

Financial Stability Institute

FSI Insights on policy implementation No 59

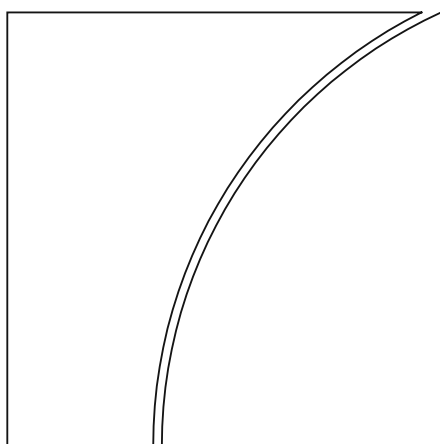
Liquidity stress tests for banks – range of practices and possible developments

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October 2024

JEL classification: G21, G23, G28

Keywords: bank run, contagion, haircuts, NBFIs,
outflow rates, scenario analysis



BANK FOR INTERNATIONAL SETTLEMENTS

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ISSN 2522-249X (online)

ISBN 978-92-9259-791-7 (online)

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Liquidity stress tests for banks – range of practices and possible developments¹

Executive summary

Authorities regularly monitor liquidity risk in the banking sector. The traditional role played by banks in credit intermediation and maturity transformation exposes them to liquidity risk. This risk is therefore a key consideration for banks, as well as for the authorities concerned with their prudential supervision and with financial stability. Recent episodes of banking stress have reaffirmed the importance of the management of liquidity risk to the resilience of the banking sector. They have also highlighted how the nature of this risk keeps evolving given changes in the structure of the financial system, technology and customer behaviour.

Liquidity stress tests are traditionally employed by financial authorities to assess the materiality of liquidity risk within the banking sector. These tests, which allow both banks and authorities to take a forward-looking perspective, can take different forms. At entity level, stress tests allow both authorities and banks to review how the latter's liquidity positions evolve under adverse conditions and test their resilience. Authorities typically run in-house stress tests to cross-check the results of banks' exercises and form their own views about their safety and soundness. Authorities can also conduct liquidity stress tests to assess the resilience of the banks to severe liquidity shocks. These exercises can also allow authorities to assess the interconnections and interdependencies among banks, possibly extending coverage to other types of financial institution.

An important element of liquidity stress tests with a sector- or system-wide focus is the need to reflect the shift in the allocation of liquidity in the system. In a system-wide liquidity crisis, liquidity tends to drain away from the institutions that are perceived to be the weakest and often becomes concentrated in stronger firms, putting the former at risk. Liquidity stress tests, by sizing net outflows under a predetermined stress scenario, help to identify the most vulnerable banks. In the very short time horizon of a stress test, and differently to solvency stress tests, each bank's management reactions can both increase the bank's survival chances and alter the impact of the initial shock on the rest of the banking sector, or on other financial firms. Crucial to the realism of liquidity stress tests is therefore a set of assumptions that reflect management responses, contagion and second-round effects, although these have proved extremely difficult to model up to now.

This paper reviews a range of approaches used by authorities running liquidity stress tests. Six authorities have been interviewed for this paper: the Australian Prudential Regulation Authority (APRA), the Bank of England (BoE), the Central Bank of Brazil (BCB), the Monetary Authority of Singapore (MAS), the Sveriges Riksbank (SCB) and the Single Supervisory Mechanism of the European Central Bank (ECB/SSM). The paper discusses exercises that build on bank-run stress tests as well as those that are conducted by the authorities and that cover the banking sector and non-bank financial institutions (NBFIs). At the core of the paper are exercises that are specifically designed as liquidity stress tests with a

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sector-wide focus. These are fully fledged, self-standing liquidity stress tests that cover the banking sector in a given jurisdiction.

Three distinctive approaches emerge from the review of the selected authorities' practices.

The first approach is to rely on stress tests run by the individual banks themselves. In this case, authorities derive a sector-wide view of liquidity risk by building on the results of the bank-run stress tests. This approach is common to all sampled jurisdictions. The second approach is stress testing exercises that have been specifically designed with a banking sector-wide focus. Three examples of this approach – exercises conducted by the BCB, the ECB/SSM and the SCB – are discussed in detail in the paper. The exercises are compared across several dimensions, including objectives, governance, scope, scenario design, methodology and supervisory follow-up. The third approach is exercises that focus on better understanding the interactions between banks and NBFIs. These exercises are exploratory, typically run only occasionally, given their complexity and the level of resources that they involve. Both the BoE and MAS have and/or are conducting such one-off exercises.

Recent market stress episodes have highlighted further areas of development for liquidity stress tests. A liquidity stress test incorporates multiple assumptions, concerning for instance depositors' behaviour and corrections in asset prices. Their features may evolve over time and such changes need to be reflected in the tests. Following the 2023 banking turmoil, innovations in liquidity stress tests may be needed to reflect changes in technology and depositor behaviour. There may also be a need to revisit other key assumptions underpinning stress tests, such as those about the treatment of high-quality liquid assets in times of stress, the availability of intragroup funding for banks and concentration of exposures on both the asset and liability sides.

There is also a need to further develop liquidity stress tests concerning modelling of interactions among banks and between banks and NBFIs. Moving from a single bank to a system-wide perspective requires tracking the impact of the liquidity shock across several financial firms. To do so, authorities need a comprehensive mapping of interactions among banks (eg connections via interbank markets, common exposures) and, increasingly, between banks and NBFIs. However, such modelling is demanding, to the extent that analysing the impact of links with NBFIs is still mostly qualitative. When considering second-round effects and contagion risk, authorities use simplifying assumptions, which are made to approximate the transmission of the liquidity shock across individual financial firms. However, such assumptions may be inadequate, and underestimate the severity of shocks and the speed with which liquidity may disappear in stress scenarios. There is also an increasing need for new vintages of liquidity stress tests to reflect the actions of individual banks and NBFIs. Finally, stress tests would ideally also allow to assess the cumulative impacts of these actions and reactions on the financial system. This could shed light on the circumstances under which changes in the collective behaviour of banks or NBFIs may lead them to become shock absorbers or shock amplifiers during a liquidity crisis.

Section 1 – Introduction

1. **Liquidity risk is a major source of bank vulnerability, given the structure of banks' balance sheet, and has been the focus of banks' and authorities' attention for a long time.** Liquidity risk can manifest itself in various forms and is typically subdivided into market and funding liquidity risks.² Market liquidity refers to the liquidity of assets and the ability to convert them into cash – either by selling them outright in the market or by pledging them as collateral to secure cash with little or no loss in value. Funding liquidity risk is the risk that the bank will not be able to meet its current and future cash flows and collateral needs without affecting its daily operations or its financial condition. Both types of risk reflect banks' traditional role in credit intermediation and maturity transformation. Liquidity risk is therefore a well established concept that is associated with banks' need to manage the liquidity and maturity mismatches that arise from their assets, traditionally comprising less than fully liquid loans, and their liabilities, largely made up of short-term or sight deposits.

2. **While authorities have several tools at their disposal to assess liquidity risk, liquidity stress tests are especially relevant.** Stress tests allow both banks and authorities to take a forward-looking perspective and review how stable banks' liquidity positions remain under adverse conditions. Banks conduct liquidity stress tests as part of their liquidity risk management and prudential requirements. Authorities can run in-house stress tests to cross-check the results of banks' stress testing capabilities and results and form their own views on a bank's safety and soundness and on its resilience during a period of liquidity stress. Authorities can also conduct liquidity stress tests to monitor liquidity risk at the level of the banking sector as a whole.³ For the latter, they can either combine bank-level stress tests or conduct system-wide exercises. Taking a broader perspective, authorities can also run liquidity stress tests for the financial sector, extending coverage to other types of financial institution.

3. **The need for a comprehensive and robust liquidity stress testing framework was reaffirmed in the wake of the Great Financial Crisis (GFC).** When the GFC started in 2007, it was initially caused by credit losses arising from assets that were used to support short-term funding (asset-backed commercial paper in particular), before spreading to other types of securitisation. It then evolved into a solvency crisis following large credit losses related to real estate exposures – mostly in the United States – with many large banking groups becoming undercapitalised. In the years that followed the introduction of the US Supervisory Capital Assessment Program in 2009, emphasis was therefore put on annual solvency stress tests. These became mandatory in many jurisdictions. First used as a crisis tool to identify and quantify capital shortfalls, regulatory and supervisory stress tests gradually became prevention tools that are used to identify vulnerabilities in the financial system.⁴ However, liquidity risk also played a major part in the GFC, both at the beginning of the crisis and then once the credit losses began to emerge, as banks' solvency became increasingly questioned by market participants. The Basel Committee on Banking Supervision (BCBS) reaffirmed the importance of liquidity risk as early as during the GFC (see BCBS (2008)),⁵ establishing that banks should conduct stress tests on a regular basis for a variety of short-term and protracted institution-specific and market-wide liquidity stress scenarios.

4. **Since the GFC, authorities have started to develop standalone sector-wide liquidity stress tests.** Because the post-GFC stress tests focused on solvency, authorities initially made efforts to integrate liquidity elements into those exercises, for instance via the introduction of market liquidity risk requiring

² A third type of liquidity risk – contingent liquidity risk – is sometimes added. In liquidity risk management, contingent liquidity risk refers to the occurrence of a low-frequency but high-severity event and shock taking place. Contingent liquidity then becomes the cost for a bank to maintain a sufficient cushion or buffer of high-quality liquid assets (HQLAs) in order to meet sudden and unexpected funding obligations and absorb potential losses.

³ For instance, the BCB has been running banking sector-wide liquidity stress tests since the early 2000s.

⁴ On the evolving use of stress testing from a crisis tool to a prevention tool, see de Guindos (2021).

⁵ See in particular Principle 10.

the application of haircuts on assets or when assessing the impact of downgrades on banks' funding costs. However, since the GFC, and recognising the importance of liquidity risk, some authorities have started to develop liquidity-specific stress tests for the banking sector. For instance, in 2019, both the BoE⁶ and the ECB/SSM conducted separate liquidity stress test exercises for the banking sector. In the ECB/SSM's case, the exercise was a sensitivity test conducted across 100 significant institutions directly supervised by the ECB.⁷

5. **Structural changes in the financial system have also prompted authorities to enhance liquidity stress tests to assess risks arising from the increased reliance on market-based finance.** As shown by the Financial Stability Board, Non-Bank Financial Institutions (NBFIs) were estimated to hold almost half of total global financial assets by the end of 2022.⁸ In 2019, the European and Securities Markets Authority (ESMA) published its stress simulation (STRESI) framework to assess the resilience of the asset management sector to shocks. Several financial sector authorities, including the MAS, have conducted their own stress tests to assess system-wide interactions and, in particular, interactions between banks and investment funds.

6. **More recently, market turmoil episodes since 2020 have confirmed the importance of system-wide liquidity risk and liquidity stress tests.** One such episode was the stress in the US Treasury market in March 2020 (the so-called dash for cash), in which a range of non-banks sought to raise cash by selling bonds in already illiquid markets. Another example was the 2022 stress in UK pension funds following a liability-driven investment (LDI) strategy. In both cases, the substantial liquidity pressures experienced by NBFIs (hedge funds and pension funds, respectively) led to asset sales, triggering further asset price declines – and both cases required interventions from central banks. A third example was the banking turmoil of spring 2023, when regional banks in the United States experienced a loss of market confidence and considerable and rapid deposit withdrawals. At around the same time, a major Swiss bank could not withstand large liquidity withdrawals driven by concerns about its long-term viability. All these cases reaffirmed the need to assess the overall resilience of the financial system to severe liquidity shocks. Liquidity stress tests are key tools for conducting assessments, prompting some authorities to undertake new projects in this area, such as the exploratory exercise by the BoE, which brings together banks and various types of NBFI.

7. **This paper reviews a sample of liquidity stress testing exercises conducted by authorities for the banking sector, highlighting the existing range of practices and drawing lessons from them.** Based on publicly available reports and on interviews with the respective authorities, the paper describes a range of stress testing practices that these authorities have developed to assess and monitor liquidity risk in their financial system, with a special focus on banks. Although practices vary and the paper only covers a relatively small number of jurisdictions due to limited disclosure on liquidity stress tests, a discussion of these exercises may help to shed light on common issues. It may also help to develop robust liquidity stress tests for both traditional and more recent drivers of liquidity risk for banks.

8. **The paper is organised as follows.** Section 2 describes the approach followed in the paper regarding the selection of the sample jurisdictions and the types of stress testing exercises covered. Section 3 reviews bank-specific exercises, which focus on liquidity risk for individual banks. Section 4 describes exercises that were specifically designed as sector-wide liquidity stress tests for banks. Section 5

⁶ In March 2021, the BoE published some of the key findings from the 2019 Liquidity Biennial Exploratory Scenario (LBES). See BoE (2021a, p 10–14).

⁷ See ECB (2019a,b).

⁸ Market-based finance is provided by NBFIs. NBFIs – or the NBFI sector – refers to a broad measure of all non-bank financial entities. It includes insurance firms, pension funds and other financial intermediaries (OFIs). OFIs include money market funds (MMFs), hedge funds (HFs), other investment funds (OIFs, such as fixed income funds and real estate funds), central counterparties (CCPs), broker-dealers (BDs), finance companies (FinCos), trust companies (TCs) and structured finance vehicles (SFVs). See FSB (2023a), and in particular Section 2, for the breakdown of the sector into classifications according to entities' economic functions and the types of vulnerabilities to which they are exposed.

presents liquidity exercises that include non-banks. Section 6 discusses some of the main and areas for further development. Section 7 concludes.

Section 2 – Liquidity risk and types of liquidity stress test

9. **Liquidity stress tests need to reflect some specific aspects of liquidity risk.** In a system-wide crisis, liquidity does not necessarily disappear from the system as a whole. Instead, it moves out of firms that are perceived as vulnerable and becomes concentrated in firms that are perceived to be stronger. In the very short time horizon of a stress test, the bank's management reaction can both increase the bank's survival chances and affect the impact of the initial shock on the rest of the banking sector, or other financial firms. Crucial to the realism of liquidity stress tests is therefore a set of assumptions of management responses, contagion and second-round effects, even if extremely difficult to model. This is different to solvency stress tests, which authorities developed first, as in liquidity stress tests, the shocks tend to be more sudden, and their impact is felt immediately and contagion effects happening faster.

10. **A bank liquidity stress test typically includes the following building blocks: the treatment of assets and liabilities, the bank's management response, and the spreading of the initial shock across the financial system.** The stress test involves making assumptions about falls in asset prices (represented by haircuts) and, on the liability side, about the speed with which liabilities may leave the bank's balance sheet (represented by outflow rates applied to types of products and/or counterparties over a pre-determined period). These assumptions are typically based on historical data and past liquidity stress events. Currently, liquidity stress tests, even when targeting a sector-wide or system-wide analysis, quantify the impact of a stress on each bank separately, without necessarily reflecting interactions between them or with other types of financial firm. In sector-wide stress tests, the key parameters (broken down by assets classes and liability types) are the same across all banks.

11. **To better understand the propagation of the shock, the liquidity stress tests can include management actions and channels along which the stress propagates itself through the financial system.** Actions that an individual firm's management takes to maximise the entity's liquidity during a crisis include downsizing its balance sheet, by selling liquid assets, reducing its commitments to lend, its lending or its guarantees of other transactions. Other actions may aim to limit outflows and conserve and secure funding.⁹ Authorities need to decide which management actions are included in the exercise, considering that the response by one bank may affect the rest of the banking sector, and possibly other financial firms too. Restricting the inclusion of management responses also reflect concerns that the hypothetical capacity to absorb a liquidity shock or to counterbalance liquidity outflows may turn out to be much smaller than expected in reality.

12. **Following the initial shock and management reactions from individual firms, the stress tests may need to consider their combined effects on market-wide liquidity.** To do so, authorities need a good mapping of the exposures and interactions within the banking sector, as well as, if possible, NBFIs, to model contagion effects. Lastly, once the shock has propagated through the financial system, authorities would need to consider second-round effects. Modelling these aspects is complex, and typically the analysis is not conducted in a quantitative way. However, an approach that includes sector-wide or system-wide view of the propagation of the risk would help to shed light on the impact of firms' collective behaviour and reactions during a period of market-wide liquidity stress, including identifying firms that may be absorbers or amplifiers of risk.

⁹ This may include drawing down all available credit or liquidity lines and issuing on markets before the costs of such issuance becomes prohibitive, increasing the cost of market-based funding and increasing both the rates paid on customer deposits and the interest rates on credit that it is willing to provide.

13. **As a result of the specific features of a liquidity stress test, scenario design and modelling assumptions for liquidity can be particularly challenging.** This is because of the need to make numerous behavioural assumptions. The three main types of assumptions are those regarding (i) the stability of funding sources, expressed as run-off rates; (ii) the price volatility of marketable assets, expressed as haircuts; and (iii) contingent liquidity assumptions, expressed as probabilities of draw for committed credit and liquidity lines. Probabilities of draw for credit and liquidity lines extended by banks to their non-bank corporate customers are particularly difficult to model.¹⁰ Moreover, as NBFIs play a growing role in the financial system, there is an increasing need, when modelling a stress test, to assess their own behavioural assumptions and their consequences for banks' funding, especially in short-term funding markets. One of the implications is the need to be able to collect and process more and more granular data originating from a larger number and wider range of counterparties.

14. **A liquidity stress test also needs to reflect the fact that in a liquidity crisis, the situation can worsen quickly through contagion effects.** While the liquidity crisis may develop in phases and may initially be limited to a given institution and/or a specific type of funding¹¹ stress can spread quickly. The crisis can be rapidly transmitted and amplified through herd behaviour, as all market participants seek to maximise their asset liquidity through fire sales. The crisis can also be exacerbated through contagion effects and other second-round effects, as wholesale investors and depositors seek to reduce their exposure to banks perceived to have similar vulnerabilities to the bank (or banks) that initiated the crisis. Modelling these second-round effects – and their accumulation, which can propagate the stress through the financial system – remains challenging and imperfect, even though their impact may exceed that of the initial shock.

15. **Given such complexity, authorities are generally reluctant to disclose information on the liquidity stress tests that they conduct.** Contrary to solvency stress tests, about which authorities have published extensively over the past fifteen years, there is much less material that is publicly available regarding liquidity stress tests. A number of authorities conduct such exercises, but they only at most disclose aggregate results. Publication of methodological notes is even rarer. This approach reflects a common concern that disclosing banks' exposures and their potential vulnerabilities to liquidity risk may lead "self-fulfilling prophecies" and to market reactions that would crystallise those risks.

16. **Jurisdictions were selected for this project based on the availability of published material.** In some cases, authorities have included information about bank vulnerabilities to liquidity risk and stress test results in their regular financial stability reports, typically at an aggregate level and sometimes only on an occasional basis. In other cases, authorities may have launched one-off exercises to assess various types of risk and their transmission channels. To achieve this, they developed a toolkit for liquidity stress tests that they may then use regularly, for internal purposes. In other circumstances, a response to stress events in domestic and/or key foreign markets may have prompted authorities to launch a liquidity stress test to assess the resilience of their own banks. As a result, it was possible to select six authorities and their corresponding banking systems for this project. The sample offers some degree of diversity in terms of banking sector structures, geographical location and types of approach. The selected authorities are the Australian Prudential Regulation Authority (APRA), the Central Bank of Brazil (BCB), the Bank of England (BoE), the Monetary Authority of Singapore (MAS), the Sveriges Riksbank (SCB) and the European Central

¹⁰ An example of this took place in March 2020, when non-financial corporates drew down credit and liquidity lines that banks had committed to provide, and also sold bonds in illiquid markets as they tried to hoard liquidity.

¹¹ See for instance Schmieder et al (2012), which includes a stylised example of the three main phases of a liquidity crisis: (i) a sudden dry-out of a funding source, (ii) gradual closure of wholesale funding markets (starting with long-term unsecured funding) and (iii) bank runs (which are subject to contagion and develop into a banking crisis in the absence of policy intervention).

Bank's Single Supervisory Mechanism (ECB/SSM). In all cases, published material was complemented by interviews with officials from these institutions.

17. **The approaches taken by the authorities vary quite markedly, reflecting significant differences between financial systems.** In all cases and regardless of the type of exercise conducted, authorities expect their liquidity stress testing exercises to help when assessing sector-wide liquidity risks in their banking systems. The fact that there is nevertheless a wide range of approaches across the selected jurisdictions reflects significant differences between their financial systems. Some authorities rely mostly on bank-level exercises conducted by the banks themselves, with the authorities providing the key parameters of the scenarios. In turn, the authorities review and challenge the banks' own liquidity stress tests as part of their supervision of banks' risk management. At the other end of the spectrum, some authorities conduct sector-wide, top-down exercises, in addition to exercises that focus on individual banks. In some cases, they also include NBFIs, turning the stress test into an exercise applied to the financial system. Where applicable, the authorities see these different approaches as complementary.

18. **Overall, the authorities that use complex liquidity exercises applied to their whole financial system also conduct simpler ones that are targeted at banks only.** In the absence of a recent banking crisis, and because of the complexities involved in running system-wide exercises, some authorities may tend to consider an approach that does not include a sector-wide assessment of liquidity risk or go beyond the banking sector to be sufficient. However, as discussed in the following sections, recent episodes of banking sector turmoil have highlighted the increasing need to consider sector-wide concentrations and contagion effects, both within the banking sector and between banks and NBFIs. As a result, several of the sampled authorities are planning to conduct – or are conducting – more complex exploratory liquidity exercises with a scope that goes beyond the banking sector. Sector-wide liquidity stress tests for the banking sector also continue to evolve as authorities develop better data and models.

19. **Liquidity stress tests conducted by the selected authorities are presented along a broadening spectrum, from bank-specific to system-wide.** The first approach, common to all the sampled jurisdictions, relies on the traditional way of conducting liquidity stress testing exercises for individual banks. In this case, authorities can derive a sector-wide view of liquidity risk by building up the results of the bank-specific stress tests. The core of the paper addresses the next approach, ie stress testing exercises that have been specifically designed with a sector-wide focus. There are three such exercises conducted on a regular basis by the sampled authorities (BCB, ECB/SSM and SCB). The BoE ran this kind of exercise once; its approach is discussed in this section too. Finally, the paper presents exercises that help to assess interactions between banks and NBFIs. They are typically run only occasionally, or possibly only once, given their complexity and the level of resources that they involve. Both the BoE and MAS have and/or are conducting such one-off exercises.¹²

¹² Given its focus on stress test practices outside of regulatory requirements, the paper does not cover the supervisory liquidity stress indicators introduced by the BCBS. In the aftermath of the GFC, the BCBS developed two liquidity indicators – the Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR) – that were derived from liquidity metrics traditionally used in banks and existing regulations in specific countries. The LCR is a standardised bank-level stress test. It requires each bank to hold an amount of unencumbered HQLAs that is sufficient to meet liquidity needs from cash outflows for 30 days under a stress scenario. LCRs are calculated for each bank separately, according to the same parameters as set by the BCBS. In most cases, LCRs are calculated on a monthly basis, but some authorities (eg in the selected sample, BoE, ECB/SSM) can compute them at a higher frequency if needed. The NSFR is also a standardised liquidity metric that is intended to prevent a bank from over-relying on short-term funding and maximising its maturity transformation. Typically, each type of funding and asset will receive a factor that approximates its stability and its liquidity, respectively.

Section 3 – Bank-level liquidity stress tests

20. **In this setting, authorities rely on bank-level stress tests to assess their exposure to liquidity risk.** In these exercises, scenarios and stress factors are applied to simulate adverse market conditions and liquidity pressures on individual banks in order to evaluate their liquidity positions and vulnerabilities. This granular view of liquidity risk is then reviewed and assessed to draw an assessment of the system-wide impact of liquidity risk. The key features of such examples among the sample authorities are provided in Table 1.

Authority/Approach	APRA	MAS
Scenario design	By banks (with APRA guidance)	By MAS
Who runs the exercise?	Banks	Banks
Time horizon	At the discretion of banks according to their risk appetite	30 days
Main assumptions (eg haircuts, deposit run-off, derivatives)	Defined by banks through their own risk assessment (with APRA guidance)	At least as restrictive as LCR parameters; same assumptions for all banks, even if possibly more restrictive than in banks' own contingency funding plans
Output	Cash flows, days of survival, LCR/NSFR impact	Cash flow analysis, days of survival
Communication	Banks report results through their internal governance process and provide to APRA on request	Occasionally, in FSR, at aggregate level
Frequency	Regular	Annual
Pass/fail	Defined by banks per their risk appetite	No

Source: Interviews with officials.

21. **Supervisors review the analysis conducted by banks and assess the results.** Supervisors regularly review the adequacy of banks' own stress testing infrastructure (eg scenario design, modelling capacity, resources). For instance, APRA requires banks to build their own scenario(s), following APRA's broad guidelines, and conduct their stress test(s) internally. APRA reviews banks' assumptions, assesses the robustness of their stress test results and engages with the banks to point out specific concerns. Benchmarking across banks also allows APRA to identify outliers and adjust the intensity of its supervisory follow-up accordingly. At the same time, APRA recognises that there may be legitimate reasons for differences in banks' risk scenarios and assumptions, and it does not expect the materiality of liquidity risk to be homogenous across banks. APRA also reviews the liquidity metrics derived from these exercises in a holistic way, taking them into account in its qualitative assessment of banks' resilience. In line with its principles-based supervisory approach, APRA does not assign a pass/fail grade to the banks, and the banks assess the outcome of the stress tests against their own expectations and based on their risk appetite. As is also the case at other authorities, the approach taken by APRA follows the Basel Committee's Principles for sound liquidity risk management and supervision (BCBS (2008)).¹³ By building on the results of the banks' stress tests, authorities can gauge a system-wide level of exposure of the banking sector to liquidity

¹³ In particular, Principles 10 and 14. Principle 10 focuses on banks' stress testing framework, their process, their scenarios and assumptions, and their use of results. Principle 14 addresses the role of supervisors and their need to conduct a comprehensive assessment of a bank's overall liquidity risk management framework and position.

risk. This approach may be especially fruitful in a highly concentrated banking sector with a few large, domestic banks.

22. **In some cases, the key features of the liquidity stress tests conducted by individual banks are specified by the prudential authority.** As MAS focuses on consistency and comparability across banks and aims to derive a system-wide view of risks, it requires that all domestic systemically important banks (D-SIBs) broadly use the scenario that it has designed and apply the same assumptions in their models (eg haircuts to assets, deposit run-off rates). The assumption underpinning such a choice is that D-SIBs in Singapore have liquidity risk profiles that are similar enough that applying the same stress test scenario and the same set of assumptions to all of them allows for meaningful comparisons. It also allows for aggregation, therefore providing the authority's macroprudential and monetary management groups with estimates of system-wide liquidity needs. In this case, the similarities in banks' risk profile are such that the benefit of comparability outweighs the potential drawback of not identifying each bank's specific risk profile. The MAS exercise focuses on assessing the adequacy of banks' liquidity buffers and engaging bank management on the feasibility of their response measures under the stress scenario. Additionally, when banks project liquidity shortfalls under the stress scenario, MAS can explore potential supervisory actions as a follow-up, on a case by case basis. By relying on the LCR and cash flow data submitted by banks, MAS also runs a parallel stress testing exercise to cross-check each bank's results and ensure that they are not underestimating their liquidity needs.¹⁴

23. **This approach provides authorities with useful insights.** For instance, APRA relies on these exercises for its systemic assessment of financial stability and resilience in the banking sector, as well as to inform its broad supervisory risk assessment. For MAS, even when the exercises are microprudential in design (with individual banks reporting their results under a common set of stress scenarios), the similarities in banks' risk profiles make it possible to assess the resilience of the financial system and help determine the stressed liquidity needs of the banking system.

Section 4 – Sector-wide stress tests for liquidity risk

24. **There are three regular sector-wide stress tests among those conducted by the sampled authorities.** The BCB, SCB and ECB/SSM all regularly conduct these complex exercises but have chosen different approaches in terms of modelling, data sources, objectives and usage of the results. A fourth authority, the BoE, has conducted a similar exercise once, but on an exploratory basis. This exercise is discussed at the end of the section.¹⁵

25. **The authorities have taken a centralised approach for all three regular system-wide liquidity stress tests, albeit to different degrees.** The authority conducting such an exercise uses its own models, and the banks themselves are not involved in the conduct of the exercise. On an exceptional basis,

¹⁴ MAS also conducts a reverse liquidity stress test which provides information about the maximum level of stress that a bank can sustain before breaching regulatory limits. In its reverse stress testing exercise, MAS requires banks to test different levels of severity of the shock parameter, against which banks would experience a negative cumulative net cash flow position at the two-week and four-week horizons. In this way, MAS can identify the most relevant stress factors for each individual bank and subsequently assess the limitations of various management actions.

¹⁵ Following the GFC, authorities started to include some liquidity elements in banking sector-wide solvency stress tests. This approach is widely used and has been adopted by most of the authorities covered in this project (Brazil is the exception, as solvency and liquidity risk are treated separately). For instance, in the European Union, all member countries join a biannual stress testing exercise coordinated by the European Banking Authority (EBA) which is focused on assessing banks' solvency. In this exercise, elements of liquidity stress are also included via the introduction of market liquidity risk requiring haircuts and asset re-evaluations. The inclusion of a liquidity shock in a system-wide solvency stress test also features in APRA's annual supervisory stress test and in the BoE's annual solvency stress test, while MAS also runs an industry-wide solvency stress test which sometimes includes a liquidity component. However, such exercises are primarily focused on solvency, with liquidity typically included as a trigger of potential additional losses.

for the first iteration of the ECB/SSM's liquidity stress test in 2019, banks were asked to perform the stress test themselves following the SSM-given methodology and scenario. Since then, the ECB/SSM runs the liquidity stress test on its own, using the same methodology and the regularly updated starting points, with no bank involvement (see Table 2).¹⁶

26. **The institutional setup for prudential and financial stability functions influences the objectives of the three exercises.** In Brazil, the central bank combines the financial stability, monetary and supervisory functions. Its liquidity stress test is conducted for system-wide analysis, but the BCB can use the same methodology to also flag outliers and initiate a dedicated review of those banks. In Sweden, the central bank conducts the system-wide exercise in line with its financial stability mandate. Prudential supervision falls within the remit of a separate agency, the Financial Supervisory Authority (FSA), which runs supervisory stress tests. In the euro area, the SSM is responsible for microprudential supervision and is separate from the ECB monetary policy and financial stability functions. In line with its institutional mandate, the SSM exercise emphasises the resilience of individual banks to liquidity stress.¹⁷

27. **By design, the three exercises cover banks only.** Considering the importance of banks to financial stability and the provision of credit to the economy, authorities first developed stress testing exercises covering only banks. The growing importance of non-bank financial firms in financing the economy has led to growing efforts to include banks and non-banks in the same exercises. However, this has proven to be so complex and resource-intensive that many authorities currently¹⁸ restrict the scope of their system-wide exercises to banks only.¹⁹ With the exception of the BCB's exercise, which covers all banks within the jurisdiction, the sampled system-wide liquidity stress testing exercises focus on the largest banks or banking groups operating within the jurisdiction. However, these generally represent three quarters or more of the respective banking systems. In addition, and if needed, the scope of the exercises can be extended to smaller banks in the ECB/SSM and SCB cases.

28. **There is a significant difference in data sources between the exercises.** Both the ECB/SSM and SCB exercises rely on regulatory data, ie the data that are collected for the purpose of implementing supervisory regulations. For liquidity, these data are typically based on the reporting of maturity ladders. In the EU, these data are available on a quarterly basis, following EU-wide templates. However, the ECB/SSM has also devised a more frequent data collection (weekly or, if needed, daily) to meet additional data needs. The BCB relies on data collected from clearing houses and which are available daily.²⁰ This choice partly reflects the fact that when its liquidity stress testing framework was developed in 2002, data on interbank market transactions was the most reliable and accessible data source.

¹⁶ In Sweden, the central bank consulted the banks extensively before publishing the methodology in 2019.

¹⁷ At the EU level, the European Systemic Risk Board (ESRB) is currently conducting work to develop a top-down stress testing model for liquidity risk in order to enhance its system-wide surveillance of vulnerabilities in the banking sectors of the EU and its members (see ESRB (2024, Box 2)). This exercise, in which both the ECB and the ECB/SSM participate, is expected to emphasise the systemic rather than the bank-level aspects of liquidity risk.

¹⁸ The EU-wide exercise currently in preparation is expected to include non-banks as well (ESRB (2024)). The following section discusses stress testing exercises that include NBFIs too.

¹⁹ Separate stress tests are run for other components of the financial system in several jurisdictions, eg for insurance companies or payment system infrastructures. In the EU, an EU-wide stress test for insurance companies is conducted annually under the competent EU authority; the fifth such exercise was launched in December 2023. Similarly, specific stress tests for payment system infrastructure are regularly conducted by the corresponding EU authority; the latest was launched in the first half of 2024. No EU authority conducts cross-sectoral stress tests.

²⁰ The BCB opted to use data from central securities depositories (CSDs) and trade repositories (TRs) for a number of reasons. The first is the frequency and quality of the data, and the fact that they are provided by an independent source. The data are collected from the payment system, as well as deposits, derivatives and securities in particular that come from CSDs and TRs.

Examples of sector-wide liquidity stress tests (part I)

Table 2

Authority/Approach	ECB/SSM	SCB	BCB
Objectives	Resilience of individual banks to liquidity stress	Assess vulnerability and estimate potential liquidity needs in a liquidity crisis	Measure and monitor liquidity risk in the banking system; it is a complementary measure to LCR and NSFR
Approach/key question	Assume inflows stop – for how long can a bank pay outflows?	Test how banks can operate under stress without having to cut lending (threshold: 75% of LCR)	Early warning indicator of possible problems – weak banks are flagged to supervisors, who will review the bank's position and initiate dialogue
Governance (Who runs the exercise? Are banks involved?)	Top-down exercise conducted by the SSM; banks provide cash flow data (the results of the SSM exercise can be used to challenge the outcome of banks' own stress tests)	Top-down exercise conducted by the SCB; banks are not involved	Top-down exercise by the BCB (which holds central bank supervisor functions); banks are not involved
Scope	Only banks (usually only significant banks, but extended to less-significant institutions (LSIs) at yearly frequency)	Only banks (large domestic and some foreign subs)	All prudential banking conglomerates (140); no other type of financial institution
Data sources	Supervisory reporting (on a monthly basis, frequency can be increased to weekly or even daily thanks to SSM-devised special reporting)	For domestic banks, maturity ladder data, supervisory reporting (provided by the FSA) on a monthly basis; for foreign subsidiaries, data reported to the SCB	Supervisory reporting and daily data from clearing houses

Sources: Documentation published by ECB/SSM, SCB and BCB; interviews with officials.

29. **There are also differences in terms of the scenario design across the three exercises.** One authority emphasises the importance of consistency over time and across banks to enhancing comparability (see Table 3). The ECB/SSM has broadly maintained over time the scenario that was used for the initial sensitivity analysis conducted in 2019, while updating the calibration of the shock.²¹ The same scenario is applied to all banks. The stability over time is justified by the fact that no full narrative has been developed for the exercise. Instead, a combination of haircuts is applied across different asset classes, constituting the initial source of stress. Even though the scenario is unchanged over the various vintages of the exercise, in order to have a sense of how severe the different scenarios may be, the ECB/SSM prepares results under two stress scenarios – an adverse shock and an extreme shock. The SCB takes a similar approach, as it develops a system-wide scenario that is applied to all banks.²² The SCB aims for comparability in the results across banks and over time; in this light, the baseline scenarios are relatively fixed and infrequently altered. The BCB designs a bank-specific stress scenario for each of the 140 banking groups it regularly covers in its stress tests. This is to make sure that each bank faces a demanding scenario. The system-wide impact is determined by aggregating the individual results. Both the SCB and the BCB

²¹ See ECB (2019a,b).

²² In separate exercises, the SCB also prepares a bank-specific scenario. It assumes a uniform type of idiosyncratic stress across banks but applies it to only one bank at a time. By design, this approach presupposes that only one bank is under stress while the others remain relatively unaffected.

change their stress scenarios over time.

Examples of sector-wide liquidity stress tests (part II)				Table 3
Authority/Approach	ECB/SSM	SCB	BCB	
Scenario	Same scenario for all banks and not changed over time; no narrative	Same scenario for all banks and baseline broadly unchanged over time	A separate scenario for each bank	
Scenario basis (historical/hypothetical)	A mix of the two (mostly based on supervisory expertise)	Both (usually separate, but can be combined)	Hypothetical, considering historical market risk data, deposit run-off rates and deposit volatility	
Horizon	1 year; 6 months for the Supervisory Review and Evaluation Process (SREP) analysis	6 months	30 days	
Key assumptions	Preset assumptions about replacement of term assets/liabilities (all haircuts are applied instantaneously) and run-off of sight deposits; static balance sheet	Preset assumptions about replacement of term assets/liabilities (all haircuts are applied instantaneously) and run-off of sight deposits; similar haircuts as in LCR, but for sovereign bonds (5% instead of 0%)	Potential market risk losses under individualised scenarios for each FI, covering changes in FX, interest rates, commodity and stock prices, haircuts specific to sources of funding, historical volatility of deposits (30-day holding period, 95% confidence level)	

Sources: Documentation published by ECB/SSM, SCB and BCB; interviews with officials.

30. **In terms of scenario design, the authorities tend to rely on both historical and hypothetical inputs.** Authorities in countries that have more recently experienced banking crises – or with banking sectors that are similar to those in countries that have recently experienced banking crises – may be more likely to rely more on historical data to design a stress scenario. Hypothetical features are generally considered useful by all interviewed authorities. For instance, in the absence of banking sector stress in Brazil over the past few years, the BCB designs hypothetical bank-specific scenarios that take into consideration historical market risk data and deposit run-off rates. In Sweden, the scenarios reflect a mix of historical and hypothetical aspects. At the ECB/SSM, scenario design is driven by historical data. This is complemented by a qualitative assessment made by supervisors and based on their experience of real cases of liquidity stress.

31. **The time horizon used in the stress tests also varies, from 30 days to one year.** For the BCB's stress exercise, the chosen time horizon is 30 days, which is also the cut-off period used under the LCR. However, both the SCB and the ECB/SSM consider longer periods – one year or six months – in their respective exercises because these make it possible to assess the impacts of the propagation of the stress shock across the financial system. This allows to capture the build-up of vulnerabilities as well as contagion effects over a longer period, even if a large part of the initial liquidity shocks have an instantaneous impact on banks' balance sheet.²³ Accordingly, longer time horizons allow the ECB/SSM and SCB to assess more comprehensively the impact of liquidity shocks. This is particularly the case as longer horizons make it possible to include term liabilities that would otherwise be unaffected and to assess the impact of shocks on them. For its part, the ECB/SSM compares banks' liquidity positions as determined under its stress

²³ The BCB has also developed an NSFR-type measure based on similar data used for the liquidity stress test with the objective of monitoring the build-up of vulnerabilities.

testing framework with the LCR cash flows and its 30-day horizon. This allows for consistency checks between the two measures.

32. All three exercises include key assumptions that are essential to designing a liquidity shock, such as assumptions about depositors' behaviour and the market value of the bank's assets.

Designing a scenario for liquidity risk requires defining certain key assumptions, such as assumptions about depositors' behaviour, the availability of market funding, asset liquidity and asset encumbrance.²⁴ The behaviour of banks' depositors and the market liquidity of a bank's assets are reflected, respectively, through the application of run-off rates, which attempt to mirror deposits' volatility during a stress period, and haircuts on the market value of the bank's assets, to reflect the stressed conditions under which they are likely to be sold.

33. The LCR is an important reference for calibrating assumptions about haircuts and run-off rates.

For both the ECB/SSM and the SCB, haircuts on assets and assumptions about run-off rates on sight deposits are derived from those used under the LCR, although in some cases, they may be higher than under the liquidity standard.²⁵ In Brazil, as the liquidity stress tests were designed well before the development of the LCR, most of the assumptions are calibrated using historical market risk data and daily information collected from clearing houses. In the BCB exercise, to ensure that valuations reflect current market conditions, assets are valued based on current market prices or the prices used for collateral in repurchase agreements.

34. Authorities also need to decide how to treat sight deposits.

Although sight deposits – which can in principle be withdrawn at any time – tend in practice to be stable, both the ECB/SSM and the SCB take a conservative approach regarding them in their respective scenarios. They assume that at least some sight deposits are withdrawn at the outset of their exercises.²⁶ The BCB estimates the resources needed to cover retail customers' withdrawal based on historical simulations and includes add-ons for early redemption from the three largest wholesale counterparties of each bank.

35. Assumptions are also needed to reflect banks' responses.

As management actions may change the composition of banks' portfolios, authorities can benefit from including in stress exercises specifications about what types of such measures, if any, can be reflected in the stress test. For instance, the ECB/SSM assumes a static balance sheet in its stress test exercise. This means that no bank reactions are taken into account and, in particular, no new sources of inflows after the reference date, no renegotiations of contracts and no revaluation of management's responses can take place. This approach, though not realistic, may facilitate assessment of the intensity of the impact of the initial shock before any mitigating actions may be taken.

36. The stress tests typically need to include assumptions about the propagation of the initial shocks over the time horizon.

While scenarios typically include all shocks that affect the banks' balance sheet at the start of the time horizon, it is more difficult to reflect the effect of shocks over time as these propagate and spread to the whole system. As a result, a methodology needs to be devised to aggregate the impact of shocks over the exercise's time horizon. In practice, and for the sake of simplicity, both the ECB/SSM and the SCB use haircuts to reflect such impacts on items with contractual maturity. Only a small fraction of term assets and liabilities that mature after the start of the exercise are assumed to be replaced. The replacement coefficient is lower for flightier funding sources (eg deposits from financial rather than commercial counterparties). In Brazil, although contagion or second-round effects are not explicitly

²⁴ See Jobst et al (2020) for a discussion of these.

²⁵ The fact that deposit run-off rates and haircuts under these scenarios may be higher than those used under the LCR reflects the fact that the objective of the international liquidity standard is to establish minimum liquidity requirements.

²⁶ Some differentiation is made depending upon the types of counterparty. For instance, both the ECB/SSM and the SCB exercises assume that deposits from financial counterparties are withdrawn in full over a period of one month. Both exercises also apply lower outflow rates to sight deposits from non-financial corporates than those applied to deposits from financial counterparties.

accounted for, the aggregation of individual bank-specific scenarios yields more severe first-round effects and serves as a proxy for these effects.

37. **FX funding is singled out in two of the stress test exercises considered.** Some authorities devote special attention to foreign currency-denominated funding, as the availability of these currencies during liquidity stresses is often much more limited than funding denominated in the domestic currency. Accordingly, both the ECB/SSM and SCB treat foreign currency funding separately in their exercises and use specific assumptions for the foreign currencies to which their banking systems are exposed. The ECB/SSM applies the same shock to all FX positions, rather than using a different one for each currency. Even with a common shock, the results from the 2019 exercise show that stress levels tend to be higher for exposures in foreign currencies, such as the US dollar and British pound, than for exposures denominated in domestic currency. In the case of Sweden, Swedish banks have a relatively high proportion of short-term financing in foreign currency. This is partly to maintain liquidity reserves in foreign currency to meet LCR requirements and partly to meet the demand of Swedish asset managers, who need to hedge investments in foreign assets with foreign currency swaps. Consequently, Swedish banks are particularly dependent on FX money markets for US dollar funding, and on the FX swap market. They are therefore quite sensitive to disruptions in these markets. In addition to stress testing individual currencies, the SCB also analyses how banks' liquidity needs in various currencies are affected depending on whether FX swaps are assumed to be renewed or allowed to mature.

38. **Exceptional central bank support is not included in the stress tests.** While support by the central bank can in principle help any bank sustain a liquidity shortage, such support may not be available during a period of stress, either because of collateral shortage or because the liquidity support needs to be denominated in a foreign currency to which the central bank may only have limited access. In addition, including such support in a stress test reduces its value for the authorities, as they would be unable to assess the system's resilience on a standalone basis. None of the three examples of stress testing exercises under study allows for the possibility of exceptional central bank support.²⁷ Banks may, however, use regular liquidity lines by the central bank after applying the appropriate haircuts to collateral. For instance, in the ECB/SSM exercise, central bank reserves remain available as a source of bank funding over the whole time horizon, at nominal value, and banks can continue to access regular repo facilities with the central bank.

²⁷ This is analogous to the exclusion of monetary policy responses in solvency stress tests.

Examples of sector-wide liquidity stress tests (part III)

Table 4

Authority/Approach	ECB/SSM	SCB	BCB
Methodology	Calculate bank-level survival period using banks' (stressed and expected) cash flow submissions and preset assumptions about replacement of term assets/liabilities and run-off of deposits	Calculate cumulative net cash flows for each bank using preset assumptions about replacement of term assets/liabilities and run-off of deposits; define liquidity needs in relation to 75% of LCR	Compute outflows in liquidity indicator as comprised of: (i) potential market risk losses under bank-specific scenarios, covering changes in FX, interest rates, commodity and stock prices; (ii) different haircuts applied to different funding lines, customised by type of ownership, modality etc; (iii) add-ons applied to withdrawals based on a VaR model, which consider the volatility of deposits, with a 30-day (or 21-business day holding period) and a 95% confidence level; and (iv) add-ons for early redemption from the three largest wholesale counterparties of each bank
Contagion/second-round effects	No contagion or second-round effects (applying all haircuts instantaneously is used as a proxy for second-round effects)	No contagion or second-round effects, haircuts are used to cover second-round effects; some assumptions implicitly involve other parts of the financial system (eg FX swaps are typically with insurance companies)	No contagion or second-round effects, but bank-specific scenarios amplify first-round effects
Output	Survival period; net liquidity positions; used as a complement to the LCR	Cumulative net liquidity needs over 6 months	Short-term liquidity ratio (liquid assets to net cash flows)
Pass/Fail	No; qualitative score used for supervisory dialogue with the banks	No	No
Supervisory follow-up	Quantitative score and qualitative assessment	Not applicable	Early warning indicator triggers supervisory review and dialogue
Communication	No external disclosure	Only occasionally in the FSR (at aggregate level); methodology is public	In the FSR (twice a year), in aggregate form

Sources: Documentation published by ECB/SSM, SCB and BCB; interviews with officials.

39. **The methodologies used vary depending on which liquidity indicator has been selected as the output of the exercise.** In the ECB/SSM's exercise, the selected indicator is derived via the cumulative net outflows, although several time horizons are considered for computing such outflows (see Table 4).²⁸ These are computed for each bank, using the bank's submissions of cash flows. For the SCB, the

²⁸ For instance, the ECB/SSM may consider cumulative net outflows over up to one week, one month or six months.

methodology also requires the computation of the cumulative net cash flows, which is done by the central bank directly. Both the ECB/SSM and the SCB build the chosen indicator of each bank's resilience under stress on this basis. In the BCB's case, each component of the short-term liquidity ratio (including deposit outflows, liquid assets and losses under market stress) is cumulated over time.

40. **The three exercises produce different bank-level indicators of liquidity stress.** The ECB/SSM focuses on the survival period, based on a bank's net liquidity position. The critical moment (the first day of failure) is the point in time when a bank's net cumulative cash flows turn negative. This is the point when the bank becomes unable to survive net outflows as its own balance sheet resources become insufficient to fund the gap. This outcome does not trigger a pass/fail assessment by the ECB/SSM. Rather, it is used as part of the supervisory dialogue with each bank. In the SCB exercise, there is also no pass or fail grade. The SCB computes an indicator of liquidity needs which compares the liquidity position of each bank – based on its net cumulative cash flows – with a threshold calculated as 75% of the LCR, by currency.²⁹ When a bank's liquidity positions (in any of the currencies) are insufficient to meet the 75% LCR threshold, the bank records a liquidity need for that period. The liquidity needs are then cumulated for each bank across the time horizon of the exercise. Finally, the BCB produces a short-term liquidity ratio relating liquid assets to net stressed cash flows. This ratio considers the amount each bank can raise in the short term, including its unencumbered federal government bonds and other liquid assets, and the potential cash outflows it would need to face in stress situations, such as deposit run-offs and potential losses on liquid assets and derivatives positions. This metric is used to estimate the frequency distribution of deposit run-offs across financial institutions. Additionally, the BCB estimates step-in risk, measured as the impact of the liquidity support that the bank would need to grant to investment funds managed by bank-linked managers for reputational reasons and to preserve the bank's market access. There is also no pass or fail grade in the BCB's stress exercise.

41. **Only the impact of direct liquidity shocks on each bank is assessed.** None of the three types of exercise under study consider contagion effects among banks (and those involving other non-financial firms) or second-round effects more generally, such as fire sales or runs on banks' liabilities. While this reflects the complexity of modelling such situations, it also implies that indirect impacts and second-round effects of liquidity shocks, which may often be the most damaging, are not reflected in the exercises. To mitigate this shortcoming, both the ECB/SSM and the SCB apply conservative haircuts to all relevant assets, including a 5% haircut to the value of government securities. Such haircuts are expected to reflect at least some of the second-round effects. The BCB also amplifies the effect of first-round effects by calculating bank-specific scenarios and picking for each bank a scenario that meets a certain probability threshold, deemed to be sufficiently conservative. These scenarios could not take place simultaneously at the banks.

42. **The type of supervisory follow-up varies across the sample.** In Sweden, as there is a separate supervisory authority, the system-wide stress test conducted by the SCB does not produce a supervisory response and does not translate into additional requirements. In the case of the ECB/SSM, the results are used by the supervisory teams. They may inform their discussions with – and their oversight of – individual banks as part of their Supervisory Review and Evaluation Process (SREP). The results are used to compute each bank's composite SREP score.³⁰ However, the results are not mapped into either the NSFR or the LCR, as the ECB/SSM considers that its stress tests complement these regulatory indicators and allow it to

²⁹ In Danielsson and Manfredini (2019), the SCB explains that the comparison requires an adjustment in the computation of the LCR for the purpose of the stress test, as the regulatory LCR is calculated over a 30-day period rather than the six months of cumulative net cash flows used for the exercise. A second methodological adjustment concerns the selection of the starting values in banks' balance sheet at the beginning of the time horizon for the stress test. To keep results from becoming skewed by unusual conditions in banks' balance sheet, the SCB performs the stress test on the last 12 months of reported data for each bank (ie 12 monthly results). It then picks the monthly results that correspond to the 90th percentile with regard to when liquidity needs arise for each bank.

³⁰ This score is calculated based on the four blocks used in the SREP, one of which is the liquidity component. See ECB Banking Supervision, "Supervisory methodology", *Supervisory review (SREP)*, www.bankingsupervision.europa.eu/banking/srep/2023/html/ssm.srep202312_supervisorymethodology2023.en.html.

address the latter's possible shortcomings. In Brazil, the results are used for both microprudential³¹ and macroprudential³² risk assessments.

43. **Disclosure of results is typically limited and restricted to aggregate indicators.** As authorities aim to prevent self-fulfilling liquidity shortages and disruptions, they tend to be very cautious or even reluctant to make disclosures that could lead to such shortages by triggering a loss of confidence in a bank. Accordingly, some liquidity stress test exercises may not even be announced publicly. Even when they are publicised, bank-level results of liquidity stress tests are generally not published. An exception was made by the ECB/SSM in 2019, when it conducted its first sensitivity analysis. Even if no bank-level results were published, at that time the ECB/SSM was willing to explain its methodology and provide an overview of aggregate results. The SCB occasionally publishes aggregate results in its Financial Stability Report when the findings shed light on some new or especially interesting feature. The BCB regularly publishes aggregate results in its twice-yearly Financial Stability Report, displaying the most relevant descriptive statistics of the sample. The disclosure helps to convey the Financial Stability Committee's view on the policy and measures to preserve financial stability.

44. **Separately, the BoE took a different approach to system-wide liquidity stress tests with a one-off exercise.** In 2019, the BoE conducted its Liquidity Biennial Exploratory Scenario (LBES). This focused on the implications of a severe and broad-based liquidity stress. Although similar to other system-wide liquidity stress tests in some respects, the LBES was a one-off exploratory exercise rather than a regular stress test for liquidity risk.³³ It included a liquidity run lasting 90 days and affecting all major UK banks simultaneously, followed by a nine-month recovery. The test was designed to assess how banks' and authorities' reactions to the stress would have an impact on the broader financial system and the economy. The results suggested that banks were generally unwilling to allow their LCR to fall below 100% if they could prevent it, even if it meant drawing from the BoE's liquidity facilities, and that they would seek to rebuild their liquidity buffers at the earliest opportunity because they were keen to avoid being perceived as vulnerable by markets.³⁴ The results also offered insights into banks' defensive actions in order to minimise their liquidity needs (for example by cutting lending to households and businesses).

³¹ At the bank level, the results from the BCB liquidity stress testing programme make up one of the components of the off-site rating system. They may be used to alert on-site supervision of relevant changes shown by the indicator on a daily, weekly or monthly basis. Individual bank results are also used as one of the elements of the supervisory review and evaluation process.

³² From a macroprudential perspective, the results are used internally to support the decision-making of the Financial Stability Committee. This Committee defines strategies, guidelines, macroprudential measures and instruments to preserve financial stability and mitigate systemic risk. It is comprised of the members of the Board of Governors. The heads of departments with financial stability-related functions may attend its quarterly meetings, but they have no voting rights.

³³ Its management was complicated by the Covid pandemic, as the BoE originally intended to run two rounds of the LBES. The second round would have had an updated scenario, to factor in participants' reactions in the first round, and hypothetical responses from the BoE. However, the second round was cancelled due to the pandemic, and the results of the first round were published in 2021 (see BoE (2021a)).

³⁴ See BoE (2021a p 20–22) for the main conclusions drawn from the exercise.

Section 5 – Exploring interactions between banks and NBFIs

45. **Another approach to liquidity stress testing is to focus on interactions between banks and NBFIs during periods of financial market stress.** The growing importance of NBFIs in the global financial system since 2008 and several episodes of stress in financial markets since then drive the increasing interest in such exercises.³⁵ In most cases, these exercises have two related purposes. The first is to explore and assess the impact of NBFIs' vulnerabilities on banks and to identify the channels through which liquidity stresses may be transmitted. The second is to assess the reactions and interactions between the various types of financial player, be they banks or non-banks (such as open-ended investment funds, pension funds, CCPs, insurers), and to what extent these may absorb or amplify the initial shocks.

46. **NBFIs can pose systemic risks to the rest of the financial system via interconnectedness, with their impact on banks possibly exacerbated by their leverage and liquidity mismatches.**³⁶ Shocks affecting NBFIs may be transmitted to the wider system through the counterparty channel and/or the asset liquidation channel.³⁷ Other forms of direct linkages between banks and NBFIs include bank loans provided to NBFIs, deposits made by NBFIs and contingency funding from banks to NBFIs. In such cases, banks may be effectively taking on the role of commercial lenders of last resort given to NBFIs that most NBFIs do not have direct access to central bank liquidity facilities.³⁸ Other forms of indirect linkages refer to common exposures in bond markets or in equity markets. Low interest rates up to 2022 have led to an increase in NBFIs leverage, amplifying the risk of fire sales.

47. **Two recent episodes of financial market turmoil triggered by NBFIs' vulnerabilities have tested the resilience of the global financial system.** The first was the "dash for cash" in March 2020.³⁹ The second was the United Kingdom's liability-driven investment (LDI) crisis.⁴⁰ Central banks intervened to provide markets with much needed liquidity in both cases. These episodes also highlighted a need to understand how interlinkages between banks and non-banks may play out in core markets in a liquidity stress.

48. **The scope of NBFIs included in these exercises may be narrow or broad.** Under the narrow approach, the initial shock is applied to one or several types of NBFIs. Exercises belonging to this category tend to focus on specific NBFIs segments, typically on financial institutions that can be subject to redemption shocks, cause fire sales and have important contagion effects on banks through the asset liquidation channel.⁴¹ NBFIs subject to such stress tests include MMFs or other open-ended funds, such as bond funds or real estate investment funds. Alternatively, authorities may decide to adopt a much broader

³⁵ In addition to MAS and the BoE, APRA has also announced such an exercise in which it plans to conduct a system-wide stress test focusing on interactions between banks and NBFIs in the near future (see Lonsdale (2024)). The ESRB is also planning to include NBFIs in its next EU-wide stress testing exercise (ESRB (2024)).

³⁶ For an overview of the different contagion channels between banks and NBFIs, see in particular BoE (2023a, Sections 2, 3 and 4) and MAS (2023, Special Feature 2).

³⁷ The counterparty channel refers to the direct linkages between NBFIs and banks, including the provision of credit, securities financing transactions, brokerage services, derivatives exposures and ownership of fund shares.

³⁸ Because of their role in bank funding and since they appeared to be a major source of systemic risk during the GFC when they became subject to early redemptions, money market funds (MMFs) have attracted considerable attention from regulators and supervisors. To learn more about MMFs and the reforms to which they have been subjected, see FSB (2024).

³⁹ The March 2020 "dash for cash" followed pandemic-related restrictions as precautionary demands for liquidity surged, combining large margin calls on derivatives transactions, large redemptions at open-ended funds and liquidity hoarding by some market participants. To learn more about the "dash for cash" crisis, see FSB (2020).

⁴⁰ The LDI crisis started with a sudden and sharp increase in yield on gilts following the presentation of the "mini-budget" in September 2022, and led to fire sales of UK gilts and other UK assets by leveraged pension funds using LDI strategies.

⁴¹ The asset liquidation channel considers the indirect linkages between financial entities. NBFIs may, in times of stress, have to conduct fire sales to meet redemption shocks or margin calls. Other financial entities with similar exposures, such as banks, become adversely affected as asset values drop.

scope because they aim to assess interactions across the whole financial system. In this case, authorities would include banks and multiple categories of NBFIs in the same exercise and subject them to the same liquidity stress scenarios.

49. **There are clear trade-offs when choosing either the narrow or the broad approach.** Exercises focused on certain types of NBFIs may be less complex to set up and less resource-intensive to run. However, they will only capture the direct impacts of these NBFIs on banks since they do not seek to assess other – indirect – interactions within the financial system. They may therefore underestimate or even ignore contagion and second-round effects. Stress testing exercises applied to the whole financial system can take more than a year to finalise. Their wider scope reflects their greater ambition since they aim to assess the impacts, interactions and reactions of numerous categories of financial agent.

50. **The exercises conducted by MAS and the BoE provide an example of each approach.** The exercises are MAS's stress test of investment funds, whose scope focuses on the types of NBFIs that are the most likely to have an impact on banks in Singapore, and the BoE's system-wide exploratory scenario exercise (SWES), which aims to assess interactions across the global financial system. These exercises share some key features: (i) they are not expected to be repeated on a regular basis; (ii) they emphasise liquidity risk as the main contagion channel between banks and NBFIs; and (iii) they include interactions between both domestic and international players.⁴²

Box 1

EU stress test of the asset management sector

An early example of stress tests covering banks and NBFIs is the exercise conducted by the European and Securities Markets Authority (ESMA) in 2019. ESMA published its stress simulation (STRESI) framework to assess the resilience of asset managers to shocks. This was a direct consequence of the strong growth experienced by the asset management industry since 2008 and of the Financial Stability Board's (FSB) recommendations to address structural vulnerabilities arising from asset management activities, first published in 2017. These recommendations include provisions related to stress tests.Ⓞ ESMA's STRESI framework is a top-down simulation-based approach led by regulators that combines micro- and macroprudential objectives.

Typically, STRESI exercises are simulation-based approaches which require large amounts of granular data and a sophisticated methodology through which the regulator models a scenario and defines assumptions along five steps. The first step is to define the sample (ie the type of fund, for instance MMFs) that will be subject to the stress simulation and the coverage. The second step is to design a common redemption and/or price shock calibrated on historical and/or hypothetical scenarios. The third is to model the reactions of funds and of funds' investors to the shock. The fourth is to assess the feedback loops between investor redemptions and fund performance, while the fifth step focuses on contagion to other entities, starting with banks.

Ⓞ See FSB (2017), in particular Recommendations 6 and 9, where authorities are invited to require fund-level stress testing and to promote system-wide stress testing to capture the effects that collective selling by funds and other institutional investors may have on the resilience of the financial system. Most of the Recommendations were operationalised in 2018 by IOSCO. The FSB updated its Recommendations in December 2023.

51. **The first example is the MAS liquidity stress simulation on investment funds in Singapore.** The main features of its methodology, which is similar to that used by ESMA in its STRESI exercises (see Box 1) and by the International Monetary Fund in its Financial Sector Assessment Program (FSAP) stress tests, have been included in MAS's Financial Stability Review for 2023. The simulation is part of a more comprehensive analysis of system-wide vulnerabilities arising from NBFIs.⁴³ The exercise applies a

⁴² The MAS exercise covers both Singapore-domiciled and foreign-domiciled funds offered in Singapore or managed by asset managers licensed in Singapore. The BoE's SWES exercise includes subsidiaries and branches of large American and European banking groups, in addition to large insurers and pension funds and asset management companies.

⁴³ See MAS (2023, Special Feature 2, Box D).

significant redemption shock to open-ended investment funds with a focus on fixed income and equities to assess their resilience. The analysis aims to determine whether individual funds have sufficient liquidity to meet redemption shocks. It also assesses the aggregate impact of the funds' asset sales on market prices. This allows to determine the impact of such one-sided markets on funds' portfolios. The scope of funds includes both funds domiciled in Singapore and foreign funds offered to Singapore investors and managed out of Singapore.⁴⁴ Going forward, MAS plans to refine and enhance the exercise. Possible enhancements include examining the impact of shocks resulting from adverse macroeconomic scenarios and assessing contagion risks arising from interlinkages and common exposures between investment funds and other financial institutions, including banks.

52. **The second example is the BoE's SWES.** This exercise is deemed "exploratory" to differentiate it from stress tests that are regularly conducted. Moreover, the SWES is not used to test the resilience of individual financial firms, nor is it used to drive the individual requirements of regulated firms (banks or insurance firms). Rather, the BoE's objective is to improve risk identification in – and the functioning and resilience of – market-based finance.⁴⁵ This is in line with the assessments carried out by the BoE and, globally, by the FSB, which both underscored the need to "strengthen resilience in the NBFIs sector for the global financial system to absorb shocks and ensure the smooth provision of financing to the real economy" and "enhance understanding of systemic risks in NBFIs and the financial system as a whole" (FSB (2020)).⁴⁶ The SWES exercise is ongoing and is due to be completed by the end of 2024.⁴⁷

53. **The SWES focuses on how a wide range of intermediaries, investors and infrastructures can interact and determine how important financial markets function.** These interactions can exacerbate or, on the contrary, help to reduce the volatility of markets in the event of a shock. There are over fifty participating financial institutions, including large banks, insurers, CCPs and a variety of funds (including pension funds, hedge funds and funds managed by asset managers). Participants include both UK-incorporated entities and entities incorporated overseas, including subsidiaries of large international financial groups and branches of large European and North American banks engaged in UK financial markets.

54. **The SWES exercise combines shocks drawn from recent events.** The scenario combines shocks to a range of market prices and indicators over 10 business days.⁴⁸ During the first round of the scenario, banks, insurers and fund managers were asked to model the impact of the shock and their intended reactions to it and to communicate their responses to the initial stress. This then allows the BoE to assess how the scenario may be affected by participants' collective actions.

⁴⁴ Funds in scope corresponded to the following fund types: Asia equity, Emerging Markets (EM) equity, global equity, Asia fixed income, EM fixed income, high-yield (HY) fixed income, global fixed income and balanced funds.

⁴⁵ In the United Kingdom, the non-bank financial system more than doubled in size between 2008 and 2020, while the banking sector grew by 60%, with both components interacting and participating in financial markets. It is therefore increasingly important to understand and assess the linkages and interactions between banks and non-banks and how the vulnerabilities of the latter can amplify and transmit a stress across the financial system. The hypothetical stress scenario underpinning the SWES exercise, which will be concluded at the end of 2024, is designed to take place faster. It is wider ranging and more persistent than recent episodes of market instability, with sharp moves in rates and risky asset prices.

⁴⁶ The main lessons of the March 2020 market turmoil are summarised in Box 2.

⁴⁷ See BoE (2023b,2024b).

⁴⁸ The shocks are roughly in line with those observed during the September/October 2022 LDI episode. The scenario also includes some elements of the March 2020 "dash for cash" and focuses on interactions between financial institutions in core UK financial markets, or "markets in focus" (see Box 2). Markets in focus include the gilt market, the gilt repo market, the sterling corporate bond market and associated derivatives markets.

Main lessons of the March 2020 “dash for cash”

The Covid-19 shock tested the resilience of the global financial system (banks and NBFIs). The breadth, size and dynamics of the economic shock and liquidity stress were unprecedented. The initial reaction of financial markets was a “flight to safety” with a tightening of market conditions, large falls in asset prices and a surge in demand for safe assets (see FSB (2020) for a detailed discussion).

Between 9 and 23 March, as countries announced lockdowns, border closures and quarantines, the “flight to safety” became a “dash for cash” involving broad-based selling where even the prices of highly rated government securities declined sharply. This ended with the extraordinary interventions from central banks combining large asset purchases, liquidity facilities and the establishment of dollar swap lines. These came in addition to measures providing regulatory relief (such as banks’ ability to use their capital and liquidity buffers) and substantial fiscal support.

The overarching lessons drawn by the FSB are the need to strengthen NBFIs’ resilience in order to enhance the financial system’s ability to absorb shocks, the importance of analysing interconnectedness across the financial system and the need to focus on certain market activities that may have caused and amplified liquidity imbalances and propagated stress.

Propagation through short-term funding markets

- Increasing risk aversion and liquidity needs first led to significant redemptions from non-government MMFs. The following sales of large amounts of short-term assets were such that investors in commercial paper (CP) and certificates of deposits (CDs) became unwilling to provide funding beyond a few days.

- Dealers struggled to absorb large sales of CPs and CDs that have little secondary markets as their balance sheets were already constrained. Dealers were also limited in their ability to provide repurchase lending to clients, including NBFIs, with this further exacerbating the asset sales. Banks became less willing to provide hedging services. Prime MMFs that traditionally supply dollar funding faced redemptions and were forced to sell assets.

- Banks’ funding costs increased as interest rates on CPs, CDs and unsecured interbank loans surged while corporates, who were no longer able to access short-term markets, drew down their credit lines with banks, crowding out other forms of bank lending.

- Dollar funding conditions tightened as demand increased. Non-government MMFs sold US dollar CPs issued by non-US banks and corporates while outflows from US dollar bonds issued by emerging market economy (EME) borrowers rose significantly.

Propagation through core government bond markets

- As demand for cash and short-term assets increased, investors also started selling large volumes of long-dated Treasuries in favour of shorter-dated assets or cash.

- Market dysfunction in government bond markets was exacerbated by large sales of US Treasuries by leveraged investors, as these had to unwind loss-making basis trades and face margin calls.

- Large-scale net selling by foreign holders of US government securities added to market pressures, reaching almost USD 300 billion in March. These included both EME authorities seeking to raise USD cash to satisfy the funding needs of non-US firms and intervention needs in FX markets.

- As with short-term funding markets, dealers’ capacity to intermediate in other asset classes was constrained. This was the case for corporate bonds, where dealers limited their purchases or reduced their inventories, leading to a sharp reduction in market liquidity, and for the provision of repurchase funding to hedge funds, which was reduced, becoming more costly and forcing some hedge funds into selling assets.

- The combination of large asset sales and limited dealer intermediation increased illiquidity and prompted margin calls in centrally cleared and bilateral markets as well as in spot markets. These in turn increased demand for liquid assets, leading to further asset sales and price volatility.

Section 6 – Challenges and areas for future development

55. **Although the selected stress testing approaches are considered useful by the surveyed authorities, they have limitations, and the recent banking turmoil has emphasized the need for enhancements.** Even before 2020, authorities saw data and modelling issues as the main limitations. In addition, the 2023 banking turmoil showed how rapidly liquidity strains can build up and limit a bank's survival options. Although the features of the recent stress events were largely case-specific, these experiences highlighted the need to improve various aspects of liquidity stress tests.

56. **Enhancements apply to data sources, modelling of networks, and assumptions about the treatment of assets, liabilities and management responses.** Better data would allow for improvements across all aspects of a stress test, such as identifying the various components of a bank's balance sheet, intra-group relations, and connections between banks and other financial firms. Improved data would also support more accurate and granular calibrations of haircuts and price declines. This would also allow to model interaction and contagion channels within the financial system. Separately, stress tests could be enhanced by introducing or refining assumptions in several areas in order to better capture concentration of exposures on the asset and the liability side, management responses to an initial liquidity shock and depositors' behaviour. Finally, improved modelling of the links among banks, and between banks and NBFIs, can help to better understand the propagation of the initial shock. The rest of the section discusses these aspects in more detail.

57. **Overcoming data limitations would allow for more comprehensive and in-depth assessments, particularly with regards to capturing concentration risks.** On the funding side, more information about the distribution of deposits, with breakdowns by customer type (eg types of corporate depositor) as well as the extent to which they are covered by deposit insurance, could make it possible to better identify concentrations and give authorities a better sense of how volatile certain deposits may turn out to be in a crisis. Identifying and assessing the behaviours of a growing range of non-bank financial counterparties in funding markets, particularly during liquidity stress periods, would also improve authorities' understanding of concentration risk in banks' funding sources. On the asset side, breakdowns of categories of assets held by banks (eg sovereign exposures by residual maturity or a security-level breakdown of exposures) would allow authorities to better assess asset liquidity risk. Together, improvements on both the asset and liability side would help conduct more accurate stress tests and more easily identify banks with volatile funding profiles. In addition, a more comprehensive mapping of banks' exposures to non-banks would help to identify the extent to which their exposures are concentrated⁴⁹ and help uncover the potential for contagion.

58. **Better data would also help to improve the treatment of specific aspects of the banking business covered in the stress tests.** For instance, introducing realistic assumptions in stress tests regarding the volatility of intraday liquidity needs, margin calls, intragroup funding and liquidity transfers, including across borders for large international groups, requires very granular information on banks' exposures.⁵⁰ In the absence of such data, some degree of approximation has been introduced in top-down

⁴⁹ Concentrated exposures held by banks can be either direct or indirect. Direct concentrated exposures are those held by multiple banks against the same non-bank counterparties, for instance through prime brokerage services. Indirect concentrations may arise when non-bank counterparties are themselves holding concentrated positions of which the banks are generally largely unaware.

⁵⁰ Some authorities have increased the frequency of bank liquidity data reporting to help address data challenges. For instance, the ECB/SSM has supplemented the monthly reporting of the maturity ladder data with additional data reporting that banks must submit weekly or even daily if needed. The BoE can also increase the frequency of data reporting to daily, while the BCB integrates data from clearings to estimate exposures and concentration. In practice, it is often difficult for financial authorities that do not have supervisory powers to require additional reporting from banks, and from financial institutions more generally, and they are more likely to be restricted to regular reporting as a result. However, these efforts are not sufficient to monitor banks' intra-day liquidity needs.

exercises, in particular through applying a single haircut to all highly rated government securities. However, more accurate analysis and assumptions may be needed to better reflect the fact that even securities with similar maturities issued by the same issuer may have different levels of liquidity.

59. **On the modelling side, extending the exercises to non-banks and including second-round effects and contagion would also be needed.** Ideally, a comprehensive stress test would include all relevant types of financial firms and all significant second-round effects. However, authorities are currently unable to conduct an exhaustive quantitative analysis of the impact of liquidity risk within the banking sector itself or in combination with other parts of the financial system. This is partly because of data limitations and partly because of the complexity involved in modelling multiple linkages and transmission channels between banks and non-banks, among banks themselves (eg via the interbank market) and across multiple markets (such as cash and derivatives markets, foreign currency markets, repo and short-term funding markets and bond markets). Similarly, capturing second-round effects and contagion across participants requires much more granular data and more sophisticated models. As a result, second-round and contagion effects are still addressed qualitatively or by using broad and simplifying assumptions.⁵¹

60. **To support the study of contagion and second-round effects, models would need to include more refined assumptions to reflect the interactions between market participants.** This is needed considering that such interactions are likely to exacerbate the impact generated by the initial shock. Ignoring these risks limits significantly the authorities' ability to appreciate the speed with which stress may spread within a banking group, as well as the banks' response capacity. It also leads to underestimating the severity of liquidity shocks.

61. **Better modelling of banks' reactions and related behavioural assumptions would help to improve the treatment of second-round effects.** When banks face a liquidity shock, their first response is generally to draw down liquidity lines, sell unencumbered liquid assets and use collateral pre-positioned with the central bank to raise cash. Authorities usually do not have sufficient information regarding banks' undrawn liquidity lines. In addition, collateral is not routinely pre-positioned with the central bank in all jurisdictions. Information about the extent to which assets may be encumbered or subject to transferability restrictions is also not directly available to the authorities; these aspects may also be imperfectly known to the banks themselves. Authorities running a stress test would therefore need to assess each bank's liquidity arrangements with third parties, select the metrics they could use to quantify them, and apply stress to determine whether and to what extent these arrangements hold up during a crisis. Precise information on asset encumbrance throughout a financial group⁵² would provide additional realism to assumptions about banks' capacity to sustain liquidity stress. Testing the impact of a range of behavioural assumptions would also help enhance the reliability of the stress tests for the authorities.⁵³ At the same time, these changes would add a significant amount of complexity to the exercise and require the collection and assessment of large amounts of very granular data.

62. **Modelling improvement would also be needed to expand the scope of the stress test beyond banks, at least in jurisdictions where NBFIs play a large role.** As mentioned in section 5, extending the scope of the stress test beyond banks provides authorities with a more realistic and a more comprehensive assessment of contagion channels and the possible propagation of risks in the financial system. For instance, when considering the extension to non-banks, the role played by insurance

⁵¹ One example of such a simplifying assumption is the application of a broad haircut of 5% on all highly-rated government securities during a liquidity stress.

⁵² In practice, this reflects the increasing importance of group-wide collateral management, with the need for a bank's management to know, in real time as much as possible, the types and amounts of collateral that are readily available in each of the group's main locations and markets and whether, at what cost and to what extent they are transferable from one entity to another and from one location to another.

⁵³ In addition, and in order to better estimate behavioural assumptions in a liquidity stress test, one way forward for authorities would be to develop and use metrics to capture changes in market sentiment about each bank. This could be achievable for instance by taking advantage of big data and machine learning.

companies as a source of funding to banks may need to be questioned. While authorities may assume that the former continue providing funding to the latter, for instance via FX swaps or repos, such an assumption may not be realistic during a stress situation.

63. **Additional areas where stress tests could be improved include assumptions concerning price declines or liability outflows during periods of stress.** As mentioned in the previous sections, many assumptions are needed to reflect as realistically as possible the prices at which assets may be liquidated during a period of stress or the speed at which banks may experience outflows. Such simplifying assumptions may, however, fail to reflect how fast liquidity may evaporate across a wide range of assets and banks' liabilities, as well as how this may vary under different scenarios of liquidity stress. Historical precedent may be less reliable for liquidity than for solvency stress tests, as liquidity can evaporate fast; structural changes can accelerate its disappearance. It can also originate from a wider range of counterparties that includes an increasing number of NBFIs.⁵⁴

64. **Other key assumptions that would deserve more effort relate to exposure concentrations on both the asset and liability sides.** Given the experience of depositor run-off during the recent banking turmoil, authorities may want to ensure that assumptions included in their stress testing models regarding run-off rates for large - and especially uninsured - deposits are appropriate. They may also want to verify that behavioural assumptions that lead to the classification of retail deposits as less flighty than wholesale ones hold up. Authorities may also need to evaluate the impact on their scenario design, especially regarding assumptions about run-off rates.⁵⁵ Concentration of deposit funding in a single type of customer (eg similar corporate profiles) may also expose banks to shocks that could hit that particular type of depositor (eg venture capital or cryptoasset-related businesses⁵⁶ facing higher funding needs around March 2023); such circumstances would need to be included in the stress testing scenario. On the asset side, the impact that direct and indirect concentration of exposures to particular asset classes may have on banks' liquidity could also need to be assessed through stress testing. Besides the issue of HQLAs mentioned above,⁵⁷ stress tests would need to reflect the impact of concentration of exposures in foreign currencies on certain types of exposure.⁵⁸

65. **Finally, an assumption in stress tests that may deserve further reflection is the accounting treatment of HQLAs when held at amortised cost.** This is because the lack of recognition of unrealised losses in banks' income could prevent banks from selling these assets at times of market stress. This would force them to recognise and publicly disclose material losses on those sales, which could trigger a bank run. The authority conducting the stress tests may therefore want to apply significant haircuts against such

⁵⁴ Stress tests would also need to reflect the fact that assumptions about price declines or liability outflows may not remain appropriate over time, especially in the event of structural changes. For instance, a dysfunctional bond market, in particular for sovereign bonds that are heavily used for trading and as collateral in repurchase transactions, could alter the level of liquidity in the market and require higher levels of haircuts, as happened during the March 2020 stress in the US Treasury market. As seen during the March 2023 market turmoil, large and uninsured customer deposits can become particularly volatile. Moreover, technological changes – such as the widespread use of social media that allow for market rumours to spread more quickly and of applications that allow for banking and securities transactions on an uninterrupted basis – can considerably increase the volatility of funding (BCBS (2023, p 9) shows the extent to which the deposit outflows of bank runs on some of the distressed banks exceeded the one-size-fits-all regulatory assumptions of the LCR.

⁵⁵ Financial technology makes it possible to transfer deposits and open/close accounts in a few clicks online; combined with social media, this may substantially increase run-off rates. To some extent, banks may be able to limit the speed of these outflows. For instance, some large international banks have introduced a cap on the monthly amount that a retail customer can transfer to other accounts in other banks, with transfers in excess of this cap requiring that the bank be notified before they are accepted.

⁵⁶ See Barr (2024).

⁵⁷ Other examples include lending to commercial real estate (CRE). Banks' direct concentrations in CRE lending can have liquidity implications when the loans come due, given that these assets are less than fully liquid.

⁵⁸ This refers to the role played by prime US MMFs as buyers of CPs and CDs issued by non-US banks and as providers of short-term funding for such banks.

assets, including government securities, with their size depending on the severity of the stress scenario under consideration.

66. **A broader issue is whether recent events may justify a change in policy frameworks and supervisory practices.** In its analysis of the recent banking turmoil, the BCBS (2023) concluded that the existing liquidity regulation remained fit for purpose. However, an enhancement of supervisory practices may be appropriate, particularly as market conditions can rapidly change from business as usual to crisis mode. At the national level, a number of authorities are currently reassessing their supervisory frameworks for liquidity risk, including their related stress testing exercises. For instance, in the United States, the Federal Reserve Board launched an internal review of the liquidity requirements in that jurisdiction, including the use and design of internal liquidity stress tests (ILSTs) by banks.⁵⁹ Although neither the results of the ILSTs nor their methodologies are currently published, the US financial authorities may nevertheless communicate expectations on the outcome of their review.

Section 7 – Concluding remarks

67. **Liquidity risk is a key consideration for banks and authorities, and stress tests can help to monitor it.** Given the traditional role played by banks in credit intermediation and maturity transformation, these need to carefully manage liquidity risk. Authorities are similarly concerned with how banks manage this risk, both to ensure the resilience of individual banks and to limit the risk of distress in the financial system. To monitor this risk, banks and financial authorities regularly conduct liquidity stress tests.

68. **The different approaches adopted by the selected authorities reflect the needs and structure of their respective banking sectors.** Typically, countries that have more recently experienced a banking crisis – or with financial sectors that are similar to those in countries with such experience – are more likely to have invested in more sophisticated stress testing frameworks. Countries with a more complex and diversified financial system, where multiple types of NBFIs closely interact with banks and may have a systemic impact, may also be keener on system-wide stress tests that take a holistic perspective. Liquidity stress tests are considered helpful even in countries with no recent experience of banking crises or particularly complex financial systems, with a banking sector-wide perspective built up through the combination of the results of bank-level exercises. Stress testing a more sophisticated and more diverse financial system will also involve more resources and a higher degree of modelling complexity.

69. **Although liquidity stress tests are well established, there are still significant challenges.** Authorities started running system-wide liquidity stress tests after the GFC, although solvency stress tests initially attracted more resources and attention given that credit risk was the main driver of that crisis. Since then, efforts have been made to increase the degree of sophistication of liquidity stress tests, not least by designing self-standing system-wide liquidity stress tests that are conducted independently of a solvency exercise. By gaining more experience with the specific features of liquidity stress tests, related challenges may become easier to identify. Data needs are one of the common limitations among the sampled authorities. In particular, high-frequency data and a considerable level of granularity are highly desirable. Modelling capacity is another major challenge, as correctly identifying the impact of a liquidity shock requires a comprehensive mapping of the interactions among banks as well as, increasingly, the interactions between banks and NBFIs. Modelling interactions and second-round effects is demanding, so such analysis, although crucial, is mostly qualitative for the time being.

⁵⁹ See for instance Barr (2024).

70. **Notwithstanding considerable enhancements made by authorities regarding their system-wide liquidity stress tests, further developments might be needed.** The ways in which liquidity risk materialises and the relative importance of the various liquidity channels can change over time, reflecting changes in the structure of the financial system. Assessing the adequacy of existing liquidity stress testing frameworks requires deeper and more frequent reviews than are needed for credit risk and solvency stress tests, where the key drivers seem to evolve more slowly over time. Recent market stress episodes have highlighted areas for further development, including with regards to the assumptions underpinning a liquidity stress test. Examples include the treatment of HQLAs and the availability of intragroup funding for banks in times of stress. Concentration of exposures on both the asset and liability sides also deserve further attention in the design of stress testing exercises.

71. **Structural changes driven by technology also need to be reflected in stress tests.** Liquidity can evaporate rapidly from the financial system, driven by both traditional and more novel factors. The roles of both social media in spreading information and technology in allowing for continuous transactions make deposits flightier. Other large liquidity drains that may take place intraday include large variation margin calls on exchanges and collateral calls by counterparties more generally. Intraday day and intra-group liquidity may therefore evaporate quickly. As a result, the assumptions underpinning stress tests used by financial authorities need to either adjust existing assumptions about asset valuations and behavioural responses, or introduce new ones.

72. **The interconnectedness between banks and NBFIs also calls for additional developments in liquidity stress tests.** In some jurisdictions, the need to better understand interlinkages between banks and non-banks drives the emergence of a new type of liquidity exercise encompassing the whole financial system, including banks and NBFIs. This is useful to determine more comprehensively the resilience of individual banks and firms as well as to better assess the overall impact of a liquidity stress test on the financial system. Given their complexity, such exercises raise significant data and modelling challenges that have yet to be overcome.

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