federal Reserve, bank financial reports; Investigation Commission of Althing 2010; Kobrin 2021; Levy-Yeyati, Martínez Pería, and Schmukler 2010; Nakaso and Hattori 2002; Nascimento 1991; *Northern Rock Applicants v Caldwell & HM Treasury* (UKUT 408, 2011); Rose 2015; Schumacher 2000; Shin 2009; Simorangkir 2011; and IMF staff calculations.

Note: Panel 2 presents the size of systemwide deposit outflows during stress periods in each country, except in the following cases: United States, 1930–33, an average of 67 failed banks; Philippines, 1981, thrift banks; Japan, 1997–98, an average of three failed banks. IndyMac = Independent National Mortgage Corporation; SVB = Silicon Valley Bank; WaMu = Washington Mutual.

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