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# Banks' Joint Exposure to Market and Run Risk

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**Banks' Joint Exposure to Market and Run Risk**

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**ABSTRACT:** Recent failures of US banks highlight that large liability withdrawals can damage capital positions—i.e., that liquidity risk and solvency risk interact. A simple risk assessment for banks in a wide group of countries finds sizable exposure to this interaction. This varies significantly across banks—primarily reflecting differences in cash buffers, capitalization, securities holdings and exposure to market risk—and is highly concentrated. Vulnerability is generally greater for banks in AEs due to lower cash buffers, securities holdings and capitalization. Within AEs—unlike in EMs—larger banks are most exposed, due to greater wholesale funding and thinner capital buffers. Estimated aggregate losses are substantial in some countries, reflecting a range of recent shocks.

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# 1 Introduction

Recent bank failures in the US highlight that liquidity risk can threaten solvency in the presence of large unrealized losses. Sudden and large withdrawals by depositors can force banks to sell assets below their book value, generating losses that may be large relative to capital—as in the case of Silicon Valley Bank in March 2023. We assess the exposure of banks globally to this dynamic through a high-level analysis of risks. We propose a methodology similar in spirit to Jiang, Matvos, Piskorski & Seru (2023) that can be applied using generally available bank-level data for a broad group of countries. We present results for 47 countries drawing on bank-level data for more than 1,200 banks globally.

We assess whether liquidity and capital cushions would be depleted by unrealized losses crystallized due to hypothetical rapid liability withdrawals at the bank level. To do so, we calculate indicative current market prices to use when marking assets to market. In advanced economies (AEs), we estimate the market value of securities using observed changes in the prices of local currency sovereign bonds. In emerging market and developing economies (EMDEs), where pricing data is less reliable, we combine the duration of sovereign bonds with changes in spreads and risk-free interest rates. We assume that other asset classes, like loans, face larger losses reflecting greater risk premia.

As bank runs are multiple-equilibrium phenomena, we consider the impact of a range of scenarios of liability withdrawals. We determine the size of asset sales required, at current market values, to meet withdrawals in each scenario. Our moderate scenario considers outflows of 20 percent of deposits and 30 percent of wholesale funding for more vulnerable banks. These assumed outflows are in line with the stresses faced by Silicon Valley Bank, Signature, and First Republic before they failed. Finally, we scale the resulting realized losses by equity. Our approach therefore identifies banks for which solvency would be threatened in the current market environment if a run were to take place.

We make important simplifying assumptions to maximize coverage across countries. This reflects our aim to assess the broader relevance of the risks that materialized in the US, rather than to produce definitive estimates at the bank level. Data availability is constrained on a number of important dimensions: actual mark-to-market losses or the share already recognized at bank level; bank risk exposures (duration, asset classes, hedging); and the types of deposits or sources of wholesale funding. We therefore assume that sovereign bond prices and credit spreads can proxy for domestic bank assets. Lack of granular data on these dimensions could lead us to overestimate losses. We therefore explore the sensitivity of our results to different

assumptions regarding the duration of bank assets and the share of losses already recognized through mark-to-market accounting. We do not impose additional fire-sale discounts on assets sales, which would raise losses above our estimates.

As our focus is on exposure at the bank level, we do not assume that simulated withdrawals are deposited at other banks and we do not presuppose any policy support. Existing provisions—including ordinary standing facilities and emergency liquidity assistance—could mitigate some of our estimated losses, at the cost of potentially providing solvency support in some cases.

There is wide variation across banks, primarily reflecting differences in cash buffers, capitalization, securities holdings and exposure to market risk. Estimated losses are highly concentrated in the most exposed banks, with the median bank largely unaffected.

We find that advanced economy banks are more exposed to the combination of market and run risk than those in emerging market and developing economies. Vulnerability is generally greater for banks in AEs due to lower cash buffers, capitalization and securities holdings.<sup>1</sup> Within AEs—unlike in EMs—larger banks are most exposed, due to greater wholesale funding and thinner capital buffers. Estimated aggregate losses are substantial in some countries, reflecting a range of recent shocks. For instance, recent debt crises that have raised spreads in some EMDEs imply unrealized losses far larger than caused by contractionary monetary policy alone. As highlighted by the IMF’s recent Global Financial Stability Report (IMF 2023), this range of stresses complicates the task for central banks facing unexpectedly persistent inflationary pressures.

**Related literature:** Our methodology for a global sample of banks differs in several ways from Jiang, Matvos, Piskorski & Seru (2023). We consider market value losses only for assets sold in the scenarios we consider, not all assets held. Due to data constraints, we use pricing and duration of domestic sovereign bonds to proxy for the exposure of bank assets and are unable to distinguish between insured and uninsured deposits. We focus on losses as a share of equity in various withdrawal scenarios, rather than on identifying the conditions under which all uninsured depositors choose to run. Nonetheless, we reach a similar conclusion: recent events have exposed new financial fragilities and that joint exposure to market and run risk is broadly relevant, both in the US and across countries.

Our work also relates to the emerging literature assessing the drivers and implications of recent turmoil in the US banking sector (e.g., Benmelech et al. 2023). We do not account

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<sup>1</sup>Lower securities holdings raise losses in our simulations because other, less liquid assets like loans are assumed to face a larger discount if banks are forced to sell them, reflecting larger risk premia.

for changes in the value of banks' deposit franchises as interest rates change (Drechsler et al. 2021, 2023). Accounting for deposit franchises is important for longer-term analysis, but is less relevant when assessing the impact of bank runs assumed to take place.

Our high-level analysis of risks is conceptually related to stress test exercises, which typically aim to draw on granular bank-specific data to assess threats to financial stability. The IMF has contributed to the development of global stress testing methodologies, and assesses financial stability in key global jurisdictions through its Financial Stability Assessment Program. See Adrian et al. (2020) for a summary of the evolution of stress-testing methodology used by the IMF. Ding et al. (2022) describe a solvency stress-testing approach that combines structured macro-financial scenarios with publicly-available data for a global set of banks. Stress tests typically examine solvency and liquidity risks separately. A key conceptual contribution of the risk assessment we present is to consider how the combination of market and liquidity risk can threaten solvency.

The remainder of this paper proceeds as follows. We describe our data in the next section. In Section 3 we lay out the methodology of our baseline assessment of risks and discuss various caveats, before presenting the main results in Section 4. In Section 5 we examine the sensitivity of these results to various alternative modeling choices. We conclude in Section 6.

## 2 Data

Our primary dataset is S&P Capital IQ Pro, which provides a large unbalanced quarterly panel of balance sheet data for banks across 150 countries. This dataset provides a timely picture of banks' assets and liabilities immediately prior to the turmoil in early 2023 as coverage is available through 2022Q4. In our baseline methodology, we restrict the sample to banks that report data on the following variables in 2022Q4: cash and cash equivalents, total securities, total assets, total deposits, wholesale funding, total equity, and cost of funds. This leaves us with 1,288 banks from 66 countries, of which 62% are in AEs and 38% are in EMDEs. Total assets in the baseline scenario are USD 74 trillion, which is 73% of total assets across all banks in S&P Capital IQ Pro, and there are 47 countries for which we cover at least five banks.

To estimate mark-to-market losses, we supplement this data with data on the price, value and duration of local currency sovereign bonds, from Bloomberg Back Office. For each country, we use the average modified duration of outstanding bonds and/or the change in their prices from January 1, 2022 to July 7, 2023, weighted by market value, as described in Section 3. The bond-level dataset allows us to account for heterogeneity in duration and price changes across a

broad set of countries.

Finally, we utilize additional country-specific spreads from the IMF’s internal Sovereign Debt Monitor, which reports par-value-weighted average spreads across each country’s sovereign bonds with remaining maturity of more than one year. Table A.1 reports summary statistics for key variables separately for AEs and EMs.

### 3 Methodology

In the presence of large adverse movements in market values that are not fully recognized due to hold to maturity accounting, sudden and large liability withdrawals that exhaust liquidity buffers can generate sizable losses relative to capital, in the absence of access to central bank facilities or emergency liquidity assistance. This section describes our methodology to quantify such losses in three stages. We estimate the mark-to-market losses realized on forced asset sales, describe our withdrawal scenarios and the implications for losses, and then comparing these losses to equity.

**Market values:** On the asset side, we distinguish between securities and other assets. We start with the reported carrying value of securities as of end-2022. In the absence of consistent cross-country data on the proportions of securities that are treated as held-to-maturity (HTM) for accounting purposes, we use the US as a benchmark and impose an HTM share of 50% for all countries, in line with the estimate of Granja (2023).<sup>2</sup> For AEs, we approximately mark HTM securities to market using the value-weighted average percentage change in price observed for local currency bonds since the start of 2022. Specifically, we first calculate the discount for the full bond portfolio

$$\text{Mark-to-Market Discount}_c^{[100]} = \sum_j (w_{j,c} \times \Delta_{7/7/23-1/1/22} \text{Price}_{j,c}) \quad (1)$$

where  $w_{j,c}$  is the value share of a given bond  $j$  among all bonds outstanding in country  $c$ . We further assume that banks’ portfolio duration is 75 percent of the country-wise duration. This assumption reflects that other institutional investors, like insurers and pension funds, are likely to account for a large share of holdings of long-term securities given their long-term liabilities.<sup>3</sup> To compute the corresponding mark-to-market (MTM) discount we sort bonds by duration  $\mathcal{D}_{j,c}$

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<sup>2</sup>We explore alternative values for the HTM share in the sensitivity analysis in Section 5. The lower the true share of HTM securities, the more we overstate losses.

<sup>3</sup>Again, we assess the sensitivity of our results to this assumption in Section 5.

and find a threshold  $\bar{D}_c$  for each country such that the weighted average duration of the subset below  $\bar{D}_c$  is 75 percent of the weighted average duration of the country's full portfolio. We can then compare the conditional MTM discount for that subset to the full-portfolio MTM discount. Define  $\delta_c^{[75]}$  as the ratio between the two:

$$\delta_c^{[75]} = \frac{\text{Mark-to-Market Discount}_c^{[75]}}{\text{Mark-to-Market Discount}_c^{[100]}} = \frac{\sum_{j \in \{j | \mathcal{D}_{j,c} < \bar{D}_c\}} (\tilde{w}_{j,c} \times \Delta_{7/7/23-1/1/22} \text{Price}_{j,c})}{\sum_j (w_{j,c} \times \Delta_{7/7/23-1/1/22} \text{Price}_{j,c})} \quad (2)$$

where  $\tilde{w}_{j,c}$  is the weight within the set of bonds defined by the condition  $\mathcal{D}_{j,c} < \bar{D}_c$ . For the US, the fraction  $\delta_{US}^{[75]}$  is 0.81, reflecting the non-linear relationship between duration and the conditional MTM discount. For simplicity and data availability, we apply the same  $\delta_{US}^{[75]} = 0.81$  to all AEs. This gives the discount factor of HTM securities in bank portfolios.

$$\text{Mark-to-Market Discount}_c^{AE} = \sum_j (w_{j,c} \times \Delta_{7/7/23-1/1/22} \text{Price}_{j,c}) \times \delta_{US}^{[75]} \quad (3)$$

For EMDEs, where the quality of pricing data for local currency bonds is often poor, we apply the change over the same period in the US yield curve at the duration of the portfolio of local currency sovereign bonds outstanding in each country, the discount adjustment factor  $\delta_{US}^{[75]}$ , plus an additional country-specific spread. We have

$$\begin{aligned} \text{Mark-to-Market Discount}_c^{EM} &= [\Delta_{7/7/23-1/1/22} r_{UST}(\overline{\text{Duration}}_c) + \Delta_{7/7/23-1/1/22} \text{Spread}_c] \\ &\quad \times \overline{\text{Duration}}_c \times \delta_{US}^{[75]} \end{aligned} \quad (4)$$

where  $\overline{\text{Duration}}_c = \sum_j (w_{j,c} \times \text{Duration}_{j,c})$  and  $\text{Spread}_c$  is the par-value weighted spread across the country's USD- or EUR-denominated sovereign bonds with more than one-year remaining maturity, calculated for the IMF's internal Sovereign Debt Monitor.<sup>4,5</sup> For both AEs and EMDEs, we then impose a larger discount of  $1.25 \times \text{Discount}_c$  on sales of other assets, reflecting that banks first sell off the securities whose value has been eroded least.

Altogether, we allow for cross-country variation in the mark-to-market (MTM) discount based on differences in average bond durations, country-specific credit spreads, and observed changes in prices.<sup>6</sup> We use yield curve changes from the [Federal Reserve](#), while bank data is

<sup>4</sup>Where we cannot match to data in Sovereign Debt Monitor, we instead use the median change in spread within the sample.

<sup>5</sup>For the 9 EMDEs in which we have good pricing data, estimated market values are similar if we use the same approach as we use for AEs instead—directly incorporating pricing of local currency bonds rather than imputing from FX bonds.

<sup>6</sup>By using recent observed changes in prices, we focus on existing unrealized losses. Unanticipated rate hikes in countries facing entrenched inflationary pressure could generate large additional losses.

from S&P Capital IQ Pro and bond pricing data is from Bloomberg as described in the previous section.

**Withdrawal scenarios:** Turning to liabilities, we model withdrawal scenarios by splitting banks within each country into those with above- or below-median cost of funds (COF).<sup>7</sup> Across our mild, moderate, and severe scenarios  $S$  we respectively assume outflows of 10%, 20% and 30% of deposits in high-COF banks, and half as much in low-COF banks, assuming that low-COF banks have stickier liabilities. We assume that banks initially meet withdrawals using their available cash and equivalent liquid assets as well as securities already marked to market and face no market value losses in doing so. We also assume additional outflows of wholesale funds, at a higher rate than deposits, while continuing to distinguish between high/low-COF banks.<sup>8</sup> We therefore have excess withdrawals (withdrawals that cannot be met with cash and equivalents and MTM securities) equal to:

$$EWithdrawals_b^S = TotalDeposit_b \times S_b + Wholesale_b \times 1.5 \times S_b - Cash_b - Securities_b^{MTM} \quad (5)$$

where we constrain that  $EWithdrawals_b^S \geq 0$  and  $S_b$  is the proportion of deposits assumed to leave in each scenario.

We then back out the book value of HTM securities that must be sold—at current market prices—to raise sufficient funds to meet withdrawals.<sup>9</sup> The larger the MTM discounts, the more book-value securities must be sold. We assume for simplicity that banks first sell off securities, and only sell other assets if securities sales are insufficient.<sup>10,11</sup> This pins down the book-value sales of each type of asset in each withdrawal scenario:

$$SecSales_b^S = \begin{cases} \frac{EWithdrawals_b^S}{[1-Discount_c]} & \text{if } \frac{EWithdrawals_b^S}{[1-Discount_c]} < Securities_b^{HTM} \\ Securities_b^{HTM} & \text{if } \frac{EWithdrawals_b^S}{[1-Discount_c]} \geq Securities_b^{HTM} \end{cases} \quad (6)$$

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<sup>7</sup>The cost of funds for each bank is the implied average interest rate on liabilities, measured as the interest incurred on liabilities as a share of all deposits and liabilities, including any that are not interest-bearing. We split banks based on the country-specific median COF to account for country-specific macroeconomic factors influencing COF. We use observed COF instead of estimated deposit betas due to the difficulty of estimating the latter precisely at the bank level in the previous low interest-rate environment.

<sup>8</sup>Wholesale funding includes both short-term repurchase agreements and long-term bonds. In the absence of data on the maturity mix, we consider in Section 5 the sensitivity of our results to alternative values of the wholesale funding runoff rate.

<sup>9</sup>For simplicity, we assume that the sale of assets to meet withdrawals occurs at the current market price with no additional fire-sale penalty.

<sup>10</sup>Across countries, the median share of banks that run out of securities in the moderate scenario is 7.5%.

<sup>11</sup>We impose an additional 25% discount on sales of other assets to reflect higher risk premia than on government and other securities. Again, we assess the sensitivity of our results to this assumption in Section 5.



$$\text{OtherAssetSales}_b^S = \begin{cases} 0 & \text{if } \frac{\text{EWithdrawals}_b^S}{[1-\text{Discount}_c]} < \text{Securities}_b^{\text{HTM}} \\ \frac{\text{EWithdrawals}_b^S - \text{Securities}_b^{\text{HTM}} \times [1-\text{Discount}_c]}{[1-1.25 \times \text{Discount}_c]} & \text{if } \frac{\text{EWithdrawals}_b^S}{[1-\text{Discount}_c]} \geq \text{Securities}_b^{\text{HTM}} \end{cases} \quad (7)$$

where  $\text{Discount}_c$  is the corresponding mark-to-market discount for AE or EM country  $c$  using equation 3 or 4 respectively. The resulting value of assets is then (in the case that  $\text{EWithdrawals}_b^S > 0$ ):

$$\text{Assets}_b^S = \text{Securities}_b^{\text{HTM}} - \text{SecSales}_b^S + \text{OtherAssets}_b^{2022} - \text{OtherAssetSales}_b^S - \text{Cash}_b - \text{Securities}_b^{\text{MTM}} \quad (8)$$

**Assessing losses:** To assess the relative exposure of each bank, we compare losses to equity. Bank-level losses are:

$$\text{Losses}_b^S = \text{SecSales}_b^S \times \text{Discount}_c + \text{OtherAssetSales}_b^S \times 1.25 \times \text{Discount}_c \quad (9)$$

In Section 4 we examine, in each scenario, both bank-level losses and the combined losses of all banks in each country.

**Caveats:** Our methodology makes significant simplifications to allow for broad coverage across countries. In the absence of consistent bank-specific data on market values of assets or risk exposures, we assume risk exposures mirror those of outstanding domestic sovereign bonds. Similarly, we do not account for hedging and do not differentiate among types of deposits or sources of wholesale funding.<sup>12</sup> We also abstract from other factors that could influence the probability of a run, such as geographic diversification, investor sophistication, and digitalization, and we do not factor in improvements in net interest income resulting from banks' deposit franchise. Simulated withdrawals are not assumed to be deposited at other banks. We do not consider access to central bank liquidity facilities. Such factors could mitigate potential losses in some cases, although our approach could also underestimate losses if banks face large fire-sale discounts when selling assets. We explore the sensitivity of our results to some of these factors in Section 5. Since our focus is on assessing the potential need for policy action, we also do not presuppose any support for banks (such as that introduced in the US in March 2023) in our

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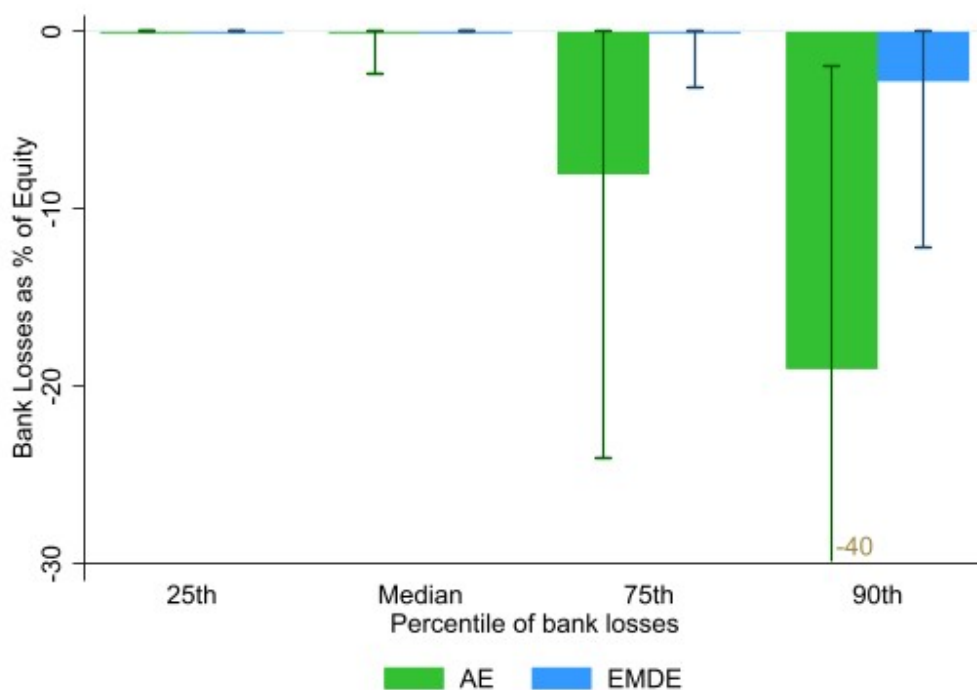
<sup>12</sup>A recent ECB data collection exercise finds only a limited offsetting role for hedging via derivatives among euro area banks. For instance, under the adverse market risk scenario used in the 2023 EU-wide stress test, interest rate hedging reduced potential losses on held-to-maturity bond portfolios by 22% (ECB 2023). Furthermore, recent work drawing on granular data finds that large gross positions in interest rate swaps translate to essentially no meaningful change in interest-rate exposure for the average bank in the US, as positions largely offset one another (McPhail et al. 2023).

baseline assessment of vulnerabilities.

## 4 Results

Figure 1 shows the distribution of estimated losses across banks, for both the moderate scenario (bars) and the mild/severe scenarios (low/high) error bars. Projected losses vary significantly across banks but are substantial for those most exposed. Estimated losses are above 20 percent of equity for about 6 percent of banks in a moderate scenario, and for nearly 20 percent of banks in a severe scenario. For the most exposed decile of banks, estimated losses are almost half of total equity in the severe scenario. This weak tail of banks, highlighted in the IMF’s recent Global Financial Stability Report (IMF 2023), may require additional scrutiny from policymakers.

Figure 1: Potential losses in AE vs. EM banks



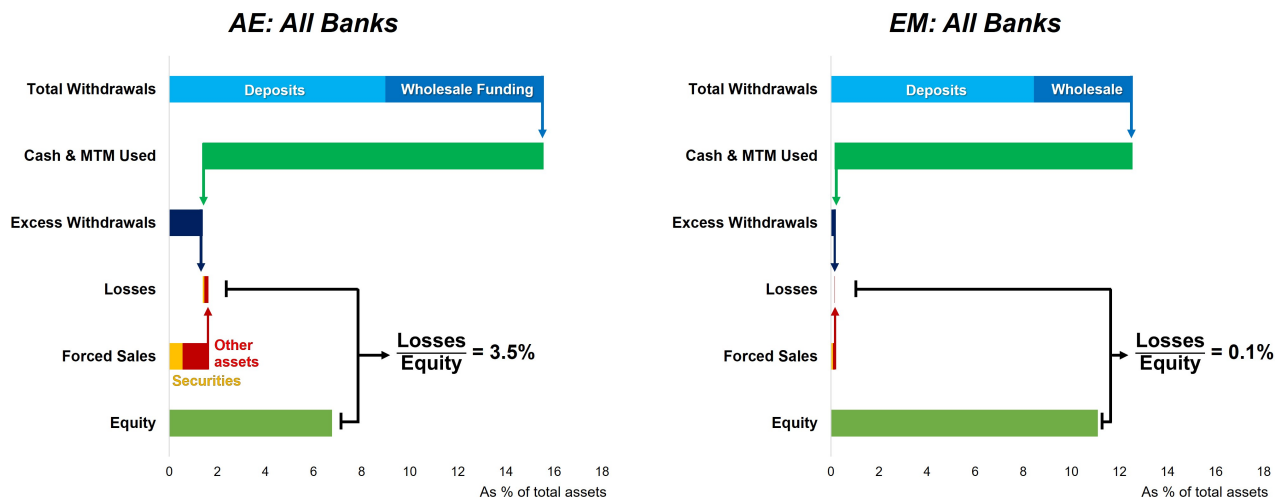
*Source:* S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

*Notes:* Graph shows estimated losses for banks at different percentiles of the distribution of bank losses. Bars show results in the moderate scenario of 20% deposit withdrawals at vulnerable banks, and low (high) error bars show losses in the mild (severe) scenarios, respectively reflecting 10% (30%) withdrawals.

Figure 2 breaks down the drivers of losses for the central scenario. The figure illustrates how larger cash buffers reduce excess withdrawals, which in turn reduces the forced sales and concomitant losses that are required to meet them. The larger aggregate exposure of banks in

AEs relative to EMDEs is driven by greater use of wholesale funding, tighter cash and capital buffers, and lower securities holdings.

Figure 2: Higher AE losses driven by greater wholesale funding and tighter capital buffers



Source: S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

Notes: Results shown for central scenario (20% withdrawals in vulnerable banks). Bars are aggregates of bank-level results across all banks within AEs/EMs.

To investigate the relative importance of different drivers of losses at the bank level, we next construct a rough approximation of Shapley values. The aim is to assess—for each bank’s estimated losses—which input variables had the most impact on the estimate, taking into account the various interactions and non-linearities in our estimation procedure. Specifically, for each bank  $b$  and variable  $i$ , we conduct the following steps: (i) construct a set  $\mathbf{S}$  of 1000 hypothetical banks, with features representative of the population, by repeatedly sampling from the relevant group (i.e., AEs, EMs); (ii) take the value  $x_{bi}$  of variable  $i$  for bank  $b$ , and apply it to all the banks in  $\mathbf{S}$ ; (iii) calculate the change in losses for those banks, assuming that all variables except  $i$  stay the same; (iv) average this change in losses across all 1000 banks in  $\mathbf{S}$ . Comparing the outcome across any two variables  $i, j$  within  $b$  then provides a measure of the relative importance of  $i$  vs.  $j$  in driving losses for  $b$ , even accounting for the various interaction effects and non-linearities, as we have respectively averaged across a realistic distribution of possible values for all the non- $i$  or non- $j$  variables. In our context, the relevant variables  $i$  or  $j$  are the following: the share of liabilities that are potentially runnable; the share of these potentially runnable liabilities that are wholesale funds; equity as a share of total assets; cash as a share of total assets; securities as a share of non-cash assets; and the vector of discounts on

securities and other assets.<sup>13,14</sup>

The results of this exercise are shown in Figure 3.<sup>15</sup> Differences across banks are primarily driven by cash holdings, capitalization, securities holdings and the mark-to-market discount. Though some emerging market and developing economy banks are also vulnerable, advanced economy banks are primarily more exposed because they have lower cash and securities holdings and smaller capital buffers. Within most advanced economies, lower capitalization and greater wholesale funding also drive higher exposure for larger banks (though not for the largest banks), shown in Figure 4. In contrast, in EMDEs smaller banks are more exposed, reflecting their higher costs of funds, less sticky liabilities, and lower levels of security holdings.

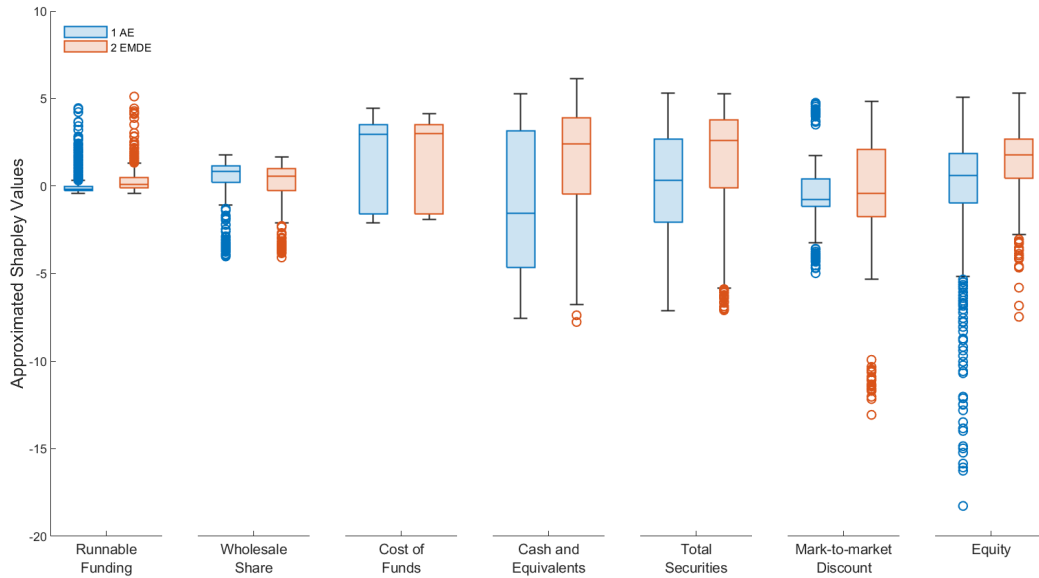
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<sup>13</sup>When applying values of these variables to the 1000 hypothetical banks, we proportionately scale up or down any remainder variables (e.g., the ‘non-cash share of assets’ when applying the ‘cash share of assets’) to ensure that we never impose unfeasible quantities (e.g., the non-cash plus cash shares summing to more than 100%).

<sup>14</sup>Potentially runnable liabilities are defined as deposits plus 1.5 times wholesale funds (see Equation 5).

<sup>15</sup>Since our focus here is the bank level rather than the aggregate impact, which is implicitly weighted by bank size, the main drivers are not necessarily the same as those in Figure 2.

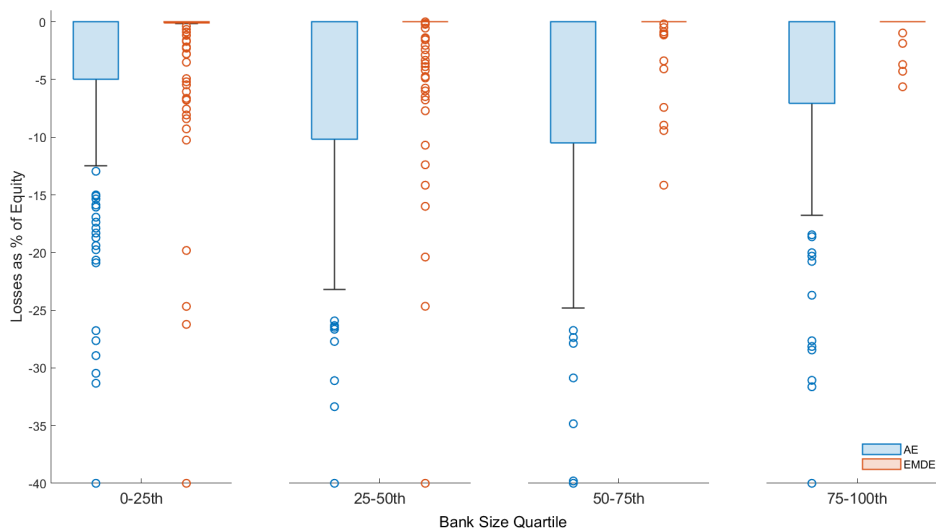
Figure 3: Drivers of losses across banks



*Source:* S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

*Notes:* Results shown for central scenario (20% withdrawals in vulnerable banks). Bars show the 25th, 50th and 75th percentiles of banks and dots show outliers. Outliers are values more than 1.5 times the interquartile range above (below) the 75th (25th) percentile. The whiskers extend to the maximum (minimum) value that is not an outlier. The relative importance scores for each variable  $i$  within each bank  $b$  are derived from the following process: (i) construct a set  $\mathbf{S}$  of 1000 hypothetical banks, with features representative of the population, by repeatedly sampling from the relevant group (i.e., AEs, EMs); (ii) take the value  $x_{bi}$  of variable  $i$  for bank  $b$ , and apply it to all the banks in  $\mathbf{S}$ ; (iii) calculate the change in losses for those banks, assuming that all variables except  $i$  stay the same; (iv) average this change in losses across all 1000 banks in  $\mathbf{S}$ . Values are multiplied by -1 so that a more negative number corresponds to larger losses.

Figure 4: Losses by bank size quartile



*Source:* S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

*Notes:* Results shown for central scenario (20% withdrawals in vulnerable banks). Bars show the 25th, 50th and 75th percentiles of banks and dots show outliers. Outliers are values more than 1.5 times the interquartile range above (below) the 75th (25th) percentile. The whiskers extend to the maximum (minimum) value that is not an outlier.

## 5 Sensitivity Analysis

In this section, we examine the sensitivity of our results to alternative assumptions and an alternative methodology. First, we vary key assumptions in our estimates of securities' market values, specifically the share of assets that are HTM vs. non-HTM and the mapping between sovereign bonds and bank asset duration. Second, we vary key assumptions involved in our assessment of the losses that result under different withdrawal scenarios, specifically the extra runoff for wholesale funding, relative to deposits, and the extra discount applied to any forced sales of other assets, relative to securities. Finally, we present results from an alternative methodology using more granular data, albeit on a smaller sample.

**Market values:** We first investigate the robustness of our results to alternative assumptions regarding the share of securities that are accounted for as HTM and duration. For the HTM share of securities, we explore alternative assumptions ranging from 25% to 75%. For the average duration of bank portfolios, we consider between 50% and 100% of the full portfolio duration in each country. Following equations 2 and 3, we calculate the corresponding discount adjustment factor  $\delta$  for the US and apply it to all countries.<sup>16</sup>

Since the impact of these two assumptions compounds—e.g., higher duration increases losses by more the greater the HTM share—we report results for a range of combinations in Figure 5. Losses as a share of equity remain higher in AEs in all cases, and rise particularly rapidly with the HTM share. Figures A.1 to A.3 in the Appendix show the results for just the 50th, 75th and 90th percentiles of banks by losses. The median bank does not face losses in EMs, and likewise in AEs if the HTM share is less than 70% (Figure A.1). In contrast, the 90th percentile of AE banks by losses experience significant losses even with 50% of the average duration and a 25% HTM share (Figure A.3).

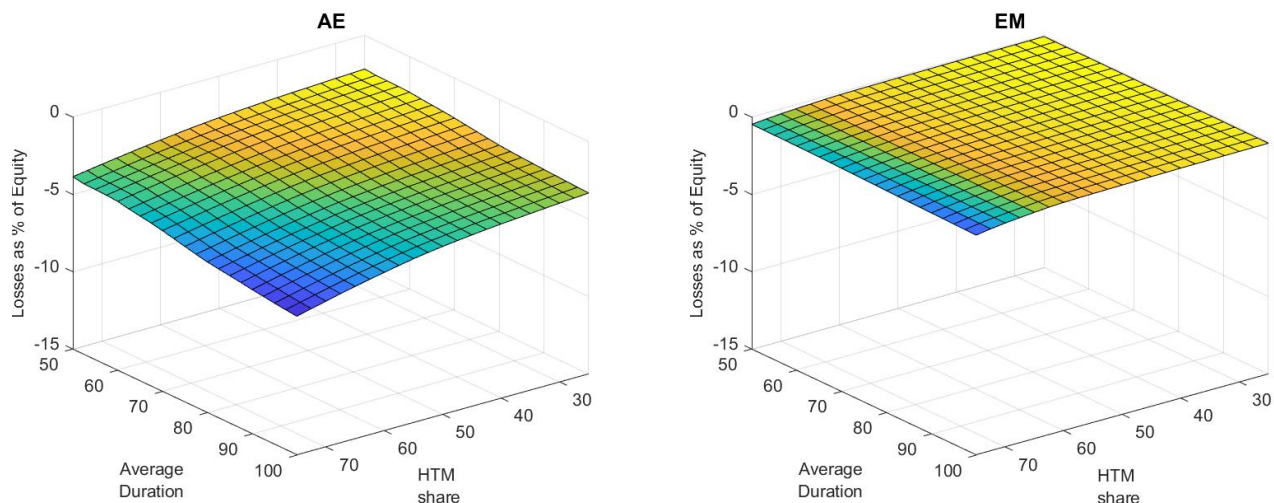
**Withdrawal scenarios:** We next investigate the robustness of our results to alternative assumptions on the extra runoff for wholesale funding, relative to deposits, and the extra discount applied to any forced sales of other assets, relative to securities. For the former, we investigate alternative multipliers ranging from 1.25 to 1.75 (against a baseline of 1.5), and for the latter, we consider multipliers from 1.0 to 1.5 (against a baseline of 1.25).

The results are shown in Figure 6. Once again, losses in AEs remain larger than those in EMs in all cases, with total losses relatively insensitive to the values of the multipliers, particularly in EMs. Figures A.4 to A.6 in the Appendix show the results for the 50th, 75th and 90th

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<sup>16</sup>For instance, we apply:  $\delta_{US}^{[50]} = 0.65$ ,  $\delta_{US}^{[62.5]} = 0.70$ ,  $\delta_{US}^{[75]} = 0.81$ ,  $\delta_{US}^{[87.5]} = 0.91$ ,  $\delta_{US}^{[100]} = 1$ .

Figure 5: Losses under alternative assumptions on HTM assets and duration



*Source:* S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

*Notes:* The graphs show how bank losses in AEs/EMs vary under alternative assumptions on HTM assets and duration. Values are aggregates of bank-level results across all banks within AEs or EMs. All estimates are for the central scenario (20% deposit withdrawals at vulnerable banks).

percentiles of banks by losses. Even for the maximum wholesale outflow differential of 75%, there are no losses in the 75th percentile bank in EMs or in the 50th percentile bank in AEs. For the 90th percentile of banks by losses, a high-high (low-low) combination of the two multipliers can generate losses in AEs approximately 5% larger (smaller) than our baseline of approximately 20% (shown in Figure 1). For EMs, losses at the 90th percentile are relatively unaffected by the size of the additional discount applied to other assets, as few banks sell all of their securities (which in our model is a precondition for any sales of other assets, as described in Section 3).

**More granular methodology:** Lastly, we extend our approach—for those countries with the requisite data—by distinguishing between sovereign bonds and other securities and applying an extra discount to the latter based on the change in the spreads of BBB-rated US corporate bonds. Specifically, we add the following term to equations 3 and 4:

$$\text{Extra Discount}_c = \Delta_{7/7/23-1/1/22} \text{Spread}_{USCorpBonds} \times \overline{\text{Duration}_c} \quad (10)$$

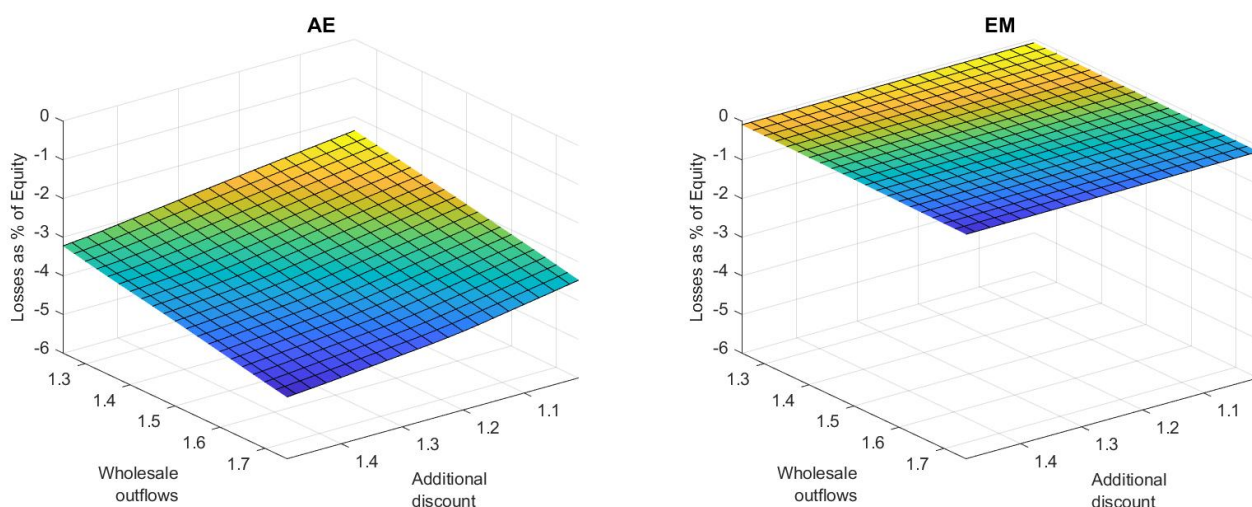
where  $\text{Spread}_{USCorpBonds}$  is from the ICE BofA option-adjusted spread index. We also compare losses to regulatory capital rather than equity.<sup>17</sup>

In this more granular version, total assets in the baseline scenario are USD 31 trillion, which

<sup>17</sup>We therefore use two additional variables from S&P Capital IQ Pro in the granular version: debt issued or guaranteed by national or supranational governments and Tier 1 common capital. We assume that the former variable is equivalent to sovereign bond holdings.



Figure 6: Losses under alternative assumptions for wholesale outflows and other assets



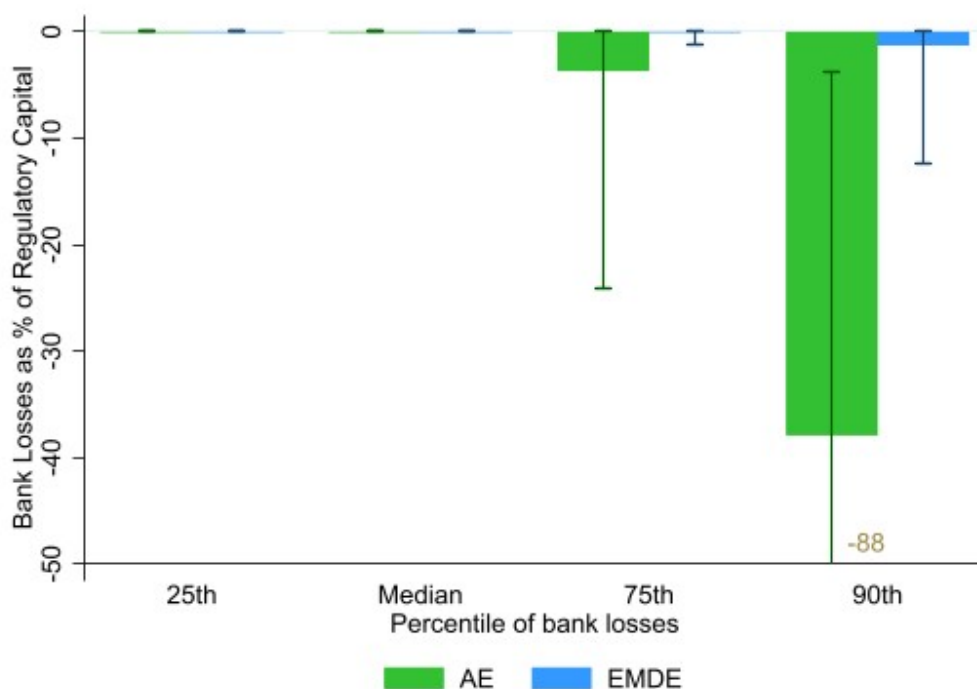
*Source:* S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

*Notes:* The graphs show how bank losses in AEs/EMs vary under alternative assumptions on the extra runoff for wholesale funding, relative to deposits, and the extra discount applied to any forced sales of other assets, relative to securities. Our baseline estimates in Section 3 use a multiplier of 1.5 for the former and 1.25 for the latter, i.e., the midpoints of the respective axes in this figure. Values are aggregates of bank-level results across all banks within AEs or EMs. All estimates are for the central scenario (20% deposit withdrawals at vulnerable banks).

is 31% of total assets across all banks in S&P Capital IQ Pro. Of these banks 50% are in AEs and 50% are in EMDEs, and there are 33 countries for which we cover at least five banks.

The main results, shown in Figures 7 and 8, are similar. Losses remain substantially higher in AEs than EMs, and are highly concentrated in the most vulnerable quartile of banks. Figure A.7 in the Appendix repeats Figure 3 for the broader range of factors in the granular method. There is little variation across banks in the sovereign bond share, while regulatory capital varies slightly more across non-outlier banks than equity. For the granular method, larger losses in AEs are primarily driven by lower securities holdings as a share of assets, greater market risk exposure and lower capitalization (Figure A.7).

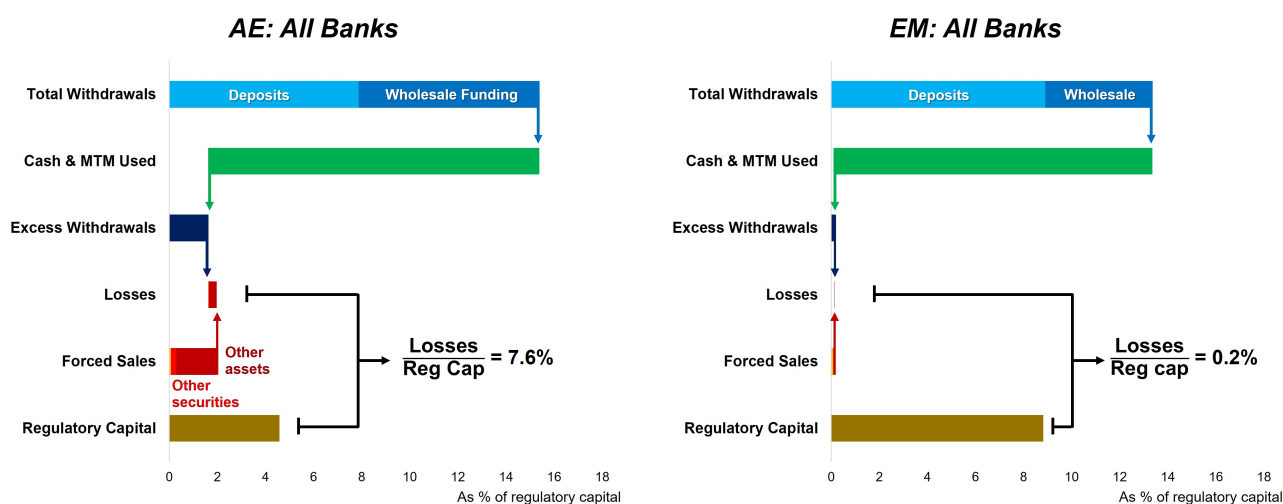
Figure 7: Potential losses under the granular methodology



Source: S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

Notes: Graph shows estimated losses for banks at different percentiles of the distribution of bank losses using the granular methodology. Bars show results in the moderate scenario of 20% deposit withdrawals at vulnerable banks, and low (high) error bars show losses in the mild (severe) scenarios, respectively reflecting 10% (30%) withdrawals.

Figure 8: Higher AE losses under the granular methodology



Source: S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

Notes: Results shown for central scenario (20% withdrawals in vulnerable banks) using the granular methodology. Bars are aggregates of bank-level results across all banks within AEs/EMs.

## 6 Conclusion

We find that exposure to the combination of market and run risk is relevant for banks beyond the US, with market value losses driven by a wider range of shocks than seen in recent failures to date in the US. Exposure is heavily skewed toward the most vulnerable banks and generally greater in AEs, reflecting lower cash buffers, securities holdings and capitalization.

Our results suggest that policymakers around the world should be attentive to the risks from liquidity-solvency interactions revealed by recent US banking turmoil. Banks should actively manage cash and capital buffers, and regulators should prepare or update contingency plans—for example preparing to rapidly introduce emergency liquidity facilities as deployed in the US following the SVB crisis if needed—as well as improve supervision going forward. As data limitations imply significant caveats, country authorities with access to detailed balance sheet data for their domestic banks could improve upon our methodology with more granular data.

## References

- Adrian, T., Morsink, J. & Schumacher, L. (2020), Stress Testing at the IMF, Departmental paper series.
- Benmelech, E., Yang, J. & Zator, M. (2023), Bank branch density and bank runs, Working Paper 31462, National Bureau of Economic Research.
- Ding, X., Gross, M., Krznar, I., Laliotis, D., Lipinsky, F., Lukyantsau, P. & Tressel, T. (2022), The Global Bank Stress Test, Departmental paper series.
- Drechsler, I., Savov, A. & Schnabl, P. (2021), ‘Banking on deposits: Maturity transformation without interest rate risk’, *The Journal of Finance* **76**(3), 1091–1143.
- Drechsler, I., Savov, A., Schnabl, P. & Wang, O. (2023), Banking on uninsured deposits, Working Paper 31138, National Bureau of Economic Research.
- ECB (2023), Unrealised losses in banks’ bond portfolios measured at amortised cost, Technical report, European Central Bank, Frankfurt am Main.
- Granja, J. (2023), Bank Fragility and Reclassification of Securities into HTM, SSRN Scholarly Paper 4409834, Social Science Research Network, Rochester, NY.
- IMF (2023), Global Financial Stability Report, Technical report, International Monetary Fund, Washington, D.C.
- Jiang, E. X., Matvos, G., Piskorski, T. & Seru, A. (2023), Monetary tightening and U.S. bank fragility in 2023: Mark-to-market losses and uninsured depositor runs?, Working Paper 31048, National Bureau of Economic Research.
- McPhail, L., Schnabl, P. & Tuckman, B. (2023), Do Banks Hedge Using Interest Rate Swaps?, SSRN Scholarly Paper 4414355, Social Science Research Network, Rochester, NY.

## Appendix A Additional Figures and Results

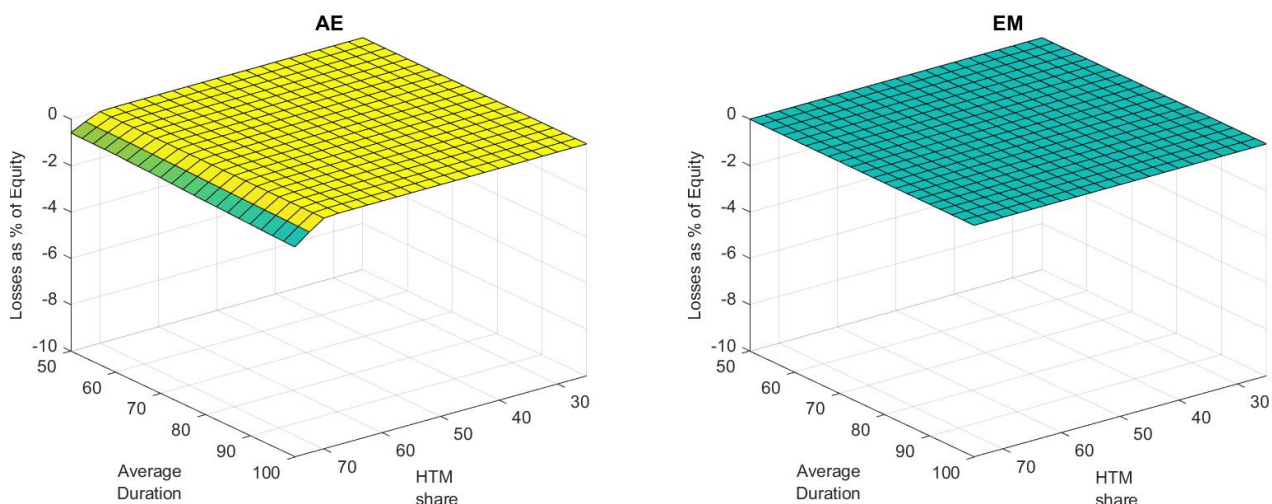
Table A.1: Summary Statistics

Variable	AEs				EMDEs			
	Mean	S.D.	Countries	Banks	Mean	S.D.	Countries	Banks
Cash and equivalents	12.6	67.7	18	775	2.63	6.81	29	463
Securities	19.9	105	18	775	5.25	15.9	29	463
Wholesale funding	20.0	84.8	18	775	3.80	13.0	29	463
Deposits	42.7	176	18	775	12.1	28.4	29	463
Equity	5.27	21.6	18	775	2.19	5.22	29	463
Cost of funds (%)	0.66	1.28	18	775	5.35	5.95	29	463
MTM discount (%)	11.0	3.35	18	775	10.6	7.10	29	463
$\Delta$ Bond prices (%)	-13.6	4.13	18	775				
$\Delta$ SDM spreads (bps)					86.8	431	29	463

*Source:* S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

*Notes:* All balance sheet items (top 5 rows) are in millions of US dollars. Bond prices are only available for AEs and Sovereign Debt Monitor (SDM) spreads are only included for EMDEs. The mark-to-market discount is calculated per equations 3 and 4.

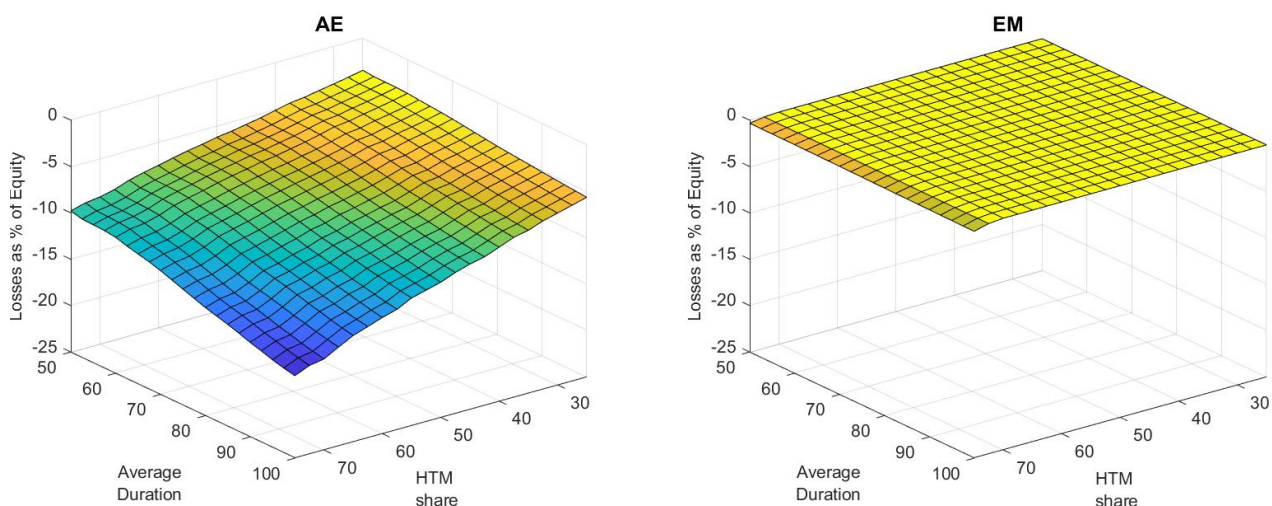
Figure A.1: Losses under alternative assumptions on HTM assets and duration (50th percentile)



*Source:* S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

*Notes:* Graph shows how the 50th percentile of bank losses vary under alternative assumptions on HTM assets and duration in the central scenario (20% deposit withdrawals at vulnerable banks).

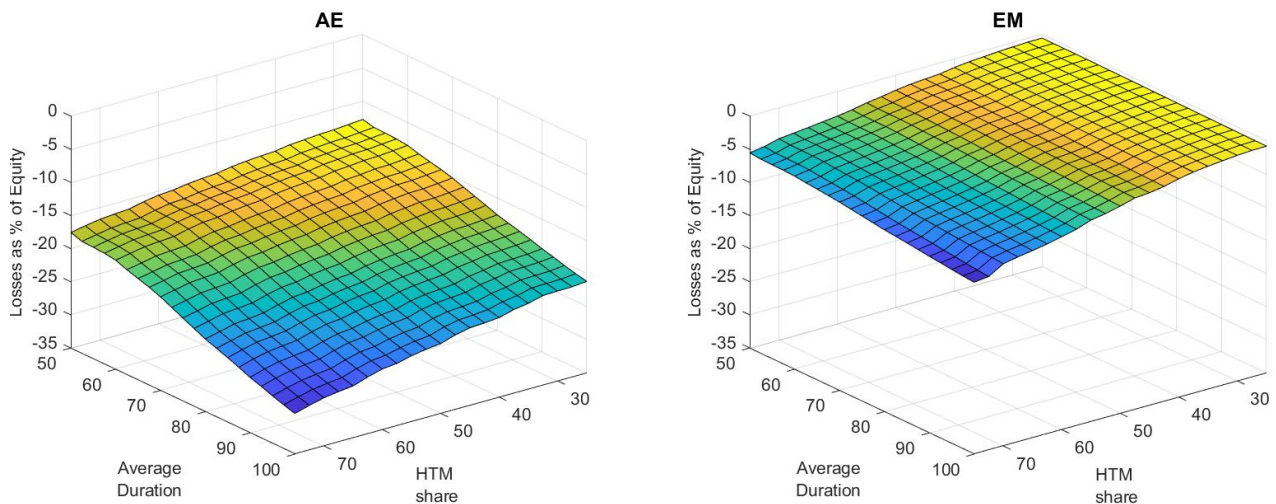
Figure A.2: Losses under alternative assumptions on HTM assets and duration (75th percentile)



*Source:* S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

*Notes:* Graph shows how the 75th percentile of bank losses vary under alternative assumptions on HTM assets and duration in the central scenario (20% deposit withdrawals at vulnerable banks).

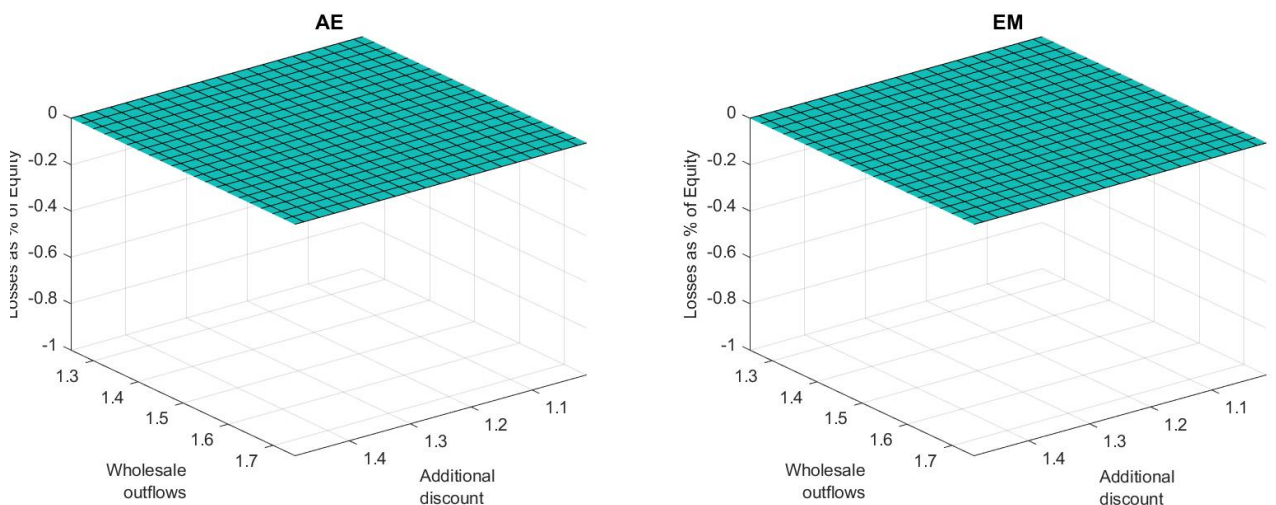
Figure A.3: Losses under alternative assumptions on HTM assets and duration (90th percentile)



Source: S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

Notes: Graph shows how the 90th percentile of bank losses vary under alternative assumptions on HTM assets and duration in the central scenario (20% deposit withdrawals at vulnerable banks).

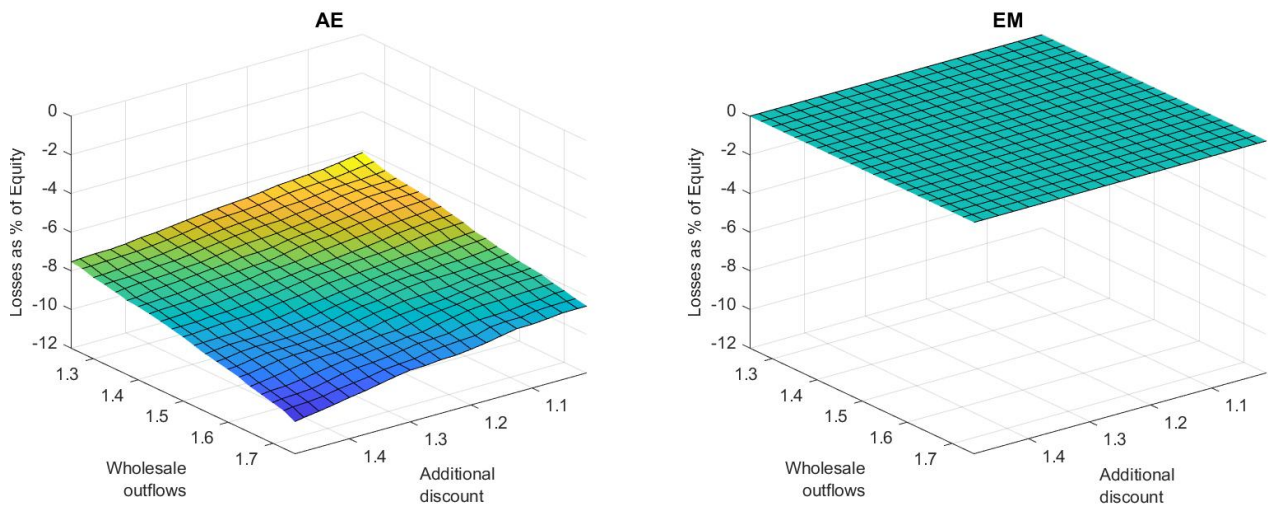
Figure A.4: Losses under alternative assumptions for wholesale outflows and other assets (50th percentile)



Source: S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

Notes: The graphs show how the 50th percentile of bank losses in AEs/EMs vary under alternative assumptions on the extra runoff for wholesale funding, relative to deposits, and the extra discount applied to any forced sales of other assets, relative to securities. Values are aggregates of bank-level results across all banks within AEs or EMs. All estimates are for the central scenario (20% deposit withdrawals at vulnerable banks).

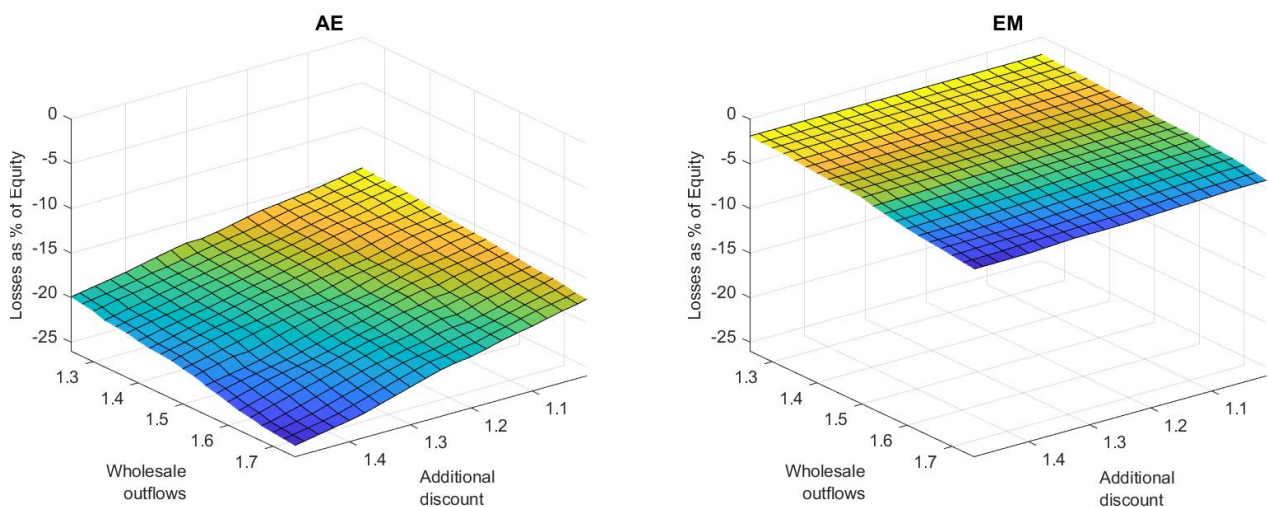
Figure A.5: Losses under alternative assumptions for wholesale outflows and other assets (75th percentile)



*Source:* S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

*Notes:* The graphs show how the 75th percentile of bank losses in AEs/EMs vary under alternative assumptions on the extra runoff for wholesale funding, relative to deposits, and the extra discount applied to any forced sales of other assets, relative to securities. Values are aggregates of bank-level results across all banks within AEs or EMs. All estimates are for the central scenario (20% deposit withdrawals at vulnerable banks).

Figure A.6: Losses under alternative assumptions for wholesale outflows and other assets (90th percentile)

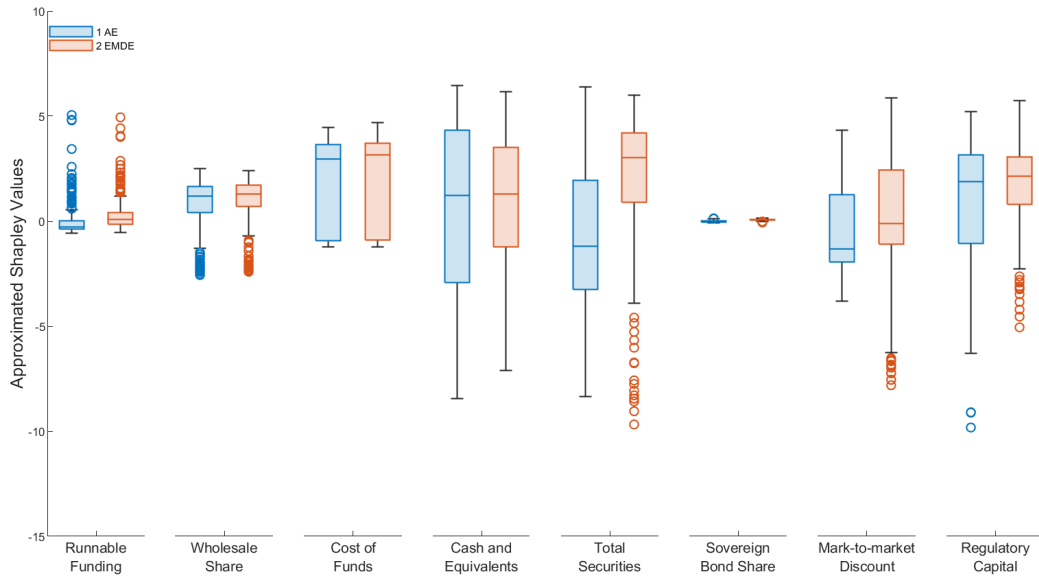


*Source:* S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

*Notes:* The graphs show how the 90th percentile of bank losses in AEs/EMs vary under alternative assumptions on the extra runoff for wholesale funding, relative to deposits, and the extra discount applied to any forced sales of other assets, relative to securities. Values are aggregates of bank-level results across all banks within AEs or EMs. All estimates are for the central scenario (20% deposit withdrawals at vulnerable banks).



Figure A.7: Drivers of losses across banks under the granular method



*Source:* S&P Capital IQ Pro, Bloomberg Back Office, IMF Sovereign Debt Monitor & IMF staff estimates.

*Notes:* Results shown for central scenario (20% withdrawals in vulnerable banks). Bars show the 25th, 50th and 75th percentiles of banks and dots show outliers. Outliers are values more than 1.5 times the interquartile range above (below) the 75th (25th) percentile. The whiskers extend to the maximum (minimum) value that is not an outlier. The relative importance scores for each variable  $i$  within each bank  $b$  are derived from the following process: (i) construct a set  $\mathbf{S}$  of 1000 hypothetical banks, with features representative of the population, by repeatedly sampling from the relevant group (i.e., AEs, EMs); (ii) take the value  $x_{bi}$  of variable  $i$  for bank  $b$ , and apply it to all the banks in  $\mathbf{S}$ ; (iii) calculate the change in losses for those banks, assuming that all variables except  $i$  stay the same; (iv) average this change in losses across all 1000 banks in  $\mathbf{S}$ . Values are multiplied by -1 so that a more negative number corresponds to larger losses.



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