FSB FINANCIAL STABILITY BOARD

Depositor Behaviour and Interest Rate and Liquidity Risks in the Financial System

Lessons from the March 2023 banking turmoil



23 October 2024

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Executive summary

Interest rates rose significantly across a number of advanced economies in 2022-23, following a decade where rates had remained at historically low levels. This long period of low rates likely contributed to higher duration and leverage across a range of financial institutions. Rate increases that began in 2022 were higher and faster than generally expected, resulting in significant valuation losses and sometimes precipitous increases in funding costs or liquidity risks, as was observed in some banks.

A number of deposit runs took place over this period, which represented the most serious disruption to the banking sector in more than a decade. The runs were the proximate cause of the collapse of Credit Suisse, a global systemically important bank. In the United States the runs caused the failure of three banks in close succession (Silicon Valley Bank (SVB), Signature and First Republic), and the voluntary liquidation of another bank (Silvergate) as its business shrank. This prompted further contagion, a broader loss of confidence, and deposit outflows at a number of other institutions. Significant official sector action was necessary to contain the episode. While the March 2023 turmoil was generally limited to banks, other types of financial institutions may have similar vulnerabilities to the confluence of interest rate and liquidity risks.

This report summarises the main findings from FSB work over the past year to: (1) assess vulnerabilities in the global financial system from the intersection of solvency and liquidity risks in an environment of higher interest rates; (2) investigate the deposit runs, including the role of technology, social media and interest rates on depositor behaviour; and (3) assess how the use of technologies may affect banks' and authorities' planning and execution of a resolution.

The analysis finds that the three entity types most vulnerable to the confluence of solvency and liquidity risks at the current juncture are banks, life insurers, and nonbank real estate investors. These entity types typically have a high proportion of interest rate-sensitive assets and liabilities and are affected by higher rates through various solvency and liquidity risk channels as follows:

- While most banks do not appear to be particularly vulnerable to the intersection of solvency and liquidity risks, there is a weak tail of banks that combines funding vulnerabilities and unrealised losses on their portfolio holdings, similar to what was observed for some of the banks that were involved in the March 2023 turmoil. The size of the banking sector, together with its role in funding other financial institutions, increase the importance of these vulnerabilities for financial stability.

- Life insurers' solvency would typically be improved by rising rates, thanks to the higher duration of their liabilities relative to their assets. However, their long-dated bond portfolios expose them to unrealised losses on the asset side, depending on the accounting framework they apply. These unrealised losses may need to be realised through asset sales if liquidity pressures materialise, e.g. due to policyholder redemption demands allowed by certain life insurance contracts. In addition, some life insurers use interest rate derivatives to hedge their duration gap, which exposes them to margin calls. From an interconnectedness perspective, these forced asset sales may put downward pressure on bond prices, with negative spillover effects to other investors. Furthermore, life insurers' investment portfolios provide significant funding to the real economy and to financial institutions, which could also be adversely affected.

- Nonbank real estate investors – comprising real estate investment trusts (REITs), real estate funds, and other nonbank mortgage lenders – can face delayed losses from higher rates since their asset valuations tend to occur less frequently, allowing for a deviation between reported asset valuations and fair market value. These investors are particularly exposed to commercial real estate, an asset class facing a number of headwinds. Leverage is used by some of these investors to boost returns, which exposes them to rising rates through the need to roll over funding. In addition, some real estate funds are open-ended and vulnerable to sizeable redemptions. Nonbank real estate investors receive a portion of their funding from entities outside their own jurisdiction, so any shocks on these entity types could be propagated across borders.

Further work to assess the identified vulnerabilities in these types of entities is being undertaken by the FSB and relevant standard-setting bodies (SSBs).

The analysis of past and recent deposit run episodes in FSB member jurisdictions reveals that:

- The speed of the recent deposit runs was very high on average, unprecedented in some cases, but heterogeneous. The three fastest deposit runs in March 2023 had outflows of around 20-30% per day. This was 2-3 times faster than the highest peak one-day outflow in an FSB member survey of past deposit runs, and multiples faster than the 1% per day average outflow of past deposit runs. However, not all of the recent deposit outflows occurred at this rapid pace.

- The scale of recent deposit runs, as a share of pre-run deposits, was large and in the upper range of outflows seen in past runs. The median deposit outflow of the recent runs, at 24% of pre-run deposits, was higher than the median of past deposit runs (10% of deposits). Furthermore, in constant US dollar terms, the outflows from Credit Suisse and First Republic were greater in size than the largest historical deposit runs.

- Banks experiencing the runs tended to have an unusually high reliance on uninsured deposits. Moreover, outflows from US banks were largely concentrated in uninsured deposits, and these deposits declined in all of the banks affected by runs.

- The concentration of the deposit base likely played a role in the large outflows. The runs tended to involve banks that had a high concentration of depositors, either by type of client (e.g. high net worth individuals or wealth management clients) or by industry (e.g. start-up firms, technology companies or clients with interests in crypto-assets).

There is some evidence that social media had an influence on some of the recent bank runs. Academic research has found that the failure of one of the US banks (SVB) was preceded by a large spike of communication about the bank on Twitter/X. The deposit runs at Credit Suisse were also associated with negative social media posts. That said, the corporate depositor and high net worth client categories that appeared to be at the centre of the recent runs are likely to have other information sources, while corporate treasurers look at equity and bond prices for signs of bank strains, so it is difficult to definitively assess the relationship between social media and runs. Nevertheless, there is the potential for social media to facilitate or accelerate future deposit runs through the propagation of information, including rumours or false information, as seen in past runs.

Technological advancements have facilitated an easier and faster transfer of deposits in recent years. Although mobile banking apps and online banking have been available for some time, their broad access and usage have increased in recent years by retail depositors. A wave of technological innovation is also taking place for corporate depositors, facilitated by open banking and Banking-as-a-Service. While there is little hard information to assess the relationship between technology and deposit runs, some jurisdictions report that developments in technology may have made depositors more willing to transfer funds between banks based on rates offered.

The recent deposit runs took place during an interest rate tightening cycle. If banks had reacted more to rising rates in this cycle than in the past, this might suggest they were facing more funding pressure. However, there is little evidence to suggest anything unusual about the repricing of deposit rates in the recent tightening cycle. By contrast, there is some evidence that banks' deposit mix may have become more sensitive to interest rate changes than in the past, perhaps as a result of technological innovations.

The findings in this report raise issues that are relevant for bank managers, supervisors, regulators, resolution authorities and policy makers. First, the speed of the deposit runs – where the velocity of outflows was significantly higher than has generally been thought likely – has implications for liquidity risk management practices and liquidity supervision, as it implies that bank managers, supervisors and central banks may need to be able to react much more quickly to deposit outflows than in the past. For example, banks could be encouraged to prepare in advance for quick access to existing central bank liquidity facilities in the event of a deposit run.

Second, in a few of the recent cases, the speed and magnitude of deposit outflows was so extreme that no amount of bank liquidity would have prevented the failures. This implies that bank managers, regulators and supervisors need to focus on ways to address the liquidity and solvency vulnerabilities that gave rise to such extreme outflows. At the system level, deposit-related vulnerabilities metrics may need to be developed for financial stability surveillance, with a focus on concentration measures and uninsured deposits.

Third, banks and authorities may wish to consider whether monitoring of social media could be helpful as an early warning tool to flag potential stress at a bank or wider turmoil that might affect banks.

The report has also noted a number of data gaps. For example, there is significantly less information available on bank deposits than bank assets, while the availability of public information on unrealised losses on bank securities portfolios, the level of uninsured deposits, and the number of deposit accounts is uneven across jurisdictions. Consideration could be given to collecting and publishing additional information in these areas in jurisdictions that do not provide this information, though the costs of this would need to be weighed against the benefits.

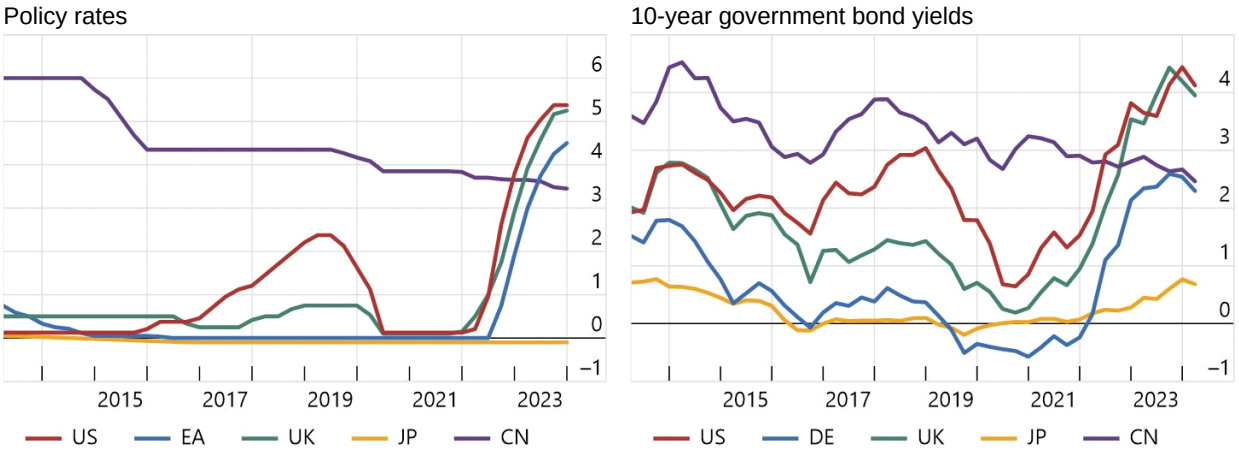
The possibility of further rapid deposit runs in the future also raises challenges for authorities' ability to execute a resolution. Since resolution timelines may be more compressed, authorities and banks should enhance operational readiness via, for example, ex-ante preparations and testing, with an emphasis on fast-fail scenarios. The potential for rapid spread of information, including through social media, also highlights the importance of incorporating effective communication strategies in banks' resolvability capabilities and authorities' preparations through communication networks among key stakeholders to ensure coordinated and consistent messaging.

Introduction

Over 2022 and 2023, interest rates rose significantly in a number of advanced economies, following a decade where rates had remained at historically low levels (Graph 1). This long period of low rates likely contributed to higher duration and leverage across a range of financial institutions engaged in liquidity and maturity transformation. Rate increases were higher and faster than generally expected, resulting in significant valuation losses and sometimes precipitous increases in funding costs or liquidity risks.

Policy rates and government bond yields, selected jurisdictions

In per cent **Graph 1**



Notes: US is for the United States, EA for the euro area, DE for Germany, UK for the United Kingdom, JP for Japan and CN for China.

Sources: BIS; Bloomberg; FSB calculations.

A number of bank deposit runs took place in the period following these interest rate rises, which represented the most serious disruption to the banking sector in more than a decade.[1] These deposit runs were the proximate cause of the collapse of a G-SIB (Credit Suisse) – only the second time that a G-SIB has failed since the G-SIB list was started in 2011 – and the failure of three US banks (SVB, Signature and First Republic) in close succession, and the voluntary liquidation of another (Silvergate) as its business shrank.[2] The US bank failures prompted further contagion in the US banking sector, with deposit outflows spreading to other institutions, illustrating that the failure of banks not designated as G-SIBs can lead to systemic events. Ultimately, this broader loss of confidence in banks was contained through official sector action to: (1) facilitate Credit Suisse's acquisition by UBS; (2) sell SVB (UK) to HSBC; (3) protect depositors at SVB and Signature using the systemic risk exception; and (4) provide central bank liquidity support to other banks that might be facing deposit runs.

Following these events, the FSB initiated work to: (1) assess vulnerabilities in the global financial system stemming from the intersection of solvency and liquidity risks in an environment of higher

1 See FSB (2023), *Promoting Global Financial Stability: 2023 FSB Annual Report*, October; and BCBS (2023), *Report on the 2023 banking turmoil*, October.

2 See the annual list of G-SIBs on the FSB website. The only other G-SIB that has failed was Dexia, which went into resolution in October 2011. Silvergate's business was largely based on providing banking services to clients active in crypto-asset markets. Although this report refers to Silvergate as having experienced a run, the very large deposit outflows at the end of 2022 (months before its voluntary liquidation in March 2023) were very different from a classic bank run. The outflows resulted from the massive pullback from crypto-asset markets following the collapse of FTX and not from a loss of confidence in the bank, per se.

interest rates; (2) investigate the deposit runs further, including by looking at the role of technology, social media and interest rates on depositor behaviour and deposit 'stickiness'; and (3) assess how the use of technologies may affect banks' and authorities' planning and execution of a resolution. The analysis drew on various data sources, FSB members' own analyses and survey responses, a review of the academic literature and stakeholder feedback. The main findings of this work, which complemented the review on lessons learnt for the FSB's resolution standard that was published last year,[3] are presented in this report.

The rest of the report is structured as follows: Section 1 (complemented by the Annex) presents an assessment of the types of entities most vulnerable to higher interest rates through their exposure to the confluence of solvency and liquidity risk and their interlinkages. Section 2 presents stylised facts about the recent deposit runs and examines the role of social media, technology and interest rates in the runs. Section 3 concludes with policy implications.

1. Interest rate and liquidity risk in the financial system

This section considers how higher rates – understood as parallel shifts in the yield curve – can affect the solvency and the liquidity of financial institutions. The work focuses on the direct impact of higher rates and not the second-order effects on credit losses and rating downgrades, which might also significantly affect the solvency of many entity types.

1.1. Framework used for the horizon scan

Rising rates can affect both sides of the balance sheets of financial institutions through liquidity and solvency channels. These two effects are not mutually independent: a solvency shock could trigger a run, while high redemptions can force institutions to sell and realise losses on the assets they hold, thereby affecting their solvency.

Solvency risks could materialise through three main channels:

1. *Mark-to-market channel*, where there are mark-to-market losses on investments in fixed-income securities. This economic channel can also act through the liability side of balance-sheets: in the case of insurers and defined benefit pension funds, rising rates reduce the present value of their liabilities by a larger measure than that of their assets, which dampen the overall effect on solvency.

2. *Delayed-loss channel*, where there is an accumulation of unrealised losses for securities registered at book value, which may need to be suddenly recognised on the institution's balance sheet and realised if the securities are sold.

3. *Profitability channel*, associated with the changes in the income on assets and changes in the cost of servicing or refinancing/issuing new debt. For banks this impact will be mainly through net interest margins, which depends on the maturity mismatch between assets and liabilities.

[3] See FSB (2023), *Bank failures: preliminary lessons learnt for resolution*, October.

Liquidity risks could materialise through three main channels:

1. *Redemption channel*, associated with cash outflows (e.g. outflows of deposits from banks, redemptions by investors in open-ended funds or surrenders of life insurance policies).

2. *Rollover channel*, if market participants providing wholesale funding decide not to renew their funding (akin to runs but in wholesale markets), or if the borrower does not have enough liquidity to repay its maturing debt or decides not to roll over due to higher cost of refinancing, or if banks do not have sufficient collateral to borrow from central banks.

3. *Margin channel*, where institutions face margin and/or collateral calls on derivative positions or securities financing transactions.

1.2. Comparison across entity types

The banking and NBFI sectors are of comparable size at the global level (Graph 2), though significant differences exist between jurisdictions. The relative size of various entity types may however evolve significantly over time, as a result of both valuation effects across asset classes and portfolio reallocation effects (e.g. movement of funds from banks to money market funds (MMFs)). A number of criteria (see below) can be used to assess the impact of rising rates on each of these types of financial institutions.

Financial system assets, 2022 **Graph 2**



Note: The split of the banking sector into types of banks is estimated using the proportion of assets from a sample of banks to total assets of the banking sector. For banks, UB = universal bank, IB = investment bank, CB = commercial bank, WB = wholesale bank, SL = specialty lender and SB = savings bank. For long-term investors, IC = insurance corporation and PF = pension fund. For funds, EF = equity fund and ETF, BF = bond and mixed fund and ETF, MMF = money-market fund and RE = real estate investment trust and fund. For other NBFI, BD = broker-dealer, HF = hedge fund, SFV = structured finance vehicle, FIN = finance company and TC = trust company

Source: Jurisdictions' submissions for the 2023 FSB Global Monitoring Report on NBFI (national sector balance sheet and other data); FSB calculations.

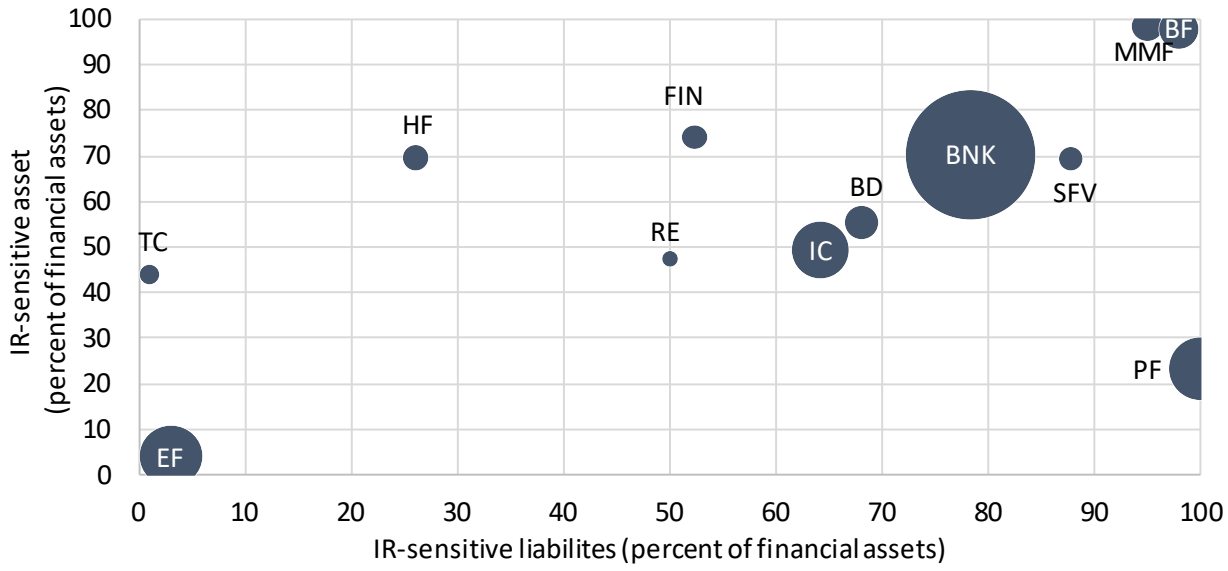
Interest rate sensitive assets and liabilities

One of the criteria that can be used as a rough proxy for financial institutions' potential exposure to rising rates is the proportion of interest rate (IR) sensitive assets and liabilities on the balance sheet of each entity type. IR-sensitive financial assets include fixed income securities, loans and repo assets, while IR-sensitive liabilities comprise debt issued, borrowing via loans and repo,

deposits, interest-rate sensitive long-term liabilities (e.g. pension fund liabilities) and other runnable liabilities (e.g. investors' shares in money market and bond funds). A limitation of the dataset is that it is not possible to distinguish shares of bond and money market funds in the 'non-IR-sensitive' asset category. Therefore, the approach underestimates the sensitivity of the assets to interest rates.[4]

Graph 3 shows the types of entities most exposed to changes in interest rates based on the financial assets and liabilities side on their balance sheets. Bond funds and money market funds are the most exposed to interest rate risks, as their assets are entirely IR-sensitive, while they have runnable liabilities in the form of investors' shares in the funds. Since MMFs invest in short-term assets, their sensitivity to interest rate movements should be lower than for bond funds with long maturity. Banks also have significant IR-sensitive assets and liabilities. Other entities that have a high proportion of IR-sensitive assets and liabilities are broker-dealers, securities financing vehicles, finance companies, hedge funds (a greater sensitivity is expected for those investing in fixed income assets), life insurance companies and real estate funds. This analysis however does not take into account the duration of assets or any off-balance sheet hedges (e.g. derivatives) and does not distinguish between fixed and floating rates for these types of entities.

IR-sensitive assets and liabilities, 2022 **Graph 3**



Note: IR-sensitive assets are loans (including repo assets) and securities. IR-sensitive liabilities include wholesale funding (repo liabilities, debt issued and loan borrowing), deposits, other runnable liabilities and long-term liabilities. The size of the bubbles is proportional to total assets. Some jurisdictions only provide data for credit hedge funds. Life insurance companies are likely to have higher IR-sensitive assets and liabilities than the total insurance company sector shown in the graph. For real estate funds, the assumption used was that half of the liabilities are runnable, in the absence of quantitative data.

Source: Jurisdictions' submissions for the 2023 FSB Global Monitoring Report on NBFI (national sector balance sheet and other data); national flow of funds statistics; FSB calculations.

[4] For example, pension funds and insurers hold shares of bond funds, which cannot be identified. Further, in the absence of data on the share of open-ended real estate funds, real estate liabilities could not be quantitatively split between "other runnable liabilities" and "long-term liabilities".

Balance sheet measures of solvency and liquidity risks

Another way to compare entity types to determine which are the ones most vulnerable to rising interest rates is to use balance-sheet data to calculate a set of metrics of their solvency and liquidity risks. These metrics are grouped as follows: (i) net interest rate exposure, (ii) funding structure, (iii) asset liquidity, (iv) asset risk and solvency, (v) profitability, and (vi) valuation. This analysis excludes mutual funds, MMFs and private funds.[5]

Entity types are grouped to allow comparison between entities with similar business model or asset exposure. Finance companies are split between those engaging in mortgage lending (referred to as mortgage lenders in Graph 4) and those lending to the retail sector or the non-financial corporation sector, as the former are thought to be closer to mortgage real estate investment trusts (REITs) than other finance companies.

Each metric is computed for a cohort of 1,781 individual institutions (for a total of $174 trillion in assets). For each entity type the analysis looks at (i) the median value and (ii) the value of the most vulnerable decile. These values help determine a rank for each entity type and each metric. This results in a heatmap showing the entity types with the largest median and tail values, which suggest different levels of solvency and liquidity risks (Graph 4).

While the median score for banks is relatively low, there is a weak tail which may be vulnerable to solvency and liquidity risks. Finance companies, whose business model can be close to that of banks though their funding is mostly wholesale (and often short-term), appear to be moderately vulnerable. Broker-dealers score relatively well compared to other entity types. Equity and mortgage REITs, as well as mortgage lenders, appear to have significant vulnerabilities. Some life insurers in the tail score high on some of the metrics indicating asset liquidity vulnerabilities, but overall, the metrics in this analysis do not reflect certain balance-sheets specificities for these firms, which militates for a more tailored approach (see section 1.3).

[5] MMFs and mutual funds are excluded because they are 'pass-through' vehicles (i.e. losses affect the solvency of their investors), although they may be subject to liquidity mismatch risk that could amplify investors' losses and negative market dynamics.

Heatmaps of sector rankings by financial statement indicator

Graph 4

Ranking based on median of peer group

	Banks	Finance companies	Broker-dealers	Equity REITs	Mortgage lenders	Mortgage REITs	Life insurers	P&C insurers
Net interest rate exposure								
Interest-earning assets / interest-bearing liabilities	5	3	6	1	4	2	7	6
Funding structure								
Wholesale funding / total assets	6	3	5	4	1	2	7	6
Wholesale (non-deposit) funding / total funding	6	1	1	1	1	1	7	6
Wholesale funding / interest-earning assets	6	4	5	1	3	2	7	6
Wholesale funding / illiquid credit & investment assets	6	5	2	1	3	4	7	6
ST wholesale funding / total assets	3	5	1	6	4	2	7	1
ST wholesale funding / total funding	3	5	1	6	4	2	7	6
Asset liquidity								
Liquid assets / total assets	5	4	6	1	2	3	7	2
Liquid assets / ST wholesale funding	5	2	6	4	3	1	5	6
Cash / total assets	4	5	6	1	2	3	7	6
Cash / ST wholesale funding	6	3	5	4	2	1	1	1
Cash & marketable securities / assets	5	4	6	1	2	3	1	1
Illiquid credit & investment assets / assets	4	3	6	5	1	2	7	4
Asset risk and solvency								
Total securities % assets	2	4	1	5	6	3	2	1
Long-term securities % shareholders' equity	1	5	2	4	5	3	4	2
Borrowings / equity	1	4	5	6	2	3	6	7
Shareholders' equity / assets	2	3	5	6	1	4	1	4
Profitability								
ROAA	3	5	4	6	1	2	3	7
Valuation								
Price / book value	3	2	5	4	6	1	7	7

Fatness of weak tail – Ranking based on worst decile

	Banks	Finance Companies	Broker-dealers	Equity REITs	Mortgage lenders	Mortgage REITs	Life insurers	P&C insurers
Net interest rate exposure								
Interest-earning assets / interest-bearing liabilities	6	1	8	4	7	3	5	2
Funding structure								
Wholesale funding / total assets	4	7	3	5	1	8	2	6
Wholesale (non-deposit) funding / total funding	7	5	2	3	4	1	8	6
Wholesale funding / interest-earning assets	2	4	8	1	7	5	3	6
Wholesale funding / illiquid credit & investment assets	1	6	2	5	7	3	4	8
ST wholesale funding / total assets	3	4	1	5	8	2	6	7
ST wholesale funding / total funding	2	1	3	3	3	3	3	3
Asset liquidity								
Liquid assets / total assets	7	5	8	3	6	1	2	4
Liquid assets / ST wholesale funding	6	4	7	2	5	1	3	8
Cash / total assets	2	5	8	3	6	4	1	7
Cash / ST wholesale funding	5	7	3	4	6	1	2	8
Cash & marketable securities / assets	6	3	7	1	4	2	8	5
Illiquid credit & investment assets / assets	7	5	3	1	6	8	4	2
Asset risk and solvency								
Total securities % assets	1	6	2	3	7	4	5	8
Long-term securities % shareholders' equity	1	4	6	3	8	7	5	2
Borrowings / equity	3	6	2	5	1	7	8	4
Shareholders' equity / assets	4	8	2	7	1	3	6	5
Profitability								
ROAA	2	6	5	1	7	4	3	5
Valuation								
Price / book value	1	6	5	2	7	3	4	1

Notes: The number in each cell is the ranking of the indicator's value across entity types. 1 means that the indicator ranked the worst. Mortgage lenders are a subset of finance companies engaging in mortgage lending. Liquid assets are taken as cash and equivalents plus short-term trading securities; illiquid credit and investment assets include loans, property investments and other long-term investments other than marketable securities; wholesale funding are all repayment obligations other than deposits; short-term (ST) wholesale funding is all non-deposit instruments due for repayment in the short-term (it includes interbank and money market instruments as well as other assets with a maturity of less than a year); ROAA stands for return on average assets.

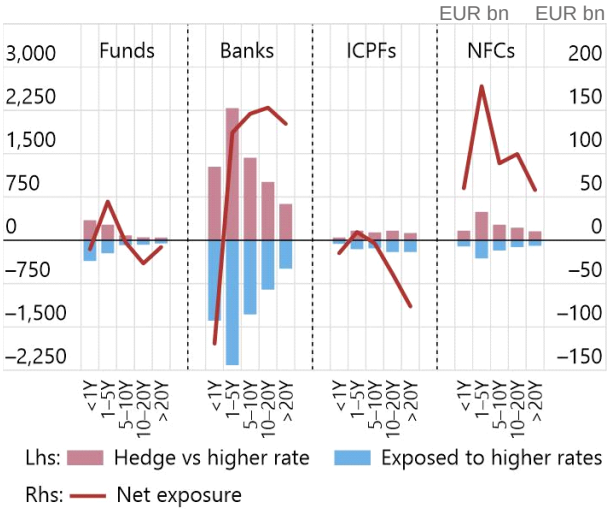
Source: SNL; FSB calculations.

Susceptibility to margin and collateral calls

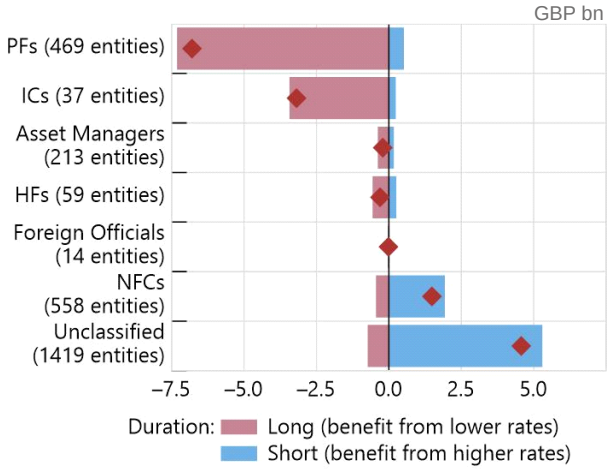
Many financial intermediaries take on interest rate derivative (IRD) positions, typically to hedge balance-sheet exposures against a change in interest rates, but also as part of their market-making (broker-dealers) or simply their business model (central counterparties or CCPs). Those hedging against a decrease in interest rates would have to pay variation margin calls when the rate increases. Using trade repository data from the European Economic Area (EEA) and the United Kingdom, this section seeks to identify which entity types use interest rate derivatives and whether they face liquidity needs when interest rates increase. In the jurisdictions analysed, insurers are the entity type that would have to pay a larger amount of variation margin if interest rates increase (Graph 5).

Exposure to IRDs per sector **Graph 5**

Exposure to IRDs by maturity buckets in the EU[1]



Sensitivities to 100bps increase in GBP interest rates in the United Kingdom[2]



[1] Data are netted at individual institution level and then grouped by sector. [2] Based on SONIA interest rate swap markets as of 30 November 2023. PFs is for pension funds, ICs for insurance companies, HFs for hedge funds, NFCs for non-financial corporates. Investors were allocated to an investor group using a best-endeavour sectoral classification.

Note: The analysis for the EEA and the UK cannot be directly compared since EU calculations are based on gross notionals, while the study on the UK is based on sensitivity.

Sources: ESMA; UK EMIR trade repository data; FSB calculations.

Exposure to different solvency and liquidity channels

The analysis has also considered the main entity types in isolation, making use of publicly available data to assess the relevance of each of the solvency and liquidity channels. Entity types which combine liquidity and solvency channels are more relevant, since these channels may interact and create a negative feedback loop.

Among the channels, some may have more importance for a forward-looking assessment than others. The delayed-loss and rollover channels can take time to affect the balance-sheet of institutions. Even if rates do not increase from their current level, these channels may not have fully transmitted previous increases in interest rates yet, and so the impact could materialise at some time in the future if rates remain high. The Annex provides details for the banking sector and certain nonbank entity types assessed as important in the context of rising interest rates.

Banks, life insurers and real estate investment trusts and funds (REITFs) are the entity types with the highest number of channels potentially at play. Banks, life insurers, REITFs, private credit/equity funds, and finance companies are affected by rising rates through the delayed-loss and rollover channels. These entity types may therefore be most vulnerable to rising rates.

1.3. Takeaways from the analysis

The key takeaways from the various analyses of the entity types most vulnerable to the confluence of solvency and liquidity risks in a context of rising rates are as follows:

- When considering the amount of interest rate sensitive assets and liabilities, banks and bond funds appear most vulnerable.
- When considering financial statement indicators, nonbank entities exposed to real estate stood out as most vulnerable. The indicators for banks generally did not score high, though they identified a weak tail of banks that might be vulnerable as well (see also the Annex for details).
- When considering the susceptibility to margin and collateral calls following an increase in interest rates, life insurers appeared more exposed than other entities.
- When considering the various transmission channels, banks, life insurers and REITFs were the entity types with the highest number of channels potentially at play. In addition, looking at the delayed-loss and rollover channels, private credit and equity funds, and finance companies can also be identified as vulnerable.[6]

In conclusion, it appears that the group of entity types most vulnerable to the confluence of interest rate and liquidity risks is banks – and in particular a weak tail in the banking sector – life insurers, and nonbank real estate investors. There is a second group of entity types that appear vulnerable in some of the analysis but to a lesser extent. These are (a) bond funds, in particular those with holdings of greater duration and illiquid assets; (b) highly leveraged hedge funds holding fixed income assets; and (c) private credit/equity funds, which can face delayed losses due to the infrequent valuation of their asset holdings and which may be affected by all types of liquidity risk channels.

2. Depositor behaviour, technology and social media

This section investigates the 2022-23 deposit runs and develops a set of stylised facts, comparing these runs to the past. It also assesses the role of social media, technology and interest rates in those runs.

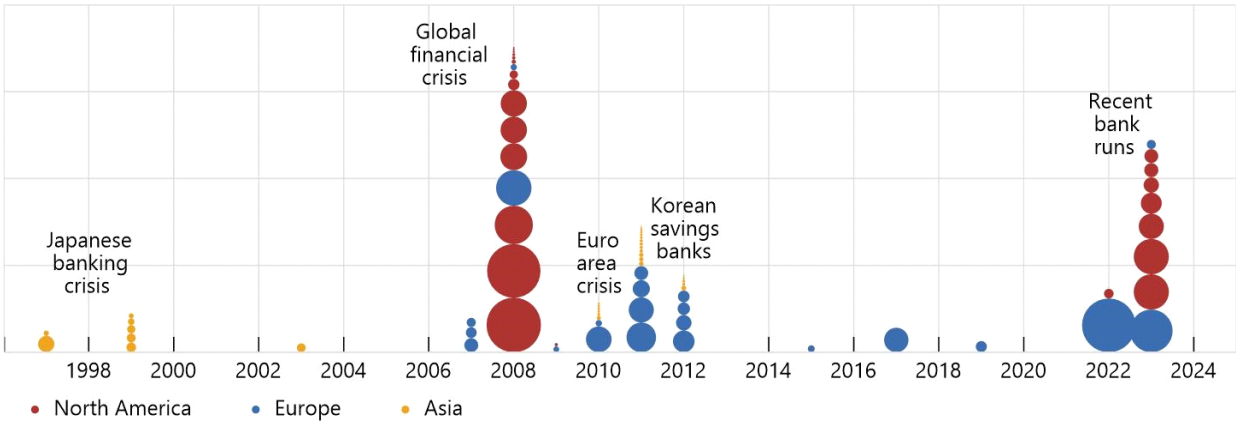
To compare recent deposit runs to past runs, FSB members provided information on notable deposit run episodes in their jurisdiction in recent decades. The survey results include more than 70 different banks that have faced deposit runs, including the five banks that failed or were

6 However, the data used did not permit distinguishing finance companies involved in real estate lending from others.

liquidated in March 2023 (Graph 6).[7] The results are clustered around different crises, with episodes from the Japanese banking crisis in the late 1990s, the 2008 global financial crisis, the euro area crisis of 2010-12, the Korean savings banks episode in 2010-12 and the deposit runs in 2022-23.

Bank deposit run survey results **Graph 6**

1. Deposit run episodes over time[1]



[1] The size of the circles is proportional to the level of pre-run deposits in USD.

Source: FSB calculations.

There are a number of caveats associated with the survey that should be borne in mind. First, the survey did not use quantitative criteria to select the banks in each jurisdiction that had notable deposit runs. Second, the survey respondents generally relied on publicly available information. Third, the use of such information, rather than more detailed supervisory data, may lead to some measurement errors; in particular, some episodes involving banks that survived runs would not be included in the survey if the run was not publicly reported. Finally, there are data gaps, with certain pieces of information unavailable for some of the deposit runs.

2.1. Stylised facts about the deposit runs

While the triggers that sparked the deposit runs were diverse, ranging from a series of incidents at Credit Suisse to a failed capital raise at SVB, the survey responses suggest that the runs followed a build-up of significant vulnerabilities at these banks:

- *Rapid growth*. In the years leading-up to the banking turmoil, the growth in bank balance sheets was pronounced at several of the banks that later experienced runs. Bank deposits swelled, including uninsured deposits, largely as a result of the combination of pandemic-related support packages and quantitative easing, and banks' fixed-income assets and loan books built up rapidly.

[7] The results mainly include deposit runs in the period from 1997-2023, though there is also one bank run from the 1970s and one from the 1980s, and encompasses bank runs from a range of jurisdictions. The data also treat different phases of a deposit run at a bank as separate events, and also count runs involving more than one bank as separate runs, so there are about 80 distinct deposit runs in the survey results.

- *Poor management*. At some banks, the growth in bank balance sheets took place without sufficient management of increasing interest rate, liquidity and operational vulnerabilities.[8] These included large exposures to long-duration bond portfolios, a surge in uninsured deposits and depositor concentrations (e.g. industries, types of clients, or individual depositors with large balances).[9]

- *Asset impairment*. The long-duration bond portfolios left some banks exposed to the rise in market interest rates, leading to realised and unrealised losses on their securities holdings, and prompting concerns from depositors about the banks' solvency.

- *Liquidity mismatches*. The decline in the market value of securities meant that the longer-term bond holdings at some banks could not be used to raise liquidity to meet deposit outflows as realising the resulting losses could have led to their insolvency.

Contagion also appeared to be at work in the recent deposit runs, and this was due not only to similarities in bank assets, but also their liabilities. Following the problems at SVB and Signature, depositors and investors became concerned about other banks with similar characteristics, such as large unrealised losses on bond portfolios and a high proportion of uninsured deposits.[10] This implies that contagion occurred not only due to similarities on the asset side of the balance sheet – the unrealised losses – but also due to similarities on the liabilities side of the balance sheet – high reliance on uninsured deposits. Quarterly data from Q4:2022 shows that the US banks that failed or were liquidated in the recent period tended to have a high proportion of uninsured deposits and either a relatively low capitalisation – after adjusting for unrealised losses – or a relatively high concentration of deposits (Graph 7).

8 Poor management at Credit Suisse led to repeated incidents, including financial losses resulting from exposure to Greensill and Archegos, as well as scandals (e.g. Mozambique case and surveillance affair), large fines and supervisory enforcement actions, that led to growing uncertainty about the bank's business model, franchise value and solvency. See Swiss National Bank (2023), *Financial Stability Report 2023*; FINMA (2023), *Lessons learned from the CS crisis*, December; and FSB (2023), *2023 Bank Failures: Preliminary lessons learnt for resolution*, October.

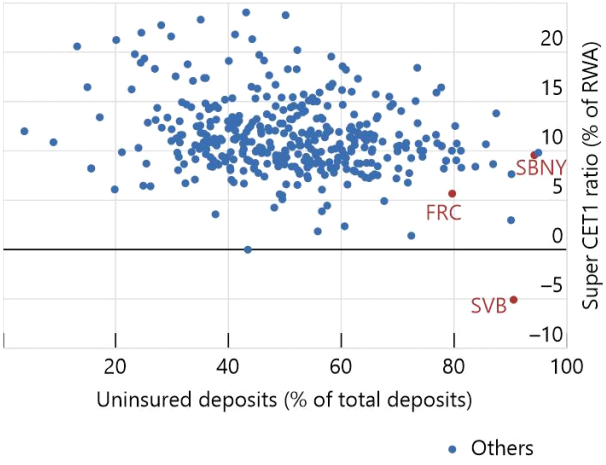
9 Depositors at SVB were concentrated in the technology start-up and venture capital sectors; Credit Suisse and First Republic had significant deposits from high net-worth individuals; while Silvergate and Signature bank had large deposits from crypto-asset related customers. See Gruenberg (2023), Recent bank failures and the Federal Regulatory Response, March.

10 See, for example, Choi et al. (2023), *Contagion effects of the Silicon Valley bank run*, August.

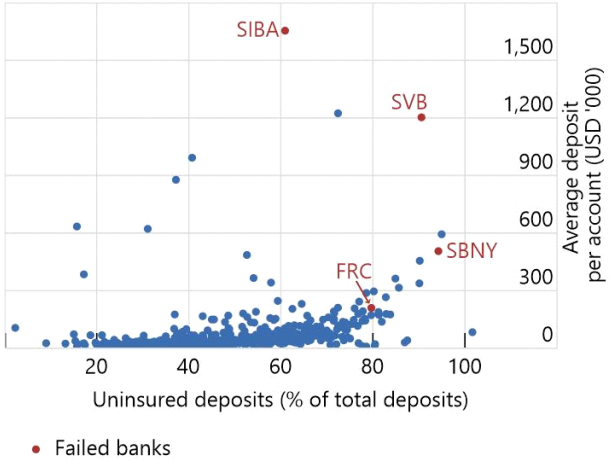
US bank vulnerability metrics, Q4:2022

Graph 7

1. Capitalisation and uninsured deposits[1]



2. Deposit concentration and uninsured deposits[2]



Others Failed banks

FRC=First Republic; SBNY=Signature; SIBA=Silvergate; SVB=Silicon Valley all shown with red dots.

[1] Capitalisation is shown as CET1 capital less unrealised losses on held-to-maturity and available-for-sale securities, as a percent of risk-weighted assets. Note that unrealised losses on AFS securities are excluded for the G-SIBs and other banks that already recognise these losses in CET1 capital. [2] Concentration is proxied by the average deposit balance per account at each bank.

Sources: S&P Capital IQ; FSB calculations.

Overall, the recent deposit runs were sizeable, with several banks having much larger outflows than in the past. One comparison metric is the size of the outflow, measured in constant (2022) US dollar terms.[11] This metric suggests that the size of the Credit Suisse October 2022 deposit outflow was far larger than any other deposit run in the survey (Graph 8, panel 1). In addition, the outflows at First Republic and Credit Suisse in March 2023 were also larger than any of the historical episodes. SVB's deposit outflow, however, was similar to some past deposit runs. The size of the other recent deposit runs was within the range of past runs.

The scale of the recent deposit outflows, measured as a percentage of pre-run deposits at each bank, was concentrated in the upper third of historical episodes (Graph 8, panel 2). The First Republic and Silvergate deposit runs were the first and third largest on this metric, but similar to some of the largest historical deposit runs (e.g. Continental Illinois). The median deposit outflow of the recent runs, at 24% of deposits, was higher than the median of the past deposit runs in the survey (10% of deposits).[12]

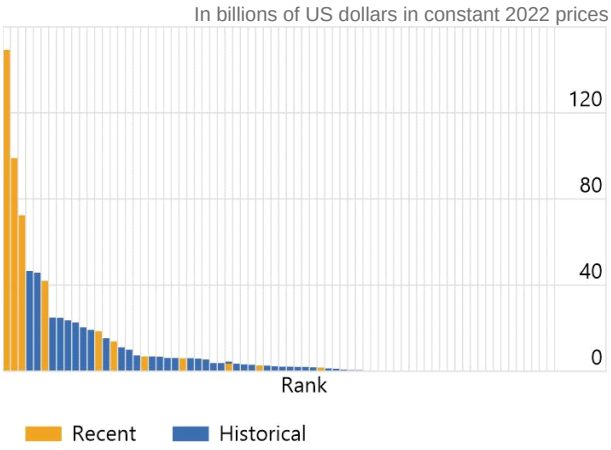
[11] The workstream also looked at other metrics for the size of the deposit runs, including the level of the deposits at a bank facing a run relative to GDP in that jurisdiction and the level of deposits relative to total deposits in the banking sector in that jurisdiction. However, these metrics are not used in this report as they tended to reflect differences in the characteristics of banking sectors across jurisdictions (e.g. the size of the sector relative to the size of the economy or the number of banks in the sector) rather than differences in the deposit runs.

[12] This metric may provide a rosier picture of some runs because it does not include outflows that were requested, but not executed, prior to the bank's failure. Including such "planned" outflows would increase the scale of the SVB run to more than 80% of deposits and the scale of the Signature Bank run to 30% of deposits. Such planned outflows were excluded due to a lack of historical data.

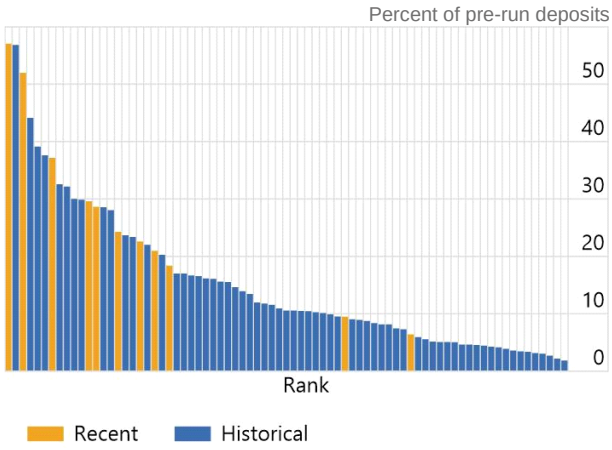
Size and scale of bank deposit runs

Graph 8

1. Size of deposit outflows[1]



2. Scale of deposit outflows[2]



[1] The graph shows the size of the outflow in each episode, converted to US dollars and then to constant 2022 prices using the US consumer price index. [2] The graph shows outflows over the deposit run episode as a whole rather than over a constant time period.

Source: FSB calculations.

There was a wide variation in the length of the recent deposit runs. The survey shows that runs at SVB, SVB (UK) and Signature Bank only occurred for one day (Graph 9, panel 1). At the other end of the spectrum, Credit Suisse's October 2022 and March 2023 deposit outflows occurred for around 40 and 20 business days, respectively. The most acute run phases occurred for around 5 days in both runs and accounted for a large proportion of total deposit outflows. After these acute phases, deposit outflows continued at a much slower pace for a certain time ("cooling phase") until they finally came to a halt. Overall, Credit Suisse's March run was not far from the average length of the deposit run in the survey (17 days). However, the length of a deposit run is also contingent upon actions by authorities. In the case of Credit Suisse, the severe outflows stabilised after measures taken by the Swiss authorities from mid-March. The outflows then continued at a slower pace until around the end of the month when they came to a halt. Without these interventions, outflows might instead have increased further and the run may have accelerated.

The speed of some of the March 2023 deposit runs was different from past runs, with several of the runs unprecedented in their velocity. One way of measuring the speed of the runs is to look at the average daily outflow (as a share of pre-run deposits) over the whole deposit run in the survey (Graph 9, panel 2). Most of the recent bank runs were faster than any of the historical runs in the survey. However, some of the recent runs were not particularly fast by historical standards, including the combined episode at Credit Suisse (i.e. taking into account both the acute and cooling phase).[13] The median speed for the recent deposit runs was 7% per day, much higher than the 1% per day median of past deposit runs. These averages are dwarfed by the speed of the SVB (UK), SVB and Signature deposit runs that ranged from 20-30% per day.[14]

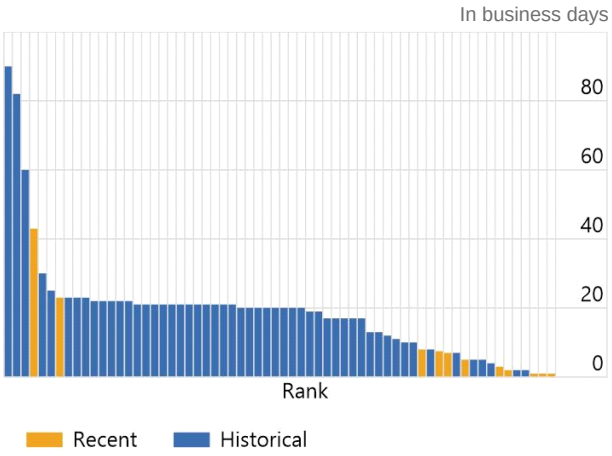
[13] For Credit Suisse, there were considerable deposit outflows in short periods of time during the acute phase. Outflow rates for retail deposits, in particular those with a high value, were significantly higher than was assumed under liquidity regulations. See Swiss National Bank (2024), *Financial Stability Report 2024*.

[14] Including planned outflows would increase the speed of SVB's deposit run to more than 40% per day.

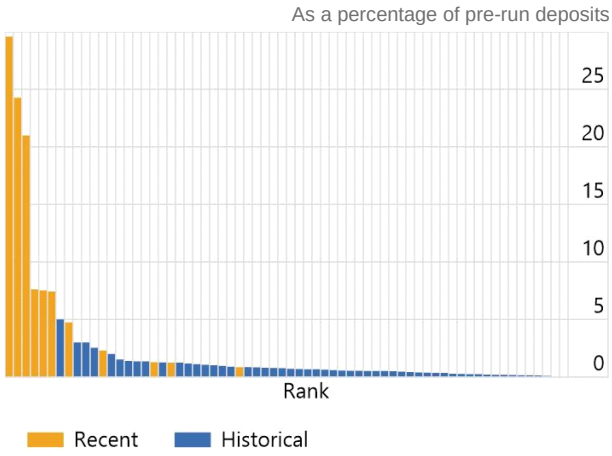
Length and speed of bank deposit runs

Graph 9

1. Duration of deposit runs



2. Average daily outflow of deposit runs

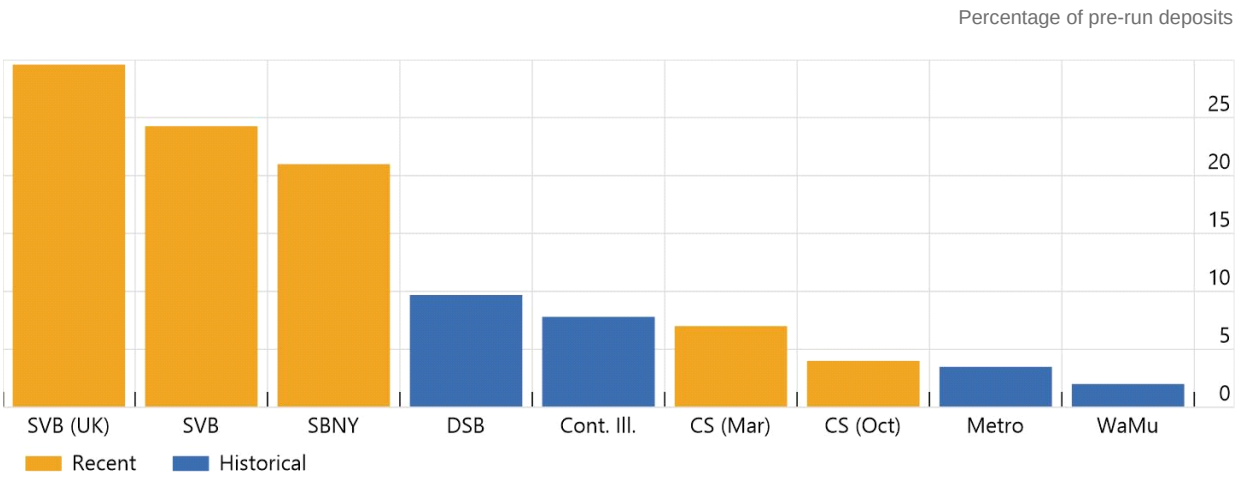


Source: FSB calculations.

The speed of the recent deposit runs can also be shown by the peak one-day outflow. Such a metric looks at the maximum outflow faced by a bank in one day and confirms that the deposit runs at SVB and Signature were unparalleled in their speed (Graph 10). As these runs occurred within one day, the speed is the same as the average daily outflow, but it is interesting to also compare peak outflows for deposit runs that occurred for a longer amount of time. Unfortunately, this information is only available for a small number of the deposit runs in the survey.

Peak one-day deposit outflow

Graph 10



Source: FSB calculations.

Qualitative information suggests that the recent bank runs mostly involved larger depositors. The available information suggests that the recent runs largely involved wealth management clients and high net worth individuals (Credit Suisse and First Republic), crypto-asset related depositors (Silvergate and Signature) and start-up businesses or other large corporates (SVB and Signature) (Table 2). In addition to concentration by type of depositor, it is possible that a

relatively small number of depositors may have played a significant role in the runs.[15] Though not definitive, it is worth noting that the largest 8 depositors at SVB – excluding intracompany deposits – accounted for about 5% of total deposits.[16] Retail depositors did not appear to play a significant role, other than in the March 2023 Credit Suisse run. Recent research, using high frequency data from payment systems, also finds that the recent US deposit runs were driven by large institutional depositors.[17]

Types of depositors involved in the recent runs

Table 2

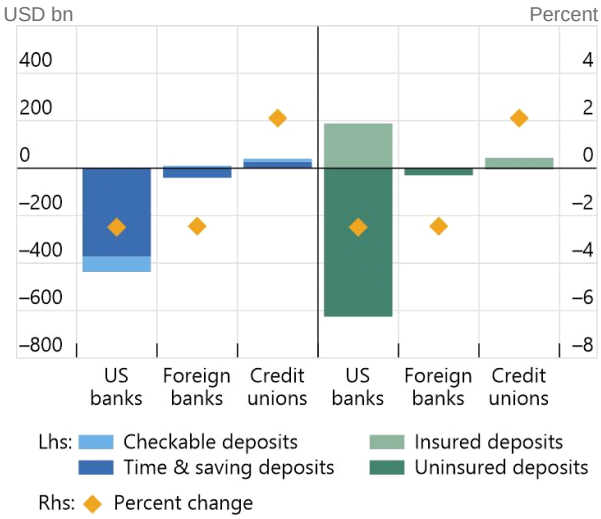
Bank	Start of deposit run	Types of depositors involved in the run
Credit Suisse	Oct 22 and Mar 23	Wealth management clients, corporates and, in Mar 23, retail depositors
Silvergate	Nov 22	Crypto-asset related depositors
Silicon Valley Bank	Mar 23	Large commercial clients and start-up businesses
Signature Bank	Mar 23	Crypto-asset related depositors and large commercial clients
First Republic Bank	Mar 23	High net worth individuals

Source: FSB.

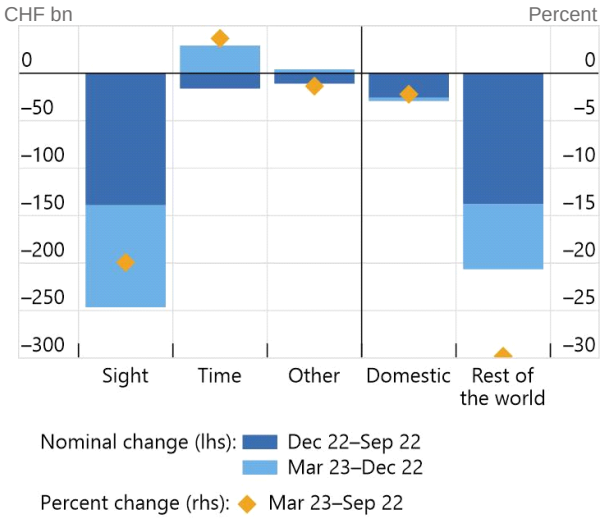
Change in banking sector deposits

Graph 11

1. US banking sector, Q1:2023-Q4:2022



2. Swiss banking sector, Mar 2023-Sep 2022



Sources: Swiss National Bank; Board of Governors of the Federal Reserve System; FSB calculations.

Aggregate banking sector statistics suggests that most of the recent outflows were in non-time and uninsured deposits. In the United States the outflows in March 2023 were in savings

15 Silvergate's run was concentrated in crypto-asset clients, who withdrew 68% of their funds; at Signature Bank, the largest 60 and four depositors accounted for 40% and 15% of deposits respectively. See Rose (2023), Understanding the speed and size of bank runs in historical comparison, *Economic Synopses* No. 2012, Federal Reserve Bank of St. Louis, May.

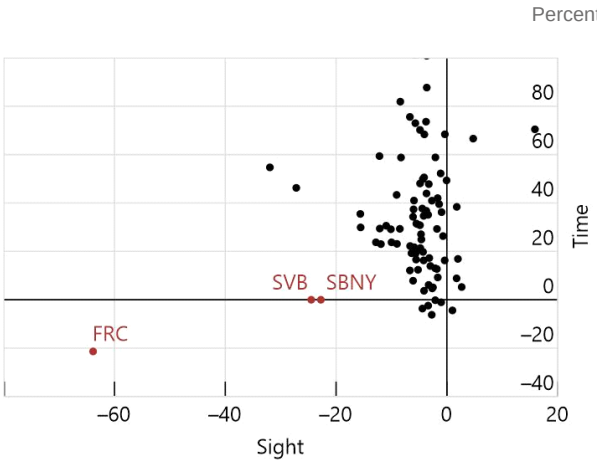
16 See Financial Times (2024), "Y2K23's Y2K moment: blaming the internet for bank runs", February.

17 Cipriani et al. (2024), Tracing bank runs in real time, *Federal Reserve Bank of New York Staff Reports* No. 1104, May.

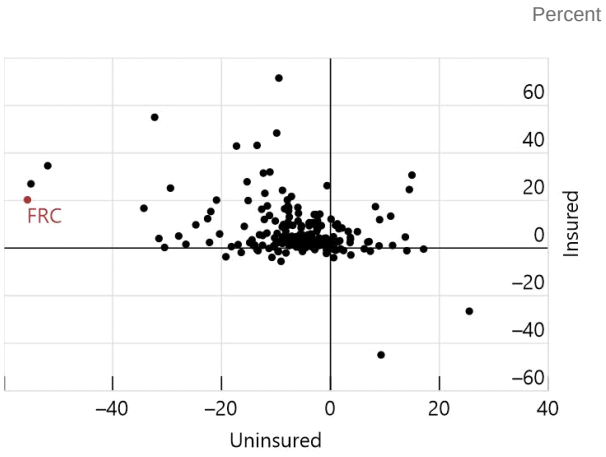
deposits and in uninsured deposits (Graph 11, panel 1).[18] The outflows from the banking sector in Switzerland were also in non-time (or sight) deposits and were almost entirely by non-resident depositors (Graph 11, panel 2). Data for individual US banks confirms that outflows were largely in sight and uninsured deposits, though with significant heterogeneity across banks (Graph 12).

Change in US bank deposits, Q1:2023-Q4:2022[1] **Graph 12**

1. US bank time and sight deposits[2]



2. US bank uninsured and insured deposits[3]



[1] This chart shows US banks with a deposit level that is greater than $10 bn. [2] Note that for SVB and SBNY it is assumed that time deposits were unchanged. [3] Data on insured and uninsured deposits are not available for SVB and SBNY.

Sources: S&P Capital IQ; FSB calculations.

Although some of the deposit outflows in the recent runs were recycled to other banks, the banking sectors experienced net outflows in aggregate. US statistics suggests that funds withdrawn from the banking sector were reallocated to MMFs. However, this reallocation of funds in Q1:2023 was likely not only due to the deposit runs, but also because households were reallocating their assets to take advantage of the higher rates on offer at MMFs in a period of rising rates. In Switzerland, it is more difficult to track where the deposits that left the banking system were sent as non-residents were involved.

2.2. Role of social media

Although it is difficult to draw definitive conclusions, there is some evidence that social media had an influence on the recent deposit runs. One academic study has documented a large spike of communication about SVB on Twitter/X on 9 March, the day the run started.[19] The study also documented larger stock price declines following the start of the run on SVB for banks with a higher intensity of pre-run Twitter/X conversations with an even stronger effect for banks with similar vulnerabilities to SVB, including mark-to-market losses and uninsured deposits. There is no conclusive evidence of a similar effect for deposit outflows around the time of the runs.[20]

[18] Savings deposits are the largest category of deposits for US banks, and so it is not surprising to show up prominently in outflows.

[19] Cookson et al (2023), Social media as a bank run catalyst, *Université Paris-Dauphine Research Paper*, July. See also Kotlikoff and Miller (2023), Fixing banking for real, VOXEU CEPR blog post, April.

[20] Stronger evidence of social media affecting deposit flows can be found in study of Italian banks, where negative Twitter sentiment was found to correspond with lower growth rates in retail deposits, particularly in distressed banks. See Accornero and Moscatelli (2018), Listening to the buzz: social media sentiment and retail depositors' trust, Banca d'Italia Temi di Discussione, February,

Credit Suisse also faced negative posts on social media from 1 October 2022, prior to its first run, with a tweet alleging problems at an 'unnamed major international investment bank'.[21] Its second deposit run was also associated with viral social media posts, in the form of messages and videos about one of its main shareholders ruling out further capital injections.

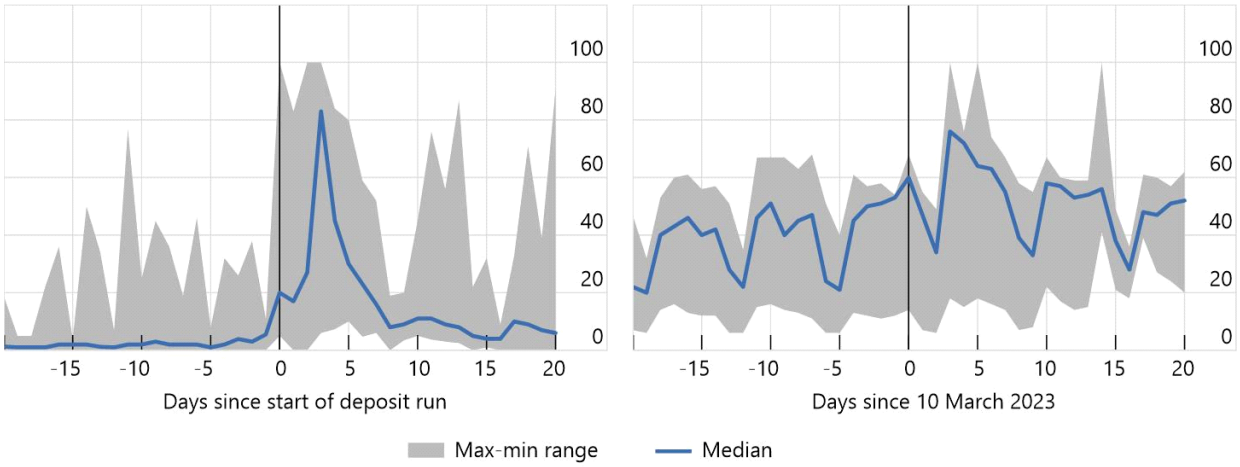
Internet searches about the banks facing the recent deposit runs surged (Graph 13, panel 1). While this does not measure social media posts directly, internet searches are likely to be correlated to social media posts.[22] Internet searches about G-SIBs that did not experience deposit runs had instead no clear pattern (Graph 13, panel 2).

Internet searches of banks[1]

Index: highest number of searches = 100 **Graph 13**

1. Banks in recent deposit runs

2. Selected G-SIBs



[1] The graph shows internet searches for individual bank names, indexed so the highest number of searches over the quarter is shown as 100. Panel 1 includes the banks involved in the recent bank runs, centred around the start of the deposit run. Panel 2 includes G-SIBs that were not involved in bank runs (BNP Paribas, Bank of America, Deutsche Bank, HSBC and JPMorgan), centred around 10 March 2023 when the deposit runs at several banks were ongoing.

Sources: Google Trends; FSB calculations.

The corporate depositors and high net worth clients that appeared to be at the centre of the recent runs are likely to have other information sources, suggesting some caution about the role of social media in these runs. The startup community involved in the SVB deposit run was highly connected through social media before the run and used social media to exchange information about the bank during the runs.[23] Corporate treasurers may additionally pay attention to bank equity and bond prices that could provide information on strains at banks. Indeed, share prices at the banks facing recent deposit runs tended to fall before the runs started, and fell by more than the shares of banks that did not face runs (Graph 14).

[21] The post said, "Credible source tells me a major international investment bank is on the brink", David Taylor, 1 October 2022.

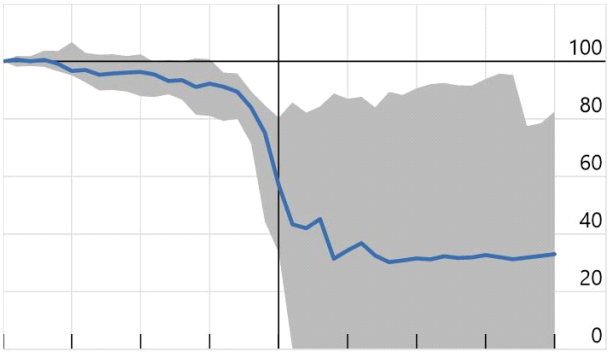
[22] The analysis is based on internet searches using Google Trends data as a proxy.

[23] Cookson et al (2023).

Bank equity prices[1] **Graph 14**

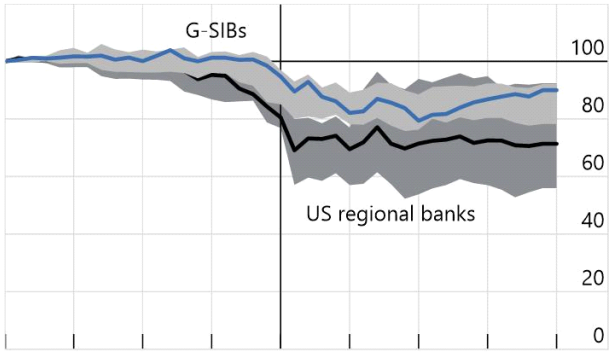
1. Banks in recent deposit runs

Index: 20 days before start of run=100



2. Selected banks

Index: 20 Feb 2023=100



Max-min range Median

[1] Panel 1 includes the banks involved in the recent bank runs, centred around the start of the deposit run. Panel 2 includes G-SIBs that were not involved in bank runs (BNP Paribas, Bank of America, Deutsche Bank, HSBC and JPMorgan), and 10 of the largest members of the S&P US regional banks index that did not face bank runs, again centred around 10 March 2023 when the deposit runs at several banks were ongoing.

Sources: Bloomberg; FSB calculations.

There is the potential for social media to be involved in future deposit runs. First, the repeated information in social media, which users experience through the re-posting or liking of other people's posts, can reinforce a message and may make the message more believable. This suggests that a depositor seeing repeated claims about their bank's health could be more likely to withdraw their funds than if they only saw the claims once. Second, the phenomenon of influencers, combined with an academic case study showing that depositors were more likely to withdraw their money if people in their social network have removed funds during a run at an Indian bank in 2001, suggests that online communities could be involved in deposit runs in the future.[24] Furthermore, social media and unsubstantiated rumours have played a role in past deposit run episodes and could do so again. Research has also shown that social media posts have been correlated with past deposit outflow episodes.[25]

2.3. Role of technology

Responses to an FSB member survey suggest that technological advancements have facilitated an easier and faster transfer of deposits in recent years. In particular, mobile bank apps and online banking are now mainstream services for retail depositors and can enable faster and more efficient payments for general purpose, smaller-value payments. A wave of technological innovation is also spreading in the corporate depositor segment, enabling efficiencies in complex business processes that involve larger-value payments. While large corporate depositors have had access to dedicated automated funds transfer solutions from their banks for several years,

[24] Iyer and Puri (2012), Understanding bank runs: the importance of depositor-bank relationships and networks, *American Economic Review*, June.

[25] Accornero and Moscatelli (2018), Listening to the buzz: social media sentiment and retail depositors' trust, *Bank of Italy Temi di Discussione*, February.

new technology facilitated by open banking[26] and Banking-as-a-Service(BaaS)[27] is likely enabling further efficiencies and higher speed for liquidity management and moving larger-value corporate deposits across banks or into other investments. Such developments could make corporate depositors less tied to any one bank and more mobile if there are concerns about a bank's health, without leading to a suspension of corporate financial transactions.

The ease of moving funds coupled with internet-based deposit platforms may have made depositors more willing to move funds to obtain better yields. Depositors appear to be more willing to move funds based on the rates offered – both between banks as well as with other financial products (e.g. MMFs). Account switching services and deposit brokerage platforms for retail depositors in some jurisdictions (e.g. euro area, UK and Korea) – while still limited in terms of volumes – allow depositors to migrate from one bank to another faster, easier and with lower cost. In some cases, these platforms connect depositors and banks directly, enabling them to choose banks to place deposits based on the offered rates, without the need of an intermediary or broker. As a consequence, banks can gather deposits from retail customers outside of their typical client base or geographical location.[28] In the US, this type of brokered deposit appears to have grown in importance as bank customers look for higher yields by "rate shopping".[29]

These new technologies can carry both benefits and risks for banks and their depositors. For depositors, platforms may make it more convenient to choose the products with highest returns due to the transparency of rates and ease of switching between products. Depositors may also use these platforms to distribute their cash holdings across banks to the maximum insurable amount to ensure their deposits are guaranteed.[30] For banks, deposit platforms provide flexibility and efficiency in raising deposits at the volumes, tenors, and currencies needed.[31] On the other hand, these business models may entail risks, as deposits gathered via such platforms may be less stable and more confidence-sensitive than those collected by well-established retail banking franchises.[32] Despite a large pool of available and often prefunded accounts, banks are competing based on transparent pricing with little product differentiation. Therefore, competitive yields above the market average are the most effective way to gather new deposits or rollover maturing ones. The lack of solid relationship may make it easier for customers on platforms to withdraw their deposits and harder for platforms to attract new ones.[33] Empirical evidence of the potential risks of deposit platforms is scarce. One study, however, estimates that banks with

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26 Open banking refers to applications and services enabled by the sharing and leveraging of customer-permissioned data by banks with third party developers and firms. See BCBS (2019), *Report on open banking and application programming interfaces*, November.

27 Banking-as-a-Service (BaaS) refers to the provision of banking products through third-party distributors such as fintech firms. See Deloitte (2021), *Banking as a Service, Explained: What it is, Why it's Important and How to Play*, October.

28 Some of the deposit platforms allow depositors to open an account with a credit institution that is part of the same group as the platform, whereas other platforms allow depositors to open an account with an intermediary credit institution, which then places deposits in a bank chosen by the depositor. Some other platforms use a non-bank entity, such as a payment institution or an e-money institution to place client funds with partnering banks.

29 S&P (2023), Regulators grow wary as US banks' brokered deposits nearly double YOY, September.

30 For example, in the US, deposit placement platforms provide reciprocal deposits that allows depositors to place deposits at multiple banks so that all (or part of) the deposits are covered by deposit insurance. See Ryfe and Saretto (2023), Reciprocal deposit networks provide means to exceed FDIC's $250,000 account cap, Federal Reserve Bank of Dallas, November. In some cases, platforms do not provide clear information on deposit guarantees, particularly if services are provided across borders; see EBA (2021), *Report on the use of digital platforms*, September.

31 S&P Global (2021), The Future Of Banking: One-Click Deposits (Risks Included), April.

32 How volatile and confidence-sensitive are these deposits would depend on factors such as deposit insurance coverage.

33 EBA (2021), *Report on the use of digital platforms*, September.

digital platforms have less sticky deposits, lowering their deposit franchise value by 40%; and that the sensitivity to interest rate changes for digital-broker banks more than doubles relative to traditional commercial banks without digital platforms or brokerage services.[34]

The responses to the survey suggest a lack of sufficient information and analysis on the relationship between technology and deposit runs. Although many respondents acknowledge that the digitalisation of banking could facilitate faster deposit runs, most of them report that they do not have concrete evidence because of lack of data or experience of recent run cases in their jurisdictions. Even jurisdictions that experienced bank runs have a lack of detailed information on the technologies used in the runs. One recent study argues that technological improvements can explain some of the increase in the speed of runs, but the large increase in speed likely only applies to households and small business depositors, as major corporates have had the ability to withdraw funds in an automated electronic manner since the late 1970s.[35]

The literature on the impact of electronic access channels on deposit outflows is also limited. The increased availability and use of online banking and mobile banking apps is well documented in various surveys and articles. Although access can vary, in general bank customers appear to have ready access to technology that allows convenient and fast deposits and withdrawals, subject to limitations imposed by banks. One recent study showed that digital banking enabled banks with low branch density to grow faster by attracting uninsured deposits during normal times, but when economic conditions worsened during the March 2023 banking turmoil, those large deposit inflows reversed.[36] However, in general, the technology used by bank customers with balances significant enough to impact a bank's liquidity and/or solvency in the event of a run is not well documented in the literature. The channels or mechanisms used to move substantial amounts of funds out of a bank quickly do not appear to have been studied in detail and could be a fruitful topic for future analysis.

Technological innovations in finance have the potential to further affect depositor behaviour. The integration of artificial intelligence (AI) in decision-making processes used by bank depositors could accelerate the speed of funds transfer – for example, where AI uses external information sources (e.g. news feeds about interest rate announcements, social media feeds about a bank) to move corporate deposits in a semi-automated fashion out of the bank. Innovations in payments, such as the tokenisation of money and other assets and wider adoption of digital wallets, may also influence the propensity of depositors to shift funds across financial institutions.

2.4. Interest rates and deposit stickiness

Rising interest rates increase bank funding costs and can lead to a change in the deposit composition. However, the transmission of policy rates to bank funding is not straightforward nor easily measured, because it depends in part on the degree of substitution among deposit and other products as their spreads adjust to market rates to varying degrees. Such substitution results in changes to banks' funding mix. Both the pass-through of policy rates to product-level

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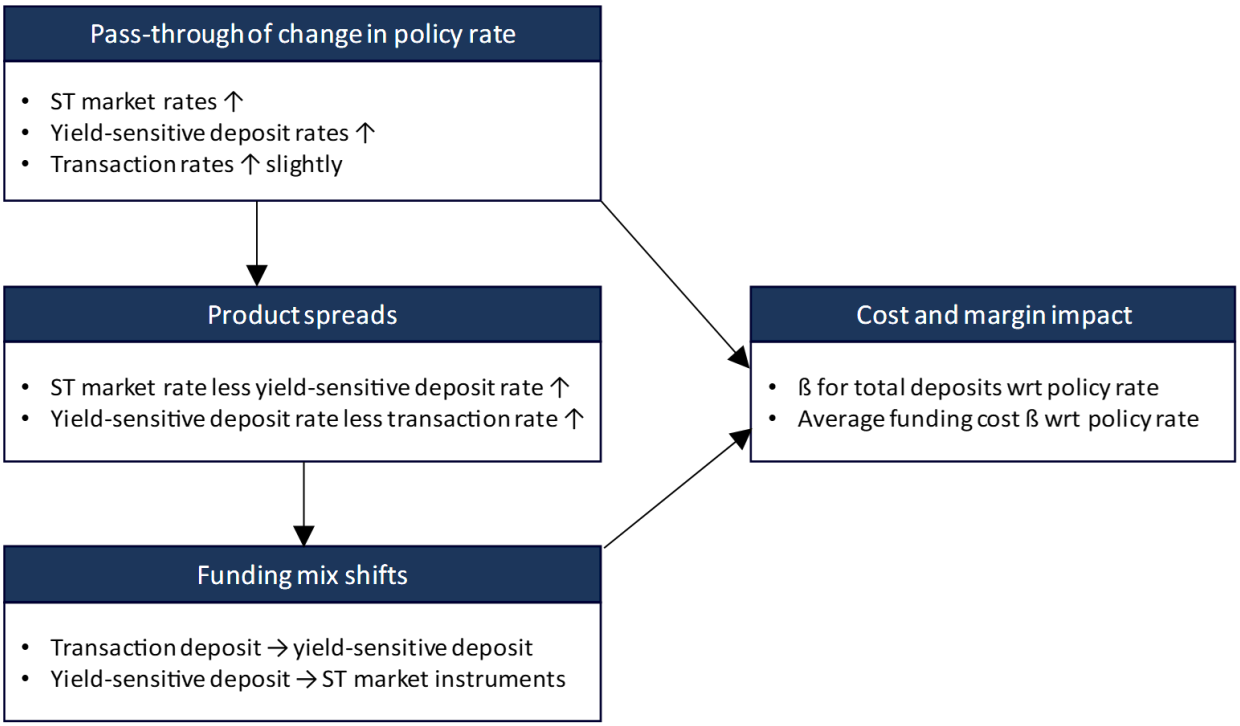
34 Koont et al. (2023), Destabilizing digital "bank walks", *New Working Paper Series*, No. 328, May.

35 Rose (2023).

36 Benmelech et al. (2023), Bank branch density and bank runs, *NBER Working Paper* No. 31462, July.

rates and the changes in the funding mix influence the overall impact of rising policy rates on funding costs (Figure 1).

Figure 1: Impact of rising rates on bank funding: forces at work[37]



Source: FSB.

Data for banking sectors across FSB jurisdictions suggest that, on average across all complete policy rate cycles, there is a partial pass-through of policy rates to bank interest rates. On average, the interest rate on total deposits changes by about 50% of the change in policy rates, i.e. the beta is around 50% (Graph 15). The beta for yield-sensitive deposits, at around 65%, is much higher than that for transactional deposits (10%). As a result, rate differentials between the two widen during rising-rate phases, and vice versa, as discussed above. However, the yield on short-term market instruments is highly (nearly 100%) sensitive to changes in policy rates, and greater than the beta for yield-sensitive deposits, again as discussed above. These forces are nearly symmetrical between rising- and falling-rate phases.

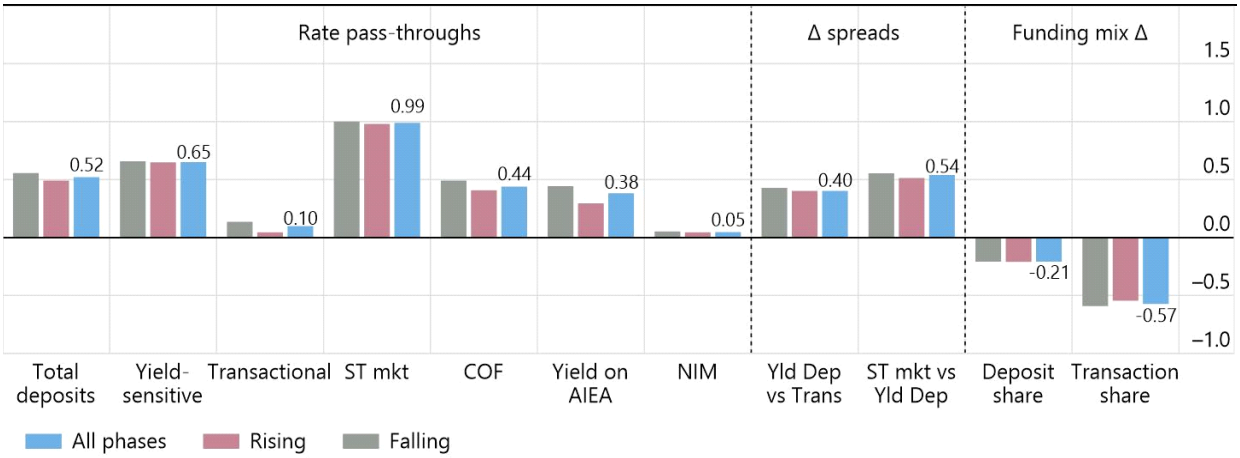
Policy rate moves also drive changes in spreads between funding instruments. An interest rate tightening cycle leads to changes in spreads between deposit and other products, which lead to shifts in the funding mix. Indeed, the data suggests that customers do shift funds away from transactional and toward yield-sensitive deposits as rates rise (Graph 15). There is also a negative sensitivity of the deposit share (i.e. the proportion of deposits to total funding), suggesting that when interest rates on deposits become less attractive relative to other market instruments customers move resources away from deposit accounts. However, there is a great deal of heterogeneity in this beta across jurisdictions. This likely reflects structural differences

[37] Transaction deposits are those that customers maintain for payments, liquidity management and other convenience attributes rather than primarily for investment yield. Their specific names differ across jurisdictions but their names typically include: "checking", "current", "overnight", "non-interest bearing", and similar. Yield-sensitive deposits are balances customers maintain at least in part to generate interest income. Their names typically refer to attributes of contract maturity, limitation of liquidity access, or yield generation. Short-term market instruments refers to money-market and other non-deposit instruments with three-month contractual maturities.

between financial systems. For example, the availability of deposit-like investments (such as money market funds) and the ease with which funds can move between jurisdictions, affects the degree to which the banking sector's deposit share can change.

Sensitivities to change in policy rates[1]

Change relative to change in policy rate over rising and declining rate phases **Graph 15**



AE = advanced economy; AIEA = average interest earning assets; EME = emerging market economy; COF = cost of funding; NIM = net interest margin.

[1] Sensitivity of a metric to changes in policy rates denotes the change in that metric, in percentage points, over a rising or falling rate episode, divided by change in policy rate over the same period. The episodes are defined as the quarter in which a policy rate started rising (or declining) to the quarter when that move ended. Measures presented are medians across observations in each set of phases specified – all, rising, falling, AE or EME. The deposit share is deposits as a proportion of total funding. The transaction share is transactional deposits as a proportion of total deposits.

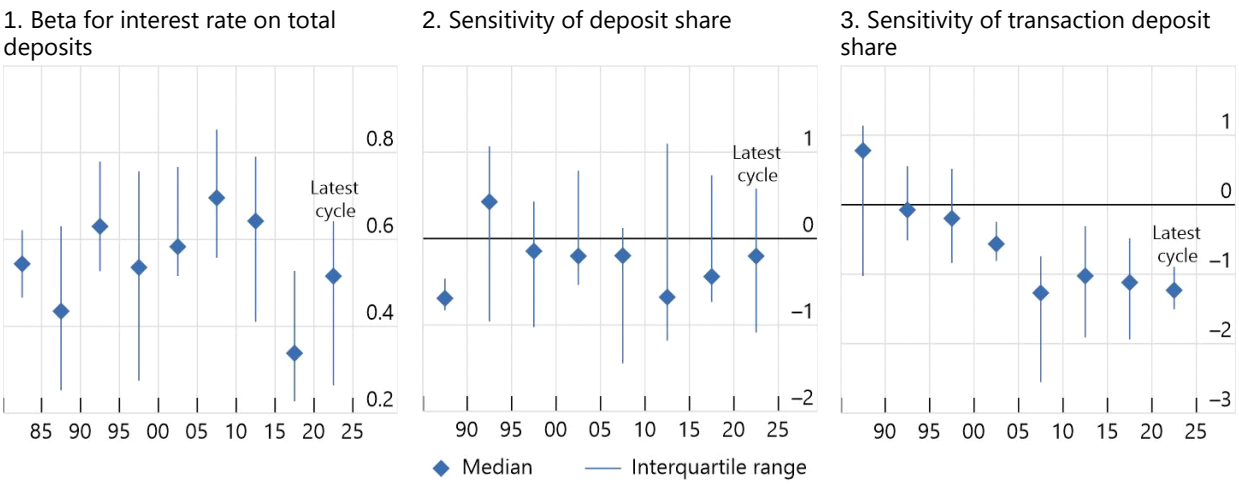
Source: Central banks; IMF; OECD; CEIC; Haver Analytics, S&P; FSB calculations.

The sensitivity of bank deposit rates to policy rates did not seem to be unusual in the current cycle. Analysis of past rate cycles indicates that the responsiveness of the interest rate on total deposits has not exhibited a clear trend over time, though it has varied across jurisdictions and policy rate episodes (Graph 16, panel 1). This suggests that there was nothing unusual about the recent tightening cycle relative to past cycles; indeed the results find that interest rate betas were, if anything, lower than the past, not higher.

While the sensitivity of the deposit share to changes in policy rates appears to have been relatively stable, the effect of interest rates on the share of transactional deposits has increased in recent years (Graph 16, panels 2 and 3). In other words, in recent years policy rate hiking cycles have been generally associated with a greater shift away from zero-maturity transactional deposits towards fixed-maturity yield-sensitive deposits. The latest rate hike cycle continues that trend, but it is by no means an outlier. This increased sensitivity is perhaps the result of changes in technology, such as: brokered deposits and deposit platforms that compare deposit rates; banking apps, open banking initiatives and switching services that make it easier to move deposits; or the rise in fintech companies that compete with banks for deposits.

Evolution of sensitivities to policy rate cycles[1]

Rate pass-throughs and balance sheet adjustments **Graph 16**



[1] The deposit share is deposits as a proportion of total funding. The transactional deposit share is transactional deposits as a proportion of total deposits. The graphs show the median and interquartile range of sensitivities across jurisdictions of each metric to policy rates, grouped over five-year periods. To account for structural differences across jurisdictions, and the fact that the statistics shown do not cover the same sample of countries in every period (because monetary policy cycles are not perfectly synchronized across countries), in this graph we first demean the country betas and sensitivities by removing the specific country means and then rescale them by adding the overall mean across all jurisdictions and years.

Source: Central banks; IMF; OECD; CEIC; Haver Analytics, S&P; FSB calculations.

The apparent structural changes in the sensitivity of the deposit mix are potentially problematic. Transaction deposits generally pay the lowest and stickiest interest rates. Their outflow could force banks to rely more on rate-sensitive and more expensive time deposits or other funding sources. However, shifts from transactional to yield-sensitive deposits can also have benefits. This is because yield-sensitive deposits, such as time deposits, have contractual maturities that can help a bank avoid destabilizing outflows. However, it is also possible for depositors to move transactional deposits at one bank to yield-sensitive deposits at another bank. Moreover, a migration of deposits out of banks to market instruments would be negative for funding stability, particularly if the result is a greater reliance on short-term wholesale funding.

3. Conclusion and policy implications

The analysis in this report suggests that the types of entities most vulnerable to the confluence of interest rate and liquidity risks in the financial system are nonbank real estate investors, life insurers, and a weak tail of banks. These entity types typically have a high proportion of interest rate-sensitive assets and liabilities, and are affected by higher rates through various solvency and liquidity risk channels, which may interact and create negative feedback loops. These entities also have funding, loan and investment linkages with the rest of the financial system and with the economy, meaning that any shocks to these entities can propagate across the system. Further work to assess the identified vulnerabilities in these types of entities is being undertaken by the FSB and relevant SSBs. There is a second group of entity types that also appear vulnerable in some of the analysis, though not as much as the three previously mentioned entity types. This second group is composed of bond funds (in particular, those with holdings of greater duration and illiquid assets), highly leveraged hedge funds invested in fixed income, and private credit/equity funds that can face delayed losses due to the infrequent valuation of their holdings.

The work on depositor behaviour raises a number of issues that are relevant to bank managers, supervisors, regulators, resolution authorities and policy makers. The Basel Committee on Banking Supervision (BCBS) has done work to assess some of these issues, for example to compare the outflows in the recent deposit runs against the outflow rate assumptions in its liquidity standards.[38] The BCBS, FSB and domestic authorities may also want to consider the issues discussed below.

The speed of some of the recent deposit runs was significantly higher than has generally been thought likely. Furthermore, the implications of technological developments and social media for deposit stickiness suggest that there could be more such runs in the future. This raises issues about risk management practices and liquidity supervision, as it implies that bank managers, supervisors and central banks may need to be able to react much more quickly to deposit outflows, especially of uninsured deposits, than in the past. For example, banks could be encouraged to prepare in advance for quick access to existing central bank liquidity facilities in the event that they were to face a deposit run.

In a few of the recent cases, the speed and magnitude of deposit outflows was so extreme (banks failed in one or two days) that no amount of bank liquidity would have prevented the failures. This implies that bank managers, regulators and supervisors need to focus on ways to address the liquidity and solvency vulnerabilities that give rise to such extreme outflows. For example, supervisors may need to scrutinise and address at an early stage any banks with unsustainable business models, inadequate risk governance or other weaknesses that may make the bank prone to a confidence crisis. More work could also be done to manage vulnerabilities linked to deposit outflows, such as a high concentration of deposits, a large share of uninsured deposits, or unrealised losses that may prevent banks from using their assets to raise liquidity. At the system level, new deposit-related vulnerabilities metrics (e.g. reliance on uninsured deposits, depositor concentration, liquidity mismatches) may need to be developed and monitored for financial stability surveillance. In addition, authorities may wish to consider the potential of high-frequency data from large value payment systems to build early warning indicators of bank liquidity problems.[39]

Social media have the potential to spread false information and rumours about financial institutions. Banks and authorities may wish to consider whether monitoring social media could be helpful in flagging potential stress at a bank or wider turmoil that might affect banks. At the same time, authorities need to be aware of the limitations in monitoring social media, including imperfect information content, technical capacity, expertise, resource constraints, and privacy concerns.

The report has also shown that there are a number of data gaps. For example, the availability of public information on unrealised losses on bank securities portfolios, uninsured deposits, and the number of deposit accounts is uneven across jurisdictions. Consideration could be given to collecting and publishing additional information in these areas in jurisdictions that do not provide this information, though the costs of this would need to be weighed against the benefits. In

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38 See BCBS (2023), *Report on the 2023 banking turmoil*, October; and BCBS (2024*), The 2023 banking turmoil and liquidity risk: a progress report*, October.

39 See, for example, Rainone (2023), Real-time identification and high-frequency analysis of deposit outflows, *Journal of Financial Econometrics*, May.

addition, supervisors tend to have less information on bank deposits than on bank assets, and there may be benefits to enhancing supervisory data on deposits, though again this would need to be assessed alongside the costs.

The possibility of further rapid deposit runs in the future also raises challenges for authorities to execute a resolution. A key element of fast-fail scenarios involving deposit runs is the provision of temporary funding to support an orderly resolution. The FSB is undertaking work to analyse the key features and availability of different public sector backstop funding mechanisms across jurisdictions for the range of potential failure scenarios.[40]

In a fast-fail scenario, resolution authorities and banks face a compressed timeline to carry out the resolution process. Recent cases suggest that preparations for resolution execution may need to be completed in weeks or even days. Furthermore, resolutions are often initiated at close of business on Friday, providing authorities with two days during which banks and markets are closed to execute the initial steps of a resolution. In fast-fail scenarios, assumptions that a resolution could be initiated during a weekend (the "resolution weekend") may need to be revisited. New challenges in managing liquidity outflows, communications and planning may arise from this.

To address the challenges associated with more compressed resolution timelines, authorities and banks should enhance their operational readiness, with an emphasis on fast-fail scenarios. Authorities should identify and streamline their internal processes during 'business as usual' to mitigate the impact of time constraints in a fast-fail resolution. Similarly, banks' capabilities to support a resolution may need to account for a compressed runway to resolution. Once appropriate processes and capabilities have been developed, it is important to test them, in coordination with resolution and supervisory authorities in a cross-border context. The FSB report on Good Practices for Crisis Management Groups[41] describes testing arrangements by authorities, including simulation and table-top exercises, and coordination between resolution and supervisory authorities.

The increased speed of deposit runs and rapid spread of information create challenges for banks' and authorities' crisis communication strategies. Potential leaks, misinformation or rumours, including through social media, could accelerate bank runs. This raises the question of whether it is preferable, for a bank or an authority, to respond to such events, and if so how. It also highlights the importance of incorporating effective communication strategies in banks' resolvability capabilities and feed into authorities' response, in line with the FSB's resolution standard.[42] During a crisis, it is important that authorities' communication and messages focus on enhancing the credibility of resolution actions taken and building confidence in the viability of the bank post-resolution.

Having established communication networks among key stakeholders is essential to ensure coordinated and consistent messaging. Where a failing bank has systemic cross-border

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40 This work builds on FSB (2016), *Guiding principles on the temporary funding needed to support the orderly resolution of a global systemically important bank ("G-SIB")*, August.

41 See section 3.1 of FSB (2021), *Good Practices for Crisis Management Groups*, November.

42 See Appendix I, Annex 4 of FSB (2024), *Key Attributes of Effective Resolution Regimes for Financial Institutions (revised)*, October.

activities, it might be important for a resolution authority to coordinate a common communication response with its international counterparts. Besides crisis communication arrangements, it would be useful to maintain ongoing communication with the general public and relevant stakeholders, to promote understanding of the resolution framework and foster confidence during a crisis.

Annex: Analysis of interest rate and liquidity risk by entity type

Banking sector

To assess quantitatively the solvency and liquidity risks due to rising interest rates, the analysis presented in this report mostly relies on (non-supervisory) financial statements from a universe of 436 banks spanning 22 FSB jurisdictions across all regions. It uses indicators split according to three types of vulnerabilities, linked to the channels identified in section 1: (i) funding vulnerabilities, linked to the redemption and rollover channels, that arise almost entirely from liabilities structures;[43] (ii) potential investment losses, linked to the delayed-loss and mark-to-market channels, which originate mainly within bank asset exposures; and (iii) asset-liability maturity mismatches, some linked primarily to redemption and rollover channels and others to solvency (profitability) channels.

Funding vulnerabilities

The most important drivers of funding vulnerabilities are the mix of funding instruments (e.g. customer deposits, repo, bonds) and the behaviour of funding counterparties (individuals, non-financial corporates, and financial institutions of various kinds). The crucial issue is which instruments and customers are associated with the sudden withdrawal of funding, motivated either by search for more attractive investment alternatives or fear that a bank will default on those instruments. No single indicator fully captures this risk, but some point to important aspects of it.

One key dimension is banks' reliance on wholesale instruments (i.e. other than customer deposits) as a share of total (non-equity) funding. Wholesale funding instruments are generally held for investment yield, do not depend on a broader banking relationship (e.g. transaction services) and are therefore more prone than deposits to outflow on either fear or search for yield (Graph A1-1).

On this measure, the "tail" of banks with wholesale funding over 40% of total funding – which constitute the highest decile of banks and amount to slightly more than 10% of sample assets – raises special concern and deserves scrutiny. Ideally, this metric should distinguish short-term wholesale funding. This information is harder to capture and assess, and banks' reporting of balance sheet tenor profiles for purposes of liquidity management is uneven. At the aggregate level, however, it appears that 28% of total wholesale funding is short-term.[44]

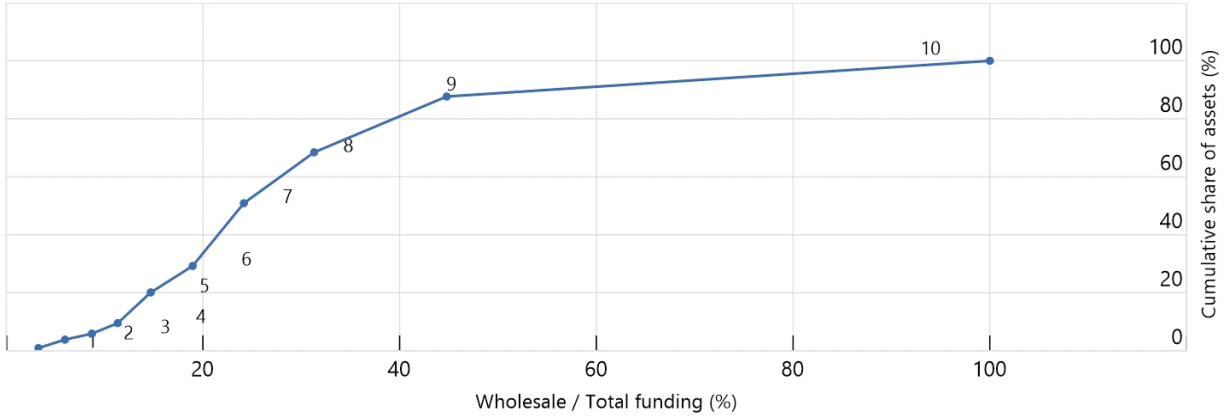
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[43] Equity funding is not considered here and below.

[44] From data collected for the FSB Global Monitoring Exercise on NBFI, covering banks from 29 jurisdictions.

Wholesale share of total funding[1]

Concentration of risk across sample banks **Graph A1-1**



[1] Numbers from 1 to 10 in this and subsequent charts indicate deciles of the bank population.

Sources: S&P Capital IQ; FSB calculations.

While deposits are generally more stable than wholesale funds, not all deposits are equally low-risk. Section 2 discusses behavioural assumptions around deposits.

Potential investment losses

The metrics presented below attempt to capture the two types of investment losses, mark-to-market and delayed losses, that can impair bank solvency. Banks can in principle mitigate the effects of rising interest rates using derivative positions. For example, a bank might purchase a contract designed to rise in value as interest rates rise, offsetting the decline in value of its bond holdings. The analysis presented below does not take account of potential hedging due to data limitations.

Mark-to-market losses can arise from all interest-sensitive assets, in line with the duration of the fixed-rate portfolio of investment assets. In principle, this includes both bonds and loans, but the former are generally of greater concern because they are more likely to be sold to meet funding redemptions (thereby triggering accounting realisation of the mark-to-market loss) and because the potential for losses on fixed income securities is more transparent to funding counterparties (who may pre-emptively pull funding if they sense that losses threaten a bank's stability).

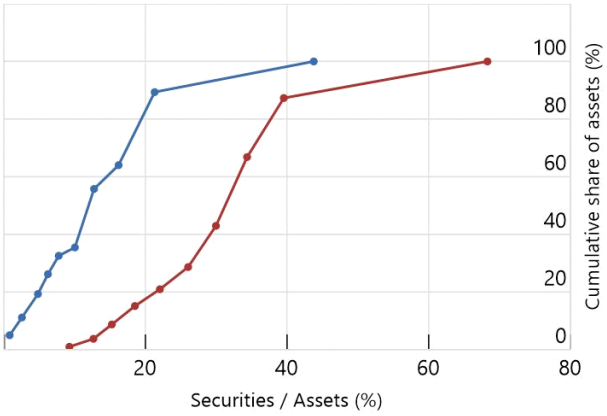
Overall mark-to-market losses are captured at a high level, from total marketable securities held on a bank's portfolio (Graph A1-2, left panel). Risk on this dimension is concentrated in the rough 20% of sample assets for which total securities are a high proportion (over 40%) of total assets. For securities held to maturity, delayed losses trigger decline in reported capital only if the banks realise the loss by selling the securities. While securities held to maturity shield banks from immediate recognition of economic losses when they occur, they represent a vulnerability to potentially large losses, often when financial conditions are tightest.

Having access to estimates of banks' unrealised losses on both 'available for sale' and 'held to maturity' securities should, in principle, allow to estimate risks to reported solvency if the bank sells these securities (Graph A1-2, right panel). In the United States, 10% of banks reporting this information at the end of 2022 had unrealised losses of more than 2.5% of risk-weighted assets

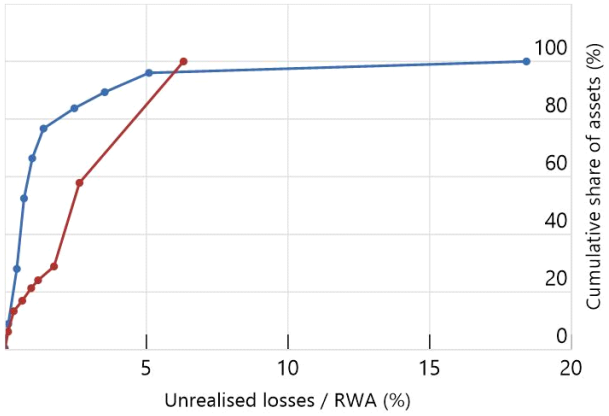
– meaning that immediate realisation of losses could cause, all things being equal, their CET1 capital ratios to decline by as much as 2.5 percentage points.[45] These include some large banks, so that this cohort amounts to nearly 40% of sample assets. In the euro area,[46] banks representing around 15% of sample assets had unrealised losses of more than 2.5% of risk-weighted assets, but a couple of outlier banks presented large unrealised losses.

Measures of asset devaluation risks and liquidity coverage for banks[1] **Graph A1-2**

Securities share of assets: Total and HTM



Unrealised losses share of RWA in the United States and the euro area





[1] Secs % assets indicates total securities as a share of total assets. HTM = held-to-maturity. HTM securities are of particular concern because unrealized losses can accumulate that might be realised if a bank is compelled to sell the securities as funding declines. Cash includes cash and reserves at central bank, due from banks, repo and fed funds.

Sources: S&P Capital IQ; ECB Data Portal; FSB calculations.

Asset-liability maturity mismatches

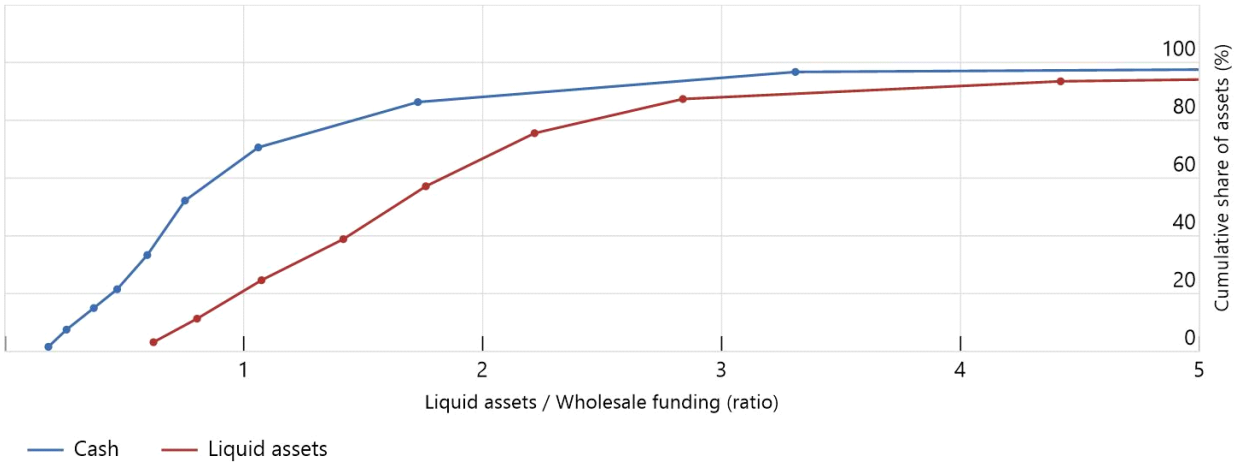
Cash (or liquid assets) available to cover wholesale funding (Graph A1-3) exemplifies a class of metrics that measure the potential outflow of liabilities (via the rollover and redemption channels) generating a funding shortfall before assets have matured. This can trigger fire sales, and lead to the realisation of delayed losses, which might in turn intensify funding outflows via the rollover and redemption channels. The metric considered suggests that more than half of banks in the sample have liquid assets greater than total wholesale funding, but there is a substantial segment (in the lower left corner) whose immediate access to cash and other liquid assets might be insufficient to cover a wholesale funding run.

45 Note that the largest banks, such as the G-SIBs, recognise unrealised losses on AFS securities in their CET1 capital ratios.

46 Data on unrealised losses for the euro area came from ECB (2023), Unrealised losses in banks' bond portfolios measured at amortised cost, July; and data on risk-weighted assets came from the ECB Data Portal, Balance sheet composition and profitability.

Cash and liquid assets relative to wholesale funding

Graph A1-3



Notes: Cash includes cash and reserves at central bank, due from banks, repo and fed funds.

Sources: S&P Capital IQ; FSB calculations.

Asset-liability maturity mismatch can also affect the solvency of banks via the profitability channel. In that case, the concept of maturity relevant to margins is "repricing" maturity, which is the shorter of contract maturity and the time at which the instrument's interest rate adjusts to changes in the benchmark. Based on repricing maturity data, one can in principle estimate the change in net interest income in response to a rise in the benchmark rate; but doing so requires a complex and ultimately approximate model that depends on many factors:

- Deposit betas (responsiveness of deposit rates to change in benchmarks) across "rate-sensitive" and "sticky" deposits.
- Change in the deposit mix, particularly a shift toward term, interest-yielding deposits as yields become more attractive.
- Repricing maturity of other interest-sensitive liabilities.
- Similar assessment of repricing dynamics and mix shifts for loans and other interest-earning assets. Of particular importance (and difficulty) is the mix of adjustable and fixed-rate mortgages, which differs markedly across jurisdictions and is not well-reported at the bank level.

Analysis across a broad set of interest rate cycles suggests that these generally have little impact on aggregate bank margins. Studying 377 policy rate cycles across 39 jurisdictions suggests that, on average, about 75% of policy rate moves pass through to deposit rates.[47] However, bank funding costs respond much more sluggishly – a 100 bps change in policy rates on average elicits only a 43 bps change in funding cost. Furthermore, because lending rates and overall

[47] Measurement of through-the-cycle rate sensitivity depends on the availability of policy and average deposit rate data, which varies by country. Cycles begin in 1980 where data are available. The number of cycles captured in each decade depends on length of data series (more countries available in more recent decades) and cycle frequency (more in earlier decades). Overall, the database captures 85, 104, 94, 55 and 3 completed cycles in each decade from the 1980s to the 2020s, and 36 cycles in progress. There is considerable variability of pass-through rates across cycles, with the first and third quartiles at 40% and 99%, respectively.

yields also change with policy rates, bank margins change very little, with a median of only 2 bps across the full sample (Graph A1-4, left panel). The dampened responds of margins to change in policy rates reflects two drivers. First, many loans (e.g. mortgages) and deposits (time deposits) reprice with a lag to changes in policy rates; and some (e.g. most current account deposits) reprice little or not at all. Secondly, some banks hedge against interest rate risk through use of derivatives.

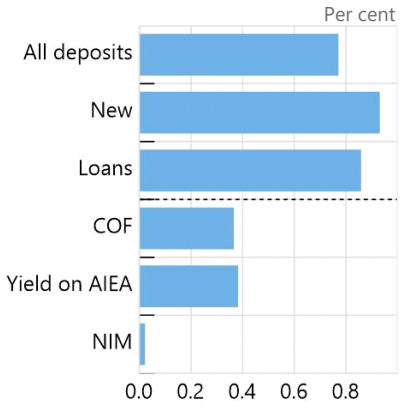
These broad findings do mask significant differences across individual banks and jurisdictions. In the United States, banks are required to report estimated earnings sensitivity to changing rate levels and the steepness of the interest rate term structure. These disclosures suggest that bank net interest margins (NIMs) change by no more than 30 bps in response to a 100 bps shift in the benchmark yield curve (see Graph A1-4, middle panel).[48] Still, one observes different sensitivities across individual banks.

The same applies when looking at banks across jurisdictions. In the absence of bank NIM data, Graph A1-4, right panel, presents the gap in "repricing maturities" between assets and liabilities that are reflecting the mix of fixed- and variable-rate instruments.[49] This average maturity gap is an important driver of differences across jurisdictions.

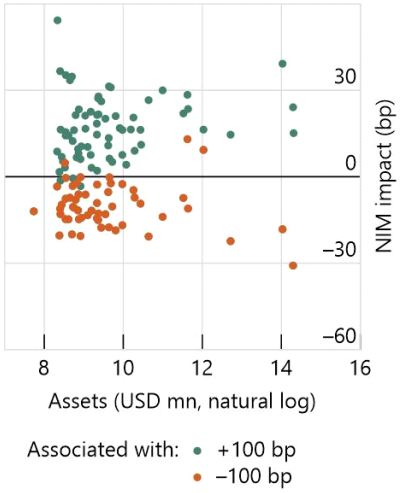
Relationship between benchmark rates and bank net interest margins

Graph A1-4

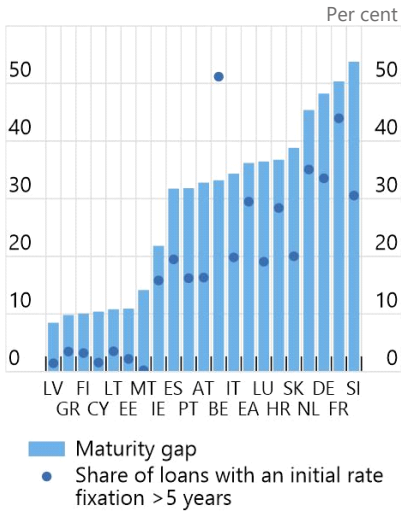
Median sensitivity of bank rates and margins to changes in policy benchmarks[1]



US banks: Estimated NIM impact of +/–100 bp parallel rate shift[2]



Euro area: Average maturity gap and share of long-repricing loans



[1] Based on quarterly policy rates, average deposit and lending rates, transaction accounts share of total deposits, and cost of funds and bank margins across a large sample of banks across 39 countries (21 developed, 18 emerging) and 377 historical interest rate cycles (179 rising, 198 falling) extending back to 1980 where data are available. COF=bank average cost interest-bearing liabilities; AIEA=average interest-earning assets; NIM=net interest margin. IBL=interest-bearing liabilities. Transaction %=transaction deposits relative to total deposit balances. Deposit and loan rates based on country-level disclosure from multilateral and national authorities. Bank funding cost and margin estimates based on bank-level disclosures. [2] End-2021 data from 70 banks, of which all reported sensitivity to a rise and 54 to a decline in rates.

Source: IMF; OECD; national authorities; Refinitiv Datastream; S&P Capital IQ; Haver Analytics; FSB calculations.

[48] These sensitivities do not take account of potential management actions nor reflecting hedging taken.

[49] This relates, in large part, to significant differences in the pricing of mortgage loans.

Selected non-bank entities

Insurers

The solvency of insurers is likely to improve when rates increase. This is because the duration of their assets is usually shorter than that of their liabilities. However. large unrealised losses in insurers' bond portfolios may also reduce their capacity to act countercyclically in future stress periods. Indeed, a large amount of unrealised losses[50] could result in reduced trading activity and portfolio rebalancing, in order to avoid realising these losses.[51]

Life insurers can also face liquidity risks through the redemption channel (lapse risk). Indeed, certain life insurance policies offer the possibility to policyholders to redeem their funds. This is typically the case of some saving products, but also of some protection products. In 2022, the sharp rise in interest rates increased this risk and already triggered the potential for additional liquidity risks.[52]

Data collection from the International Association of Insurance Supervisors (IAIS) shows that the surrender values (which correspond to the funds that policyholders could redeem) adds up to 30% of total insurers' assets, excluding separate accounts. It should be noted that tax benefits usually apply to life insurance contracts held for a sufficiently long time (determined by tax law) and provide incentives for policy holders not to redeem. In addition, approximately half of the surrender values relate to contracts which incur some type of economic penalties (redemption fees set by the insurer). However, these incentives are not a guarantee that policyholders will not redeem. Certain contracts are redeemable within one week, which creates a liquidity risk (Graph A1-5). This emphasises the need for asset-liability liquidity matching. For example, the IAIS considers liquidity risk metrics,[53] consisting of an Insurance Liquidity Ratio (which measures assets-to-liability liquidity in times of stress) as well as a stressed cash-flow approach.

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50 Farkas et al (2023), Life insurance companies – the missing relief from rising interest rates, *BIS Quarterly Review*, December.

51 For a more detailed discussion on this topic, see Bundesbank (2023), *Financial Stability Review*, November.

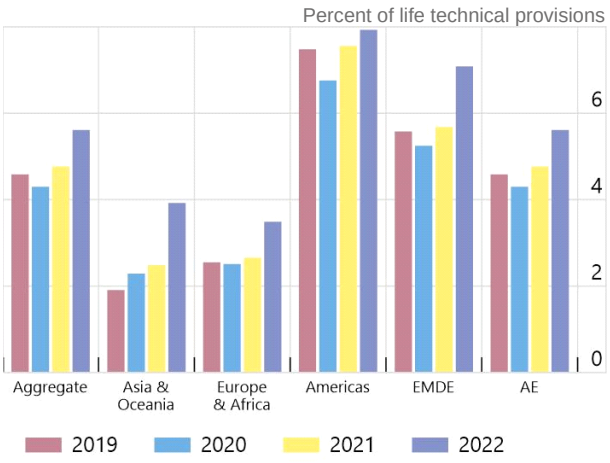
52 See IAIS (2023), *Global Insurance Market Report*, December.

53 See IAIS (2022), *Liquidity metrics as an ancillary indicator*, November.

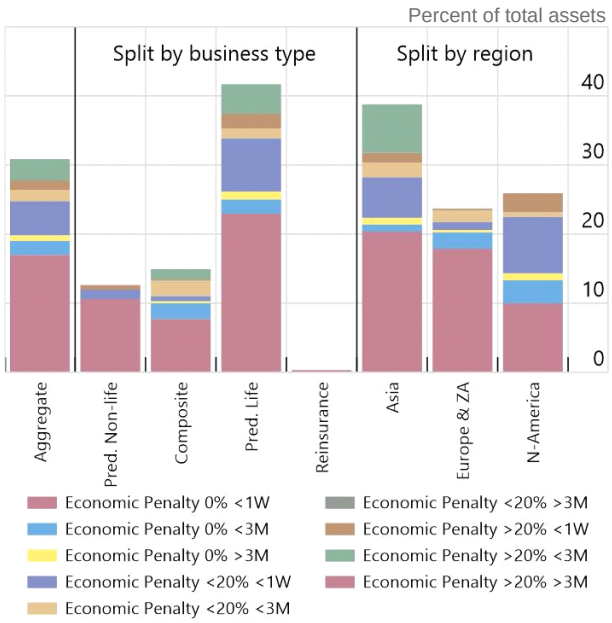
Redemption channel in insurance

Graph A1-5

1. Surrender rates



2. Surrender values as a percent of total assets[1]



[1] Excluding separate accounts.

Sources: IAIS (2023), Global Monitoring Exercise, June.

As analysed in section 2.2 life insurers can also use derivatives to hedge their financial risks – in particular interest rate derivatives to hedge their duration risk (and FX derivatives where necessary) and are therefore susceptible to be affected by significant margin calls.

Real estate investment trusts and real estate funds (REITFs)

REITFs can be affected by rising rates via the mark-to-market and delayed-loss channels. Indeed, because of the long duration of real estate assets, they are sensitive to changes in interest rates. In addition, asset valuations occur periodically rather than continuously, allowing for a deviation between reported asset valuations and fair market value. REITFs are particularly exposed to commercial real estate (CRE),[54] and these markets are facing a number of headwinds that have led to significant price decreases since their mid-2022 peak. Higher interest rates reduced the valuation of CRE investments, absent rent increases, relative to other assets such as bonds and increased the debt servicing costs, reducing profitability. There are also structural challenges for CRE markets that are shared across some advanced economies. The post-pandemic shift to remote working has contributed to a rise in office vacancy rates while retail has seen a longer-term price decline, partly as a result of more online shopping.

Open-ended real estate funds may be exposed to the realisation of losses caused by rising rates through the redemption channel. This is the case where there is a mismatch between the long duration and illiquidity of their assets and the potential liquidity needs that can be caused by

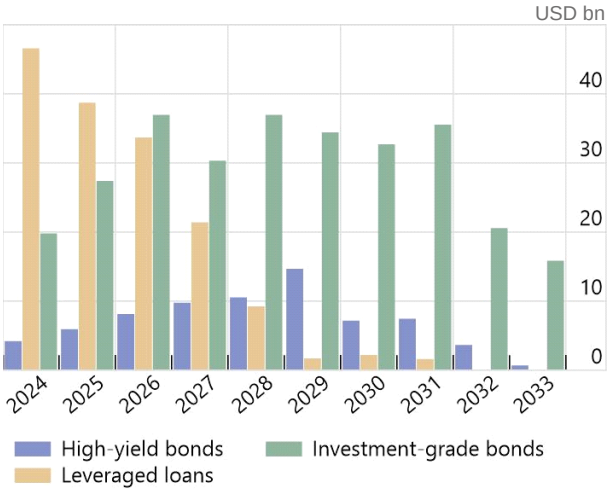
[54] The definition of commercial real estate can differ across jurisdictions. Residential real estate (particularly multi-family) may be considered commercial in some jurisdictions if it is owned by an institutional investor seeking a return on these assets. REITFs can hold a material share of commercial real estate markets in some jurisdictions: 40% in the euro area and 18% in the United Kingdom (figures reflect input from AGV workstream members).

redemptions. Some funds have, however, minimum holding and/or notice periods, which should therefore reduce the risks caused by redemptions, but that is not the case for all funds and some still offer daily dealings.

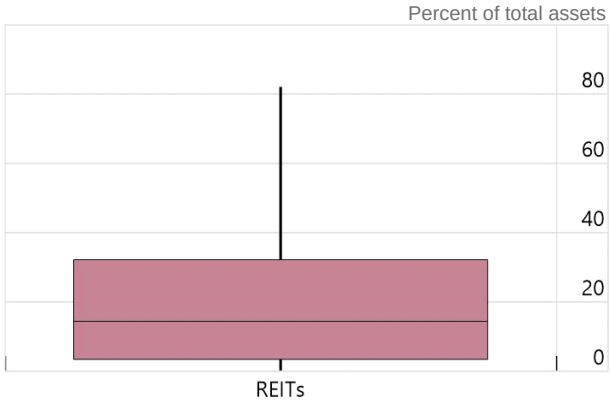
Leverage is used by REITFs to boost returns and exposes them to liquidity risk through the rollover channel. The reduction in collateral value due to rising rates could push up their gearing ratio. Together with the fall in profitability, this can make it harder for REITFs to refinance their debt (Graph A1-6, left panel), forcing them to take out costlier debt, deleverage or default if interest rates remain higher for longer. While median financial leverage of REITs is low, there is a tail of REITs which have taken significant financial leverage (Graph A1-6, right panel) and may be subject to higher risks.

Financial leverage in REITs **Graph A1-6**

1. Debt maturity analysis



2. Distribution of financial leverage[1]



[1] Leverage is calculated for those REITs that have issued high-yield/investment-grade bonds or have taken leveraged loans. This approach does not account for any secured mortgage debt that REITs may have taken against property assets.

Sources: Bloomberg; FSB calculations.

Other type of funds can be vulnerable

Bond and loan funds' portfolios are affected by rising rates via the mark-to-market channel. The decrease in the value of the asset portfolio could trigger redemptions and act upon the mismatch between asset liquidity and the daily redemption rights of fund investors. This could lead to fire sales and amplify market volatility.

Funds investing in high-yield corporate bonds, municipal bonds, and bank loans may be particularly exposed to liquidity transformation risks. Mutual bond funds currently have historically high duration levels,[55] and a higher duration means large mark-to-market losses in case of rising rates, particularly when redemptions require asset sales. However, loan funds and high-yield bond funds, which hold less liquid assets, tend to have a lower duration than investment grade or government bond funds.

[55] Interest rate risk, as measured by the weighted average duration of bonds within the Bloomberg Aggregate Bond Index, is close to its highest level since at least 2005.

The use of interest rate derivatives could reduce these losses. A study in Europe shows that indeed, some bond funds use derivatives, and this reduces tail risk.[56] On the other hand, interest rate derivatives could also be used for speculative purposes, resulting in higher exposures to interest rate risks.[57] In addition, some funds utilise liquidity management tools and redemption gates to avoid the need to fire sale assets thereby reducing potential losses.

Hedge funds mark-to-market their assets and liabilities and can therefore reflect economic losses via this channel. The main concern, however, is related to funding liquidity risks as hedge funds can be heavily involved in securities financing and derivatives transactions exposed to interest rate volatility. Their funding is typically short-term (often overnight). Sudden changes in liquidity or repricing of securities due to rising rates may therefore affect hedge funds through the rollover and margin channels. Previous analysis of hedge funds' leverage signals that the portfolio liquidity profile needs to be closely monitored to ensure that liquidity needs arising from investor redemptions and the withdrawal of financing, as well as margin calls, can be met – even during market disruptions.[58] Leverage at hedge funds could also amplify shocks, as may be the case for one particular strategy that has garnered attention after March 2020: the Treasury cash-futures basis trade (see Box A).

Private funds' asset holdings are infrequently valued (e.g. quarterly), and so the impact of rising interest rates may not have been fully reflected in fund valuations yet: private funds are therefore exposed through the delayed-loss channel. The main liquidity risk for private funds is via the rollover and margin channels. Liquidity mismatch can be caused by the use of leverage – both cash borrowing and synthetic leverage via derivatives. While a large share of private funds has limited leverage, if funds that are using cash borrowing need to rollover their funding when the value of the collateral has reduced, this can lead to asset sales and deleveraging (absent of calling committed capital, see below). Alternatively, if borrowing terms include loan-to-value covenants, asset price re-valuations can lead to covenant breaches, again leading to asset sales and the crystallisation of lower asset prices. Where funds use derivatives (i.e. synthetic leverage, often for hedging purposes) with mark-to-market margin calls, extreme price shocks in underlying asset markets can lead to large and unexpected liquidity needs which can also force unprepared funds to liquidate assets under stress.

56 European Systemic Risk Board (2022), NBFI Monitor, July – see special feature on bond funds and interest rate risk.

57 Portes et al. (2022), *Risks in non-bank financial intermediation*, August.

58 For more analyses on hedge funds' leverage, see FSB (2023), *The Financial Stability Implications of Leverage in Non-Bank Financial Intermediation*, September.

Box A: The Treasury cash-futures basis trade

This trade typically involves many nonbank entity types: firstly, hedge funds, broker-dealers, and asset managers, but also and indirectly MMFs and CCPs.[59] The trade ties together Treasury cash and future markets, both important venues for liquidity and price discovery, with hedge funds financing long cash Treasury positions in repo markets.[60] Some estimates suggest the trade could comprise around USD 500 billion in cash Treasuries.[61]

Considering a parallel shift in the Treasury curve, losses on a basis trader's long cash position would almost entirely be offset by gains on the short futures position. Funding liquidity risks, on the other hand, can arise in the repo-financed cash Treasury leg of the trade. Indeed, the cash-futures basis trade is highly levered. In normal times, the basis trade helps align the prices of Treasury securities and Treasury futures contracts and can support Treasury market liquidity. However, in a stress event, heightened volatility in Treasury markets could result in large losses for basis-trading hedge funds and increases in futures margin requirements, triggering margin calls. Problems rolling over repo financing or internal risk management considerations could force funds to abruptly unwind their positions at potentially distressed prices, particularly for the cash leg of the trade, for which liquidity conditions tend to deteriorate more at times of stress. This deleveraging could amplify initial disruptions in Treasury markets and even impair market liquidity and functioning.

59 MMFs are typically cash lenders through "sponsored cleared repo" with the Fixed Income Clearing Corporation. See Barth and Kahn (2020), *Basis Trades and Treasury Market Illiquidity*, July; Barth et al. (2023), *Recent Developments in Hedge Funds' Treasury Futures and Repo Positions: is the Basis Trade "Back"?*, August; and Aldasoro and Doerr (2023), *Money market funds, other non-bank financial institutions and sponsored cleared repo*, December.

60 See Liberty Street Economics (2015), *High-Frequency Cross-Market Trading in U.S. Treasury Markets*, August; and Barth and Kahn (2021), *Hedge Funds and the Treasury Cash-Futures Disconnect*, April.

61 Banegas et al. (2021), Sizing hedge funds' Treasury market activities and holdings, *FEDS Notes,* Washington: Board of Governors of the Federal Reserve System, October.