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Systemwide Stress Test at the IMF

Integrating Nonbank Financial Intermediary Risks

Hiroko Oura and Guillaume Arnould with Xiaodan Ding, Pierpaolo Grippa, Marco Gross, Dimitrios Laliotis, Mindaugas Leika, Caterina Lepore, Elisa Letizia, Laura Valderrama, and Yuchen Zhang.

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ABSTRACT: This paper presents the IMF's systemwide stress testing approaches, which cover multiple financial sub-sectors and their clients. Developing these tools is crucial for identifying cross-sector and cross-border amplification channels and enhancing policy responses, as recognized by the international financial stability community. The paper reviews classic and modern theories and operational methods for analyzing systemic liquidity risks that impact numerous institutions simultaneously, illustrating how shocks can spread through banks, nonbank financial institutions (NBFIs), and market-based finance via runs, redemptions, margin and collateral calls, fire sales, price dynamics, and disruptions in core markets. It details two base IMF tools—an Excel-based flow-of-funds framework and investment fund liquidity analysis with fire sale and market-impact dynamics—and their application and enhancement within Financial Sector Assessment Programs (FSAPs) across various countries.

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WORKING PAPERS

Systemwide Stress Test at the IMF: Integrating Nonbank Financial Intermediary Risks

Prepared by Hiroko Oura and Guillaume Arnould[1]

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[1] The authors would like to thank to helpful feedback from IMF colleagues, national authorities that underwent FSAP exercises quoted in this paper, and Stijn Claessens. Any inaccuracies and issues belong to the authors.

Contents

Glossary

ABM	Agent-Based Models
AE	Advanced Economies
BoE	Bank of England
BoC	Bank of Canada
BCBS	Basel Committee on Banking Supervision
BSA	Balance Sheet Approach
CCP	Central Counterparties
CDMDF	Corporate Debt Market Development Fund
CLO	Collateralized Loan Obligations
CPMI	Committee on Payments and Market Infrastructures
ECB	European Central Bank
ELA	Emergency Liquidity Assistance
EM	Emerging Market
EMDE	Emerging And Developing Economies
FDI	Foreign Direct Investments
FSAP	Financial Sector Assessment Program
FSB	Financial Stability Board
FX	Foreign Exchange
GFC	Global Financial Crisis
IAIS	International Association of Insurance Supervisors
IC	Insurance Corporation
IMF	International Monetary Fund
IOSCO	International Organization of Securities Commissions
LCR	Liquidity Coverage Ratio
LDI	Liability-Driven Investment
LOLR	Lender Of Last Resort
MILD	Market Impact from Investment Funds Liquidity Distress
MMF	Money Market Funds
NAV	Net Asset Value
NBFC	Non-Banking Financial Company
NBFI	Nonbank Financial Institution(s) or Intermediation
NFC	Non-Financial Corporates
OFI	Other Financial Institutions
PF	Pension Fund
SSB	Standard Setting Bodies
SFV	Structured Finance Vehicles
SNA	System of National Accounts
SWES	System-Wide Exploratory Scenario
UCITS	Undertakings for Collective Investment in Transferable Securities

Executive Summary

Structural changes since the Global Financial Crisis (GFC) have fundamentally reshaped financial stability risks. As NBFIs and market-based finance have become more prominent, systemic liquidity stress—where numerous financial institutions concurrently experience liquidity shortages—has grown in importance alongside traditional bank-focused solvency concerns. NBFIs now face heightened market-driven liquidity risks due to leverage, maturity mismatches, derivatives exposures, and reliance on repo funding. Their close ties to banks further amplify contagion throughout the financial system. Additionally, post-GFC reforms introducing centralized clearing have often shifted certain solvency risks, such as counterparty credit risk from defaults, into liquidity risks with the introduction of margining practices. Even in countries where domestic NBFIs are relatively small, global asset managers can transmit external shocks through volatile capital flows, linking domestic financial stability risks tightly to external and foreign exchange liquidity conditions. Recent events—including the "dash for cash" and the 2022 stress episode involving NBFIs with liability-driven investment (LDI) strategies—demonstrate how liquidity shocks can emerge suddenly and propagate across the interconnected balance sheets of NBFIs and banks, through mechanisms such as margin and collateral calls, investor redemptions, and fire sales.

In response, international financial stability groups have increasingly called for systemwide stress testing approaches that can capture cross-sectoral amplification channels among banks and NBFIs. Traditional stress testing tools typically focus on vulnerabilities within a single sector—such as banks, insurers, or investment funds—while contagion analyses are often limited to the banking network due to data availability, or rely on market price-based systemic risk measures from the academic asset pricing literature. Recognizing these limitations, the Financial Stability Board (FSB) and various sectoral Standard Setting Bodies (SSBs) have, in recent years, emphasized the importance of assessing risks and vulnerabilities from a systemwide perspective—encompassing both cross-sectoral and cross-border amplification channels—to better monitor risks and guide policy decisions. As a result, several national authorities in advanced economies have begun developing experimental top-down models using available supervisory data, an approach consistently applied in IMF exercises, while some authorities have been conducting bottom-up exercises in collaboration with private sector participants.

Despite a robust theoretical foundation, developing systemwide stress testing models is hampered by significant data, technical, and resource constraints. Academic research provides extensive insights into the mechanism of systemic liquidity stress—from bank runs and market dislocations to repo market disruptions and margin call-induced liquidity pressures. However, limited data availability, particularly for lightly regulated NBFIs, off-balance-sheet exposures, and cross-border transactions, restricts the scope and depth of these analyses. Accurately capturing behavioral responses to liquidity shocks remains challenging, as institutional reactions are complex and highly context dependent. While bottom-up exercises can help address some data gaps, integrating these results consistently across diverse environments is not straightforward. Moreover, expanding model coverage to include risks from derivatives, repos, and the positions of lightly regulated NBFIs requires substantial transaction-level data, demanding data management and coordination across agencies. These factors make comprehensive systemwide modeling both resource intensive and operationally complex.

Against this backdrop, this paper introduces two generic IMF systemwide analysis tools and their application and extensive enhancement in FSAP over the past decade. The IMF began developing these tools nearly a decade ago, recognizing that a systemwide perspective is crucial for financial stability in small open economies—particularly emerging market economies, where systemic liquidity risks are closely linked to cross-border FX flows and external

stability, both core elements of the IMF mandate. The first is an Excel-based systemwide liquidity analysis tool, leveraging sector-aggregate flow-of-funds data to monitor liquidity shocks and their transmission across domestic financial linkages. Importantly, the Excel tool is suitable for a broad range of economies, including some low-income countries, now that such data have become available for many members. The second tool is the Market Impact from Investment Funds Liquidity Distress (MILD) framework, which uses granular investment funds and their asset data to assess redemption pressures, asset sales, and secondary price effects. Both tools are adaptable for FSAPs, tailored to country-specific data and priorities and often augmented significantly to deliver customized and in-depth analysis.

FSAP applications frequently revealed key vulnerabilities and mitigating factors, and identified critical data gaps to improve. Initial efforts focused on emerging and developing economies, where external shocks, volatile capital flows, and FX liquidity constraints drive systemic risk. Often, nonfinancial entities—corporates, households, or the public sector—played major roles in transmitting or triggering systemic liquidity stress. Later FSAPs broadened systemwide analysis to advanced financial systems, integrating various NBFI segments, fire-sale price effects, and, more recently, liquidity needs from repos and derivatives based on transaction-level data. Advanced economies' cases showed that liquidity stress can rapidly spread across banks, insurers, money market funds, and core funding markets—even without significant solvency losses. In contrast with most national authorities' exercises, FSAP analyses usually explored a range of behavioral scenarios to identify the actors and actions most likely to drive or mitigate systemic risk instead of choosing specific ones. Moreover, most exercises carefully discussed the systemwide consistency of clients' money withdrawals or redemptions from financial institutions. Whether they stay in the domestic system or exit the country determines the systemic impact through macroeconomic channels involving exchange rate and capital flows—a feature that national authorities' exercises typically do not account for.

Drawing on these experiences, this paper highlights future priorities for advancing systemwide stress testing at the IMF. Progress in the near term depends on leveraging currently available, but often underutilized, data reported to national regulators—such as banks' granular counterparty credit and large exposure information—to better measure linkages with NBFIs and identify potential risk concentrations. Another key area is deeper integration of market microstructure, margining, and clearing arrangements into stress scenarios by utilizing transaction-level data collected by financial market infrastructures (FMIs), as demonstrated in the 2025 Euro Area FSAP. Because managing these data is resource-intensive and confidentiality provisions often exceed those for standard macro scenario stress tests, close collaboration with national authorities and, ideally, key FMIs is crucial. Over time, insights from bottom-up exercises and behavioral evidence can support more sophisticated behavioral modeling approaches, including agent-based frameworks. Continued international efforts to address data gaps will help illuminate dark corner of finance and more systematic data-sharing and coordination across national authorities could facilitate better use of existing data sources.

Overall, systemwide stress testing represents a valuable addition to the financial stability toolkit despite its current limitations. While not designed to deliver precise assessments of system resilience, these exercises are effective in identifying potential weak links, critical data gaps, policy trade-offs, and regulatory features that may strengthen individual sectors while increasing system-wide fragility. As financial systems continue to evolve toward greater market-based intermediation, systemwide approaches will remain central to understanding and mitigating systemic risks.

Introduction

The Rising Prominence of Nonbank Financial Institutions

The financial sector has changed markedly since the Global Financial Crisis (GFC), with nonbank financial institutions (NBFIs)—especially asset managers—assuming a far more important role (Figure 1). Of over $500 trillion in global financial assets, NBFIs now hold $256 trillion (FSB, 2025). While NBFIs have traditionally made up about half of total system assets, banks' share has gradually receded since the GFC. NBFIs are typically larger in advanced economies, whereas banks still prevail in most emerging and developing economies, though there are significant jurisdictional differences. Notably, structural changes within the NBFI sector have accelerated: "other financial institutions" (OFIs)—NBFIs excluding pension funds, insurers, and financial auxiliaries as categorized by the Financial Stability Board (FSB)—have rapidly expanded, propelled by the asset management industry, which includes money market funds (MMFs), hedge funds, and other investment vehicles.[1] The rise of NBFIs has also shifted the focus of short-term funding markets away from unsecured interbank lending and toward sovereign repos and derivatives, which are accessible by banks and NBFIs alike (Pinter and Walker, 2023; Alfaro and others, 2024).

NBFIs, and the asset management industry in particular, face significant market risks from their activities in money and capital markets, which can result in liquidity stress. Most invest in marketable securities, and many pursue higher yields via derivatives, repos, and synthetic instruments. Some of them, particularly hedge funds and private family offices, are highly leveraged with direct borrowing from banks or with synthetic instruments. Open-end funds are especially susceptible to liquidity stress: declines in net asset values (NAVs) can prompt large client redemptions, forcing managers to run down cash buffers or fire sale assets—a "dash-for-cash"—especially when investment strategies have maturity or liquidity mismatches.[2] Even without redemptions, funds with derivatives or repo exposures may face urgent collateral or cash needs due to margin calls. Simultaneously, ongoing structural changes in the insurance and pension sectors including increasing integration with the asset management industry, have made the sector more exposed to shocks.[3] Their search for yield has led them into alternative assets and more short-term investments in derivatives and repos, heightening their exposure to liquidity risk—such as seen in the 2022 stresses affecting UK pension funds with liability-driven investment (LDI) strategies.[4]

[1] An OFI is a subset of NBFIs that excludes insurers, pension funds, and financial auxiliaries, and includes money market funds (MMFs), hedge funds, other investment funds, captive financial institutions, money lenders, central counterparties (CCPs), broker-dealers, financial companies, trust companies, and structured finance vehicles. In this paper, "asset management industry" refers to the sum of MMFs, hedge funds, and other investment funds. Financial auxiliaries are entities that provide services that enable financial transactions, markets, or institutions to function but do not engage in bank-like activities such as leverage or maturity transformation and are composed for example of Brokerage firms or credit rating agencies

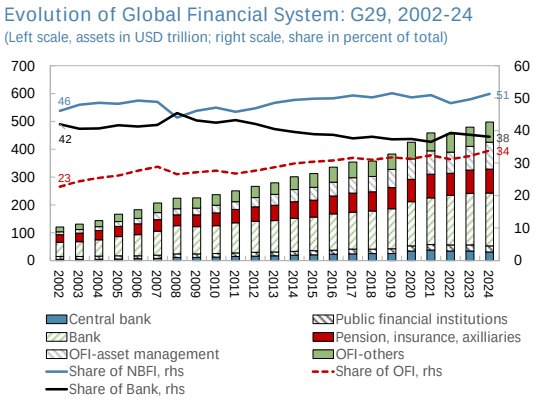
[2] The market turbulence and resulting liquidity stress may push some asset management funds to default on their short-term financial contracts (i.e., counterparty credit risk), but not necessarily to insolvency, namely negative capital. Investment funds' losses are absorbed by funds' shareholders, unless they are leveraged and fall into insolvency.

[3] Life insurers are shifting investments from traditional bonds and equities to alternative assets such as private equity, heightening risks from leverage, liquidity mismatches, and uncertain valuations. In some jurisdictions, private equity firms have bought insurers increasing cross-sectoral interconnectedness (IMF, 2023). New business models have enabled life insurers (through asset intensive reinsurance exploiting regulatory arbitrage opportunities, IAIS 2025) and property and casualty insurers (through catastrophe bonds, IAIS 2023 and IAIS and the World Bank 2025) to transfer risk to broader markets and across borders, diversifying risks, but also increasing interconnectedness.

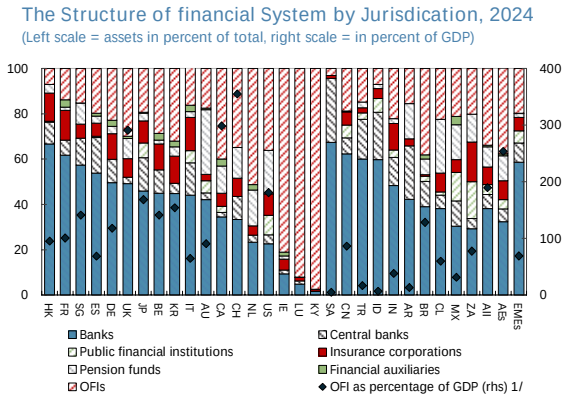
[4] LDI funds had extensively used repo to borrow cash and buy gilts to increase their leverage. This generated large collateral calls, on top of margin calls from derivative positions such as interest rate swaps. LDI funds and pension funds had mainly long-term gilts, a market with limited depth, which amplified the price impact of the large sales of gilts. It generated a self-reinforcing spiral that that threatened the functioning of core UK funding markets, forcing the Bank of England to intervene (Cunliffe, 2022, Chen and Kemp, 2023).

Figure 1. Global Financial System Landscape

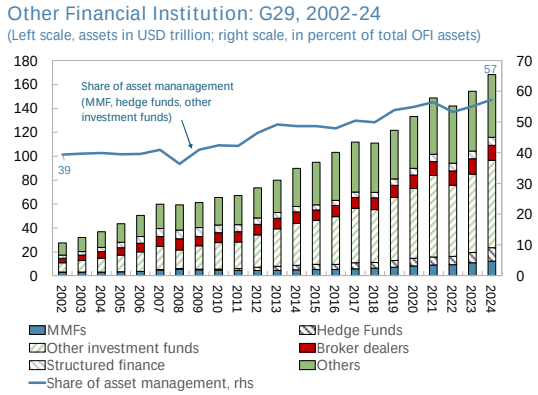
Over the past two decades, the shares of NBFIs and banks remained broadly constant.



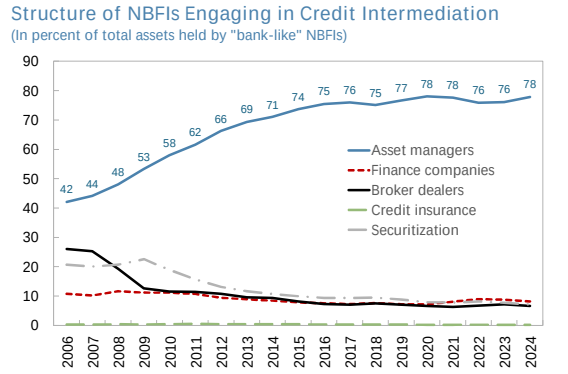
The global picture masks substantial differences across countries.



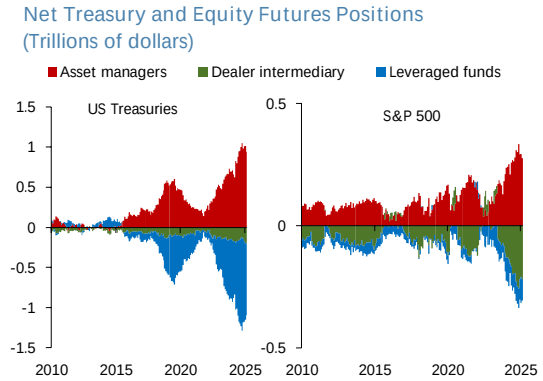
Among NBFIs, the asset management segment grew significantly in the total global financial system…



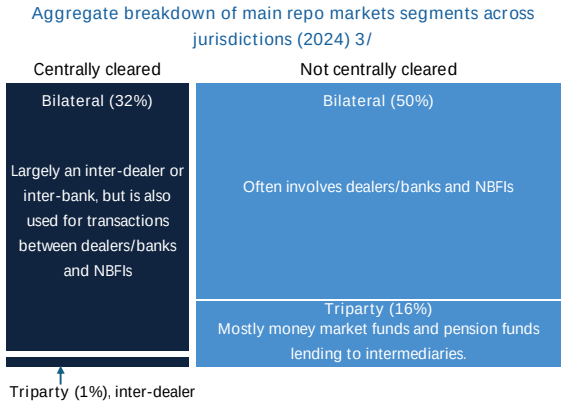
…and among "bank-like" NBFIs.



Moreover, the asset management segment further increased its footprint in key off-balance-sheet derivatives not reflected in size indicators…



…and repo markets, many of which have become benchmark rate markets around 2023, replacing LIBOR and other interbank offer rates.2



Sources: FSB NBFI Monitoring Report (2025a), FSB Vulnerabilities in Government Bond-backed Repo Markets (2026), and staff calculation.

[1] The percentage of OFI assets to GDP for the Cayman Islands (287,381), Luxembourg (20,854), Ireland (1,480) and the Netherlands (544) are not shown since they are particularly high compared to the rest of the jurisdictions.

[2] LIBOR and other interbank offer rates were previously used as benchmark rates for pricing financial contracts. Following concerns about these markets, G7 central banks adopted new benchmark rates based on repos or interest rate swaps that reflect NBFI trading activity (see FSB, "Goodbye Libor, hello basis traders," 2025).

[3] Outstanding amounts, reported by FSB members.

The Need for a Systemwide Perspective

As a result, systemic liquidity stress—sparked by sharp market shocks and amplified by NBFIs and their interconnectedness with banks—has become a core concern for financial stability. Systemic liquidity events arise when numerous institutions experience liquidity strains at once (IMF 2011; ECB 2018). Market valuation shocks may trigger liquidity stress for entities directly exposed to these assets, while also propagate to other entities due to interconnections. For example, major shifts in global monetary policy, as in 2022, can have significant impacts on NBFIs and banks (as seen in the 2023 banking turmoil). The resulting dash-for-cash may further magnify market shocks and transmit or amplify liquidity stress across the financial system, extending beyond simple fire sales and common exposures due to cash or additional collateral needs from margin calls (Duffie and others 2015; Czech and others, 2021).[5] For instance, the sudden collapse of Archegos in 2021 illustrates how margin calls on unregulated family investment offices can inflict more than $10bn in losses on banks via leveraged, concentrated, and opaque investments (Bouveret and Haferkorn, 2023). Likewise, in early 2025, trade tensions caused large swings in equity, bond, and commodity markets, leading to significant margin calls. Such shocks can be amplified through leverage (including off-balance-sheet contracts), counterparty credit risk (defaults on contracts, with or without insolvency, often stemming from liquidity distress), and funding risk (where entities lose access to funding from distressed counterparties), affecting both banks and other NBFIs.

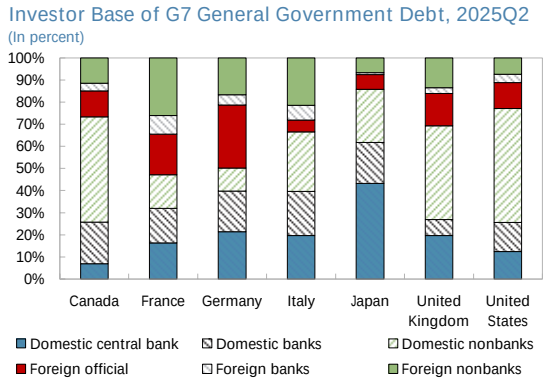
Cross-exposures between NBFIs and banks are widespread, especially in advanced economies (AEs, Figure 2). All types of NBFIs are globally interconnected with banks, each other, and across borders. The link between NBFIs and banks has grown, becoming systemic for banks in the US and Europe, where some large institutions have NBFI exposures exceeding their Tier 1 capital. However, the nature of these linkages varies by NBFI segment; notably, hedge funds often exhibit pronounced cross-border connections due to their prevalent domiciliation in favorable tax regimes. Flow-of-funds statistics (Figure 2), based on the System of National Accounts (SNA), reflect only balance sheet linkages—the true extent of interconnectedness may be greater once off-balance-sheet exposures, including derivatives, are included.

Even where domestic NBFIs remain small, as in many emerging and developing economies (EMDEs), the global asset management industry can still contribute to systemic risks. Portfolio investments into EMDEs are often channeled by global asset managers, transmitting global liquidity cycles into recipient economies. How these flows move upon global shocks depends on the structure of the investor base and asset types (Brandao-Marques and others 2022). Shocks to capital flows often hit equity and bond markets first, then ripple through the domestic financial system via local dash-for-cash behavior, impacting asset prices and exchange rates. Depending on the country's international investment position, systemic liquidity stress may originate in nonfinancial corporates (NFCs) and government sectors—which tend to rely more on foreign funding when domestic capital markets are underdeveloped—as well as in financial institutions. Ultimately, these shocks tend to result in liquidity shortfalls within domestic financial institutions via local financial linkages.

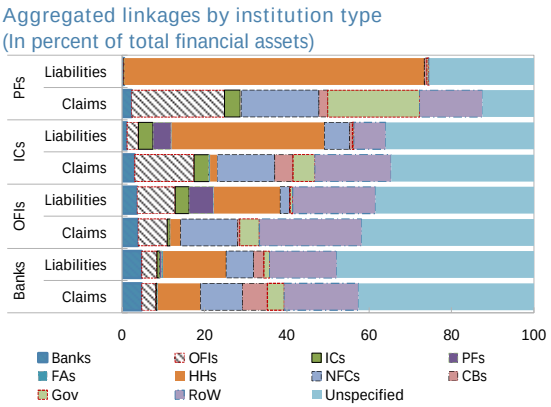
[5] Margins are collected to compensate for potential credit losses when a counterparty cannot honor contracts. Margin amount is continuously adjusted, and sudden large market movements could create additional margin calls—typically in cash or highly liquid assets—at short notice, resulting in liquidity risks.

Figure 2. NBFI and Interconnectedness

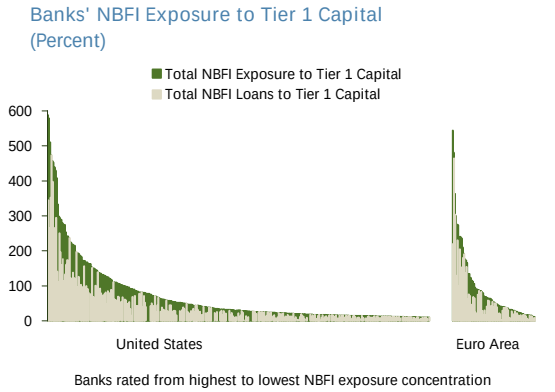
Banks and NBFIs are closely interconnected through common exposures to sovereign debt within and across borders.



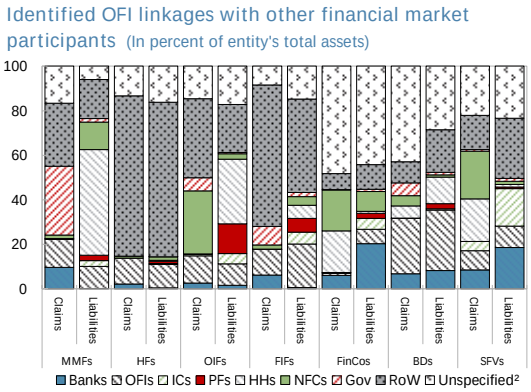
Globally, all types of NBFIs are interconnected with banks, among themselves, and across-borders.



Linkage between NBFIs and banks has become substantial for banks. In the United States, banks representing almost 50 percent of banking system assets have exposures to NBFIs exceeding their Tier 1 capital, and these links may increase both solvency and liquidity risks in the banking sector.



The patterns of interconnections (asset side, liability side) differ across different segments of NBFIs—Cross-border linkage of hedge funds stands out as many of them are domiciled in financial centers with beneficial tax regimes.



Sources: Arslanalp and Tsuda (2014), data updated; FSB (2025a), IMF October 2025 GFSR, IMF staff estimates.
Notes: The abbreviations stand for: Insurance corporations (ICs), Pension funds (PFs), Financial auxiliaries (FAs), Households (HHs), non-financial companies (NFCs). CBs include CBs and PFIs and nonbank DTCs. Unspecified indicates linkages to other sectors not identified by jurisdiction or type of institutions not defined above. The following types of OFIs are included: MMF = money market funds; HFs = hedge funds; OIFs = other investment funds; FIFs = fixed income funds; FinCos = finance companies; SFVs = structured finance vehicles.

More generally, when cross-border capital flows are systemically important, financial stability risks become closely tied to external stability risks—especially the exchange rates and the adequacy of international reserves. Large capital outflows from EMDEs and small open economies without a reserve currency raise demand for hard-currency foreign exchange (FX) liquidity. Even when foreign investors hold assets denominated in local currency and bear currency risks, their exits can cause a surge in FX liquidity needs as they repatriate funds in hard currencies. Domestic investors can also trigger capital outflows and demand for FX by reallocating assets abroad or into hard currencies (cash under the mattress or in stablecoins and other crypto assets). FX demand spikes can lead to bank FX

shortages or sharp currency depreciation. Unlike shortages in local currency liquidity, systemic FX gaps are challenging for central banks to manage, as their firepower to provide FX liquidity support is generally limited to international reserves. Thus, central bank and government financial accounts become crucial in systemwide analysis in these scenarios. In fact, incorporating financial stability–related reserve adequacy discussion has become a key part of the IMF's external stability work (IMF, 2014a and 2016).

Given the crucial role of inter-sectoral interconnectedness in propagating systemic liquidity shocks, there is a need for "systemwide" analysis to understand how such crises unfold. A systemwide analysis is defined as an interconnectedness exercise considering multiple key sectors, capturing both direct (through cross-exposures) and indirect (through common exposures, firesale price dynamics, and margin calls) contagion effects among them.[6] The IMF has been experimenting with systemwide liquidity analysis for nearly a decade in FSAPs and technical assistance work. They are bilateral exercises often using confidential country-specific data and tailored to each jurisdiction and cover broad sectors, including nonfinancial sectors when relevant, and IMF membership with cross-country perspectives. These exercises complement global vulnerability assessments, international standard-setting and policy work, and national exercises, by tracing how identified vulnerabilities may propagate across sectors and borders and interact with broader macroeconomic and external stability risks. These efforts resonate with similar calls by the FSB for systemwide approaches to NBFI risk (FSB, 2020), the ESRB High-Level Group's recommendation to use systemwide stress testing (ESRB, 2024), and initiatives by national authorities like the Bank of England's (BoE's) System-Wide Exploratory Scenario (SWES)—a "bottom-up," systemwide exercise with broad private sector involvement (BoE, 2024). The rest of the introduction section reviews the theoretical foundations of systemic liquidity crises and operational models for assessing liquidity risk in both sector-specific and systemwide settings, highlighting the IMF's contributions to date.

Literature

Theory

The academic literature on the theory of systemic liquidity crises is extensive and well-developed. Early theories of banking and financial crises, rooted in historical bank run experiences, began with Diamond and Dybvig (1983), who analyzed idiosyncratic bank runs. Subsequent research by Allen and Gale (1998, 2000, 2004), Morris and Shin (1998), Holmstrom and Tirole (1998, 2011), Freixas, Parigi, and Rochet (2000), and Rochet and Vives (2004) expanded the focus to systemic runs affecting the broader banking system. These studies emphasize that systemic runs typically arise from economy-wide stress—such as recessions—and behaviors that amplify minor shocks into full-scale crises due to heightened uncertainty.

Post-GFC research has substantially advanced the understanding of how isolated shocks can escalate into systemic crises through multiple amplification channels in financial markets. The growth of securitization—particularly mortgage-backed securities—combined with real estate booms, heightened banks' exposures to market instruments and increased their reliance on collateralized wholesale funding. These shifts in business models introduced new amplification mechanisms, including "run on repos" and collateral channels (Gorton and Metrick, 2012), fire sales

[6] In this paper, second-round effects refer to feedback generated by institutions' responses to an initial shock. For example, liquidity-driven asset sales may depress market prices, further increasing valuation losses, redemptions, margin or collateral calls, and asset sales. FSAP analyses endogenize selected feedback channels relevant to the exercise but generally remain scenario-based, partial-equilibrium assessments rather than general-equilibrium models in which prices, quantities, behaviors, macroeconomic conditions, and policy responses are jointly determined.

(Shleifer and Vishny, 2011), the interplay between market and funding liquidity (Brunnermeier and Pedersen, 2008), leverage cycles (Adrian and Shin, 2010), and cash hoarding fueled by uncertainty and network effects (Allen and Gale, 2004; Allen, Carletti, and Gale, 2009; Gai, Haldane, and Kapadia, 2011; Anand, Gai, and Marsili, 2012; Diamond and Rajan, 2011).

More recent systemic liquidity events, often triggered or amplified by margin and collateral calls, have further enriched the literature. Bakoush, Gerding, and Wolfe (2019) employed an agent-based network model to link margin procyclicality with interbank liquidity hoarding, highlighting spillovers from margin call stress in derivative markets into interbank markets. Their work also demonstrated how central clearing and tighter haircuts can increase fragility, while the central bank's market-maker-of-last-resort function can mitigate stress. Aramonte, Schrimpf, and Shin (2023) showed, using a stylized accounting framework, that margin increases can sharply reduce debt-taking capacity under widespread collateralized borrowing, triggering deleveraging and dash-for-cash dynamics, also shared with the FSB (2024a). King and others (2020) conceptualized central clearing counterparties (CCPs) as liquidity transformers, noting significant variation and opacity in margin practices across CCPs (BCBS, CPMI and IOSCO, 2022).

Empirical and Operational Risk Assessment

The application of these theories to financial stability risk assessment depends on data availability (Table 1). Regulators collect granular, institution-based confidential data for banks and insurers, while security-level asset holdings, NAV, and inflows/redemption data are publicly available for investor protection in publicly offered investment funds. However, supervisory or publicly available data are sparse for alternative asset managers such as hedge funds and private family offices—the dark corner of finance. Supervisors of financial market infrastructures (FMIs) often collect transaction-level data and stress test the resilience of CCPs. Activity-based analysis—using transaction or deal-level data for systemwide stability—remains limited, and market price-based academic approaches have gained little traction as stress testing tools with national authorities as they are too high-levels and noisy.

Significant progress has been made in modeling systemic liquidity and contagion risks within the banking sector, supported by rich data.[7] Numerous operational models now incorporate contagion effects using actual supervisory data, such as interbank matrices of claims and liabilities (Baranova and others, 2017; Sydow and others, 2024). These models typically overlay contagion channels with conventional solvency or liquidity stress tests. Contagion can be directly transmitted via counterparty credit risks through bilateral contracts—using network approaches pioneered by Eisenberg and Noe (2001) and applied by Espinoza-Vega and Sole (2010), Cont, Kotlicki, and Valderrama (2020), Bargigli and others 2015; and Covi, Gorpe, and Kok (2021)—or indirectly through common exposures (Greenwood and others, 2015; Cont and Schaanning, 2017; Duarte and Eisenbach, 2021; Coen, Lepore, and Schaanning, 2019; Bidder and others, 2024) and collateral and liquidation-price dynamics (Gai, Haldane, and Kapadia, 2011).

In the NBFI sector, systemic liquidity risk analysis is primarily centered on open-end mutual funds and, to a lesser extent, CCPs. Stress test methodologies for mutual funds have converged internationally, with Bouveret (2017), Lô and Carpantier (2023), Fricke and Wilke (2023), Gourdel and Sydow (2023), Cetorelli, Landoni, and Lu (2023), and recent FSAP exercises adopting a common structure: (1) market shocks reduce fund NAVs, (2) redemptions rise (especially for funds with greater NAV declines), and (3) asset sales drive price impacts, leading to further NAV reductions through second-round effects. Network approaches are seldom applied due to limited direct cross-holdings, except among funds of funds. Supervisory stress tests for CCPs focus on short-term market stress scenarios, evaluating

[7] See the recent survey by Aikman and others (2022) for details.

liquidity and solvency resilience of CCPs upon members' default on contracts (ESMA 2023; BoE 2023; BCBS-IOSCO 2018). However, these exercises usually do not test the resilience of the system including their members and clients who could be taking risky leveraged positions.[8] Recent work by Grippa, Letizia, and Viollet (forthcoming) provides a framework for assessing the market and counterparty risks generated by CCPs investments. Pension funds and insurers are mainly assessed for solvency risk from insurance and investment risks, as early withdrawal risk is much less important than for investment funds. Short-term liquidity stress testing from margin calls is not yet prevalent.

Table 1. Regulatory Data Gaps for NBFIs

NBFI	*Financial leverage*	*Liquidity*	*Interconnectedness*	*Currency mismatch*
Investment funds (excluding money market funds and hedge funds) ($58 trillion, 12% of GFA)				
Insurance companies ($40 trillion, 9% of GFA)				
Pension funds ($43 trillion, 9% of GFA)				
Money market funds ($8.5 trillion, 2% of GFA)	N/A			N/A
Structured finance vehicles ($6 trillion, 1% of GFA)				
Hedge funds ($6 trillion, 1% of GFA)				
Central counterparties *($0.7 trillion, 0.1% of GFA)*	*N/A*			*N/A*

Sources: IMF, April 2023 GFSR

Note: Red denotes no/very little data in areas with high or medium/high vulnerabilities; orange denotes no/very little data in areas with low/medium vulnerabilities; yellow denotes some data in select jurisdictions in areas with high or medium/high vulnerabilities; light green denotes some data in select jurisdictions in areas with low or medium vulnerabilities; dark green denotes broadly adequate data irrespective of level of vulnerabilities. GFA = global financial assets; N/A = not applicable; NBFI = nonbank financial intermediary.

The Development of Systemwide Exercises

The IMF has been developing and applying a systemwide liquidity analysis in FSAPs and technical assistance projects for nearly a decade. These exercises generally apply top-down, scenario-based approaches tailored to jurisdiction-specific vulnerabilities and available data, estimating liquidity needs and mitigating actions across relevant

[8] An exception is Bank of England's 2025 CCP stress testing exercise (see its speech as well). The assessment of CCP in the 2021 US FSAP highlighted the importance of undertaking CCP stress tests with systemwide-focus, in addition to assessing the resilience of CCPs.

sectors and tracing direct and indirect spillovers under alternative behavioral assumptions.[9] Early efforts focused on EMDEs, where cross-border capital flows via global banks and NBFIs acted as key catalysts for systemic liquidity stress, transmitting shocks through the interconnected domestic financial system. In these economies, in addition to financial institutions, government, central banks, and nonfinancial corporations often played critical roles in amplifying external shocks within the local system. Initial work in AEs examined specific linkages—such as direct connections between banks and investment funds through deposits—and mapped the system by analyzing common or cross-securities holdings among banks, investment funds, and insurers. More recent FSAPs have pioneered comprehensive approaches that integrate liquidity stress across banks, investment funds, and insurers, including the liquidity demands arising from margin calls on derivatives and repos, and the spillover effects to financial markets through asset fire sales and price impact dynamics. Between 2020-25, 19 FSAPs have employed some form of systemwide risk analysis (see Annex I).

Systemwide analysis that integrates multiple financial actors is emerging recently among national authorities as well. They experiment with a range of approaches, each offering complementary perspectives on different dimensions of systemic risk, as well as with distinct strengths and limitations (Table 2). These analyses rely on balance-sheet information and focus on cross-exposures and common exposures. Such approaches tend to have greater traction with financial regulators and institutions than correlation- or dependence-based indicators, which are more closely aligned with the definition of systemic risk in the asset pricing literature.[10]

- ***Bottom-up approach with private sector participation:*** The Bank of England's SWES exercise broadens the focus to core financial markets and their main participants, including banks, insurers, CCPs, hedge funds, pension funds, and asset managers, to assess collective amplification of shocks (BoE, 2024). It relies heavily on input from private sector participants to identify critical behavioral patterns influencing shock amplification. This approach, also adopted by France and Australia, helps address data gaps and improves understanding of behavioral dynamics, though there are challenges in ensuring systemwide consistency, especially regarding the general equilibrium effects (they usually cannot go further than second rounds given the need for inputs from participants). These exercises also rely critically on the cooperation of participating institutions and, where necessary, on collaboration among supervisory authorities to ensure comprehensive sectoral coverage.

- ***Top-down/desktop approach using supervisory data:*** The European Central Bank (Sydow and others, 2024) and Bank of Canada (BoC) have developed comprehensive models that incorporate market and NBFI risks into macro scenario-based bank solvency stress tests. In contrast, the Fund, Japan, and Mexico have focused on short-term systemic liquidity stress scenarios. The Bank of Japan's framework (Konaka, Murayama, and Nakamura, 2025) uniquely incorporates foreign investment funds outside domestic regulatory perimeters using public disclosure data. A recurring challenge is the estimation of price impacts associated with fire sales, underscoring the need for robust sensitivity analyses and systematic cross-checks using alternative assumptions or modeling approaches. The trade-off between model complexity and tractability, together with the difficulty of accurately capturing heterogeneous sectoral behavior under stress, further complicates model design. As a result, these modeling frameworks typically require substantial analytical and operational resources to develop and maintain.

[9] While their design follows broad stress-testing principles, the specification and calibration of shocks are adapted to the circumstances and analytical priorities of each FSAP

[10] See for example Adrian and Brunnermeier (2016) for CoVaR or Acharya and others (2017) for the Marginal Expected Shortfall.

Table 2. Comparison of top-down vs bottom-up approach

Dimension	Top-down systemwide analysis	Bottom-up systemwide analysis
Objective	Identify systemwide linkages and amplification channels	Understand behaviors and interactions under stress
Data & inputs	Supervisory, balance-sheet, flow-of-funds, transaction data	Firm submissions, market intelligence, supervisory dialogue
Strengths	Systemwide consistency, scalable across countries	Realistic behavior, reveals expectation mismatches
Limitations	Resource-intensive for the institution, data gaps, stylized behavior,	Resource-intensive for the institution and the participants, partial system coverage
Examples	ECB: ISA model Bank of Canada, Bank of Japan… All IMF FSAP exercises	BoE: SWES Banque de France, Reserve Bank of Australia

Source: IMF

Against this backdrop, this paper presents the IMF's systemwide risk analysis tools, their application, and notable extensions in FSAPs. Section II introduces two core tools: an Excel-based tool leveraging sector-aggregate flow-of-funds data for high-level analysis of systemic interlinkages and transmission channels, and an online dashboard for investment fund liquidity stress tests that incorporate second-round price effects from asset fire sales. Together, they illustrate how parsimonious, top-down tools can help identify key amplification channels, systemic sectors, market spillovers, and data gaps, including where granular data are limited. They also support more coherent interpretation of sectoral stress tests and provide an operational basis for policy discussions on liquidity regulation, risk management, and backstops and priorities for further analytical deepening. Section III details notable FSAP applications and refinements in selected advanced and emerging economies, and the final section concludes.

IMF's Generic Systemwide Analysis Models

IMF currently maintains two standardized systemwide analysis tools. The first one is Excel-based systemwide liquidity analysis tool using sector-aggregate flow-of-funds by counterpart (Oura 2022)—alternatively referred as Balance Sheet Approach (BSA) data by the IMF (IMF 2015, Harutyunyan and Munoz, 2018). The other is Market Impact from Investment Funds Liquidity Distress (MILD) by Letizia and Zhang (forthcoming). This approach uses detailed investment fund data, including their security-level investment, and considers how redemption-driven asset sales affect market prices and transmit investment fund liquidity stress to financial markets. FSAPs often take these tools as benchmark and tailor or enhance them as deemed adequate in each assessment and depending on available data.

Excel-Based Systemwide Liquidity Analysis Tool

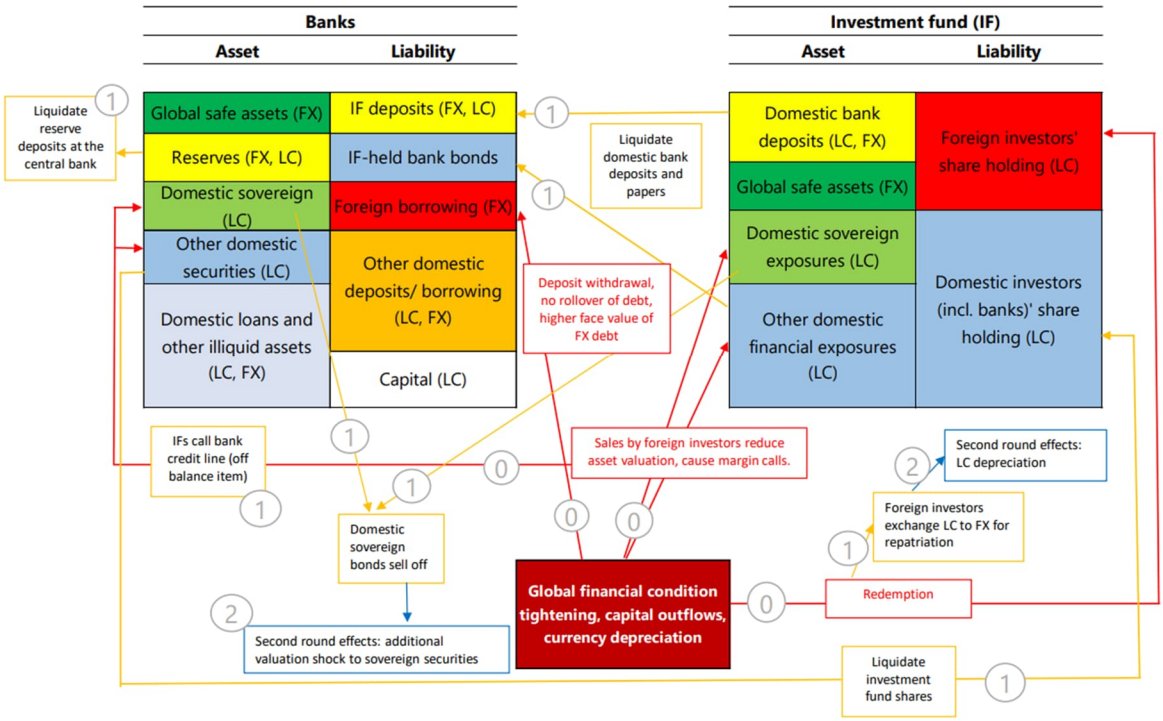
The Excel-based systemwide liquidity stress testing tool offers a high-level assessment of how aggregate liquidity shocks affect the economy through domestic financial linkages. These shocks—such as capital outflows, or shifts from domestic financial assets to commodities (like gold), real assets, and foreign-issued crypto assets—often manifest as major asset price disruptions, which then propagate through direct financial exposures among entities. The tool utilizes flow-of-funds data that detail financial assets and liabilities by sector, counterparty, and instrument. Thanks to the G20 data gap initiative[11] and IMF technical assistance, such data are now available for many IMF member countries, including some low-income economies. This enables systemwide analysis even when granular data are scarce, providing a foundation for identifying key interlinkages that may require deeper investigation with advanced methods.

Methodologically, the tool runs cash-flow-based liquidity stress tests across systemically important sectors, ensuring consistency in cross-sectoral flows. Within a whole financial system, every agent's asset is another's liability—for example, if an investment fund under redemption pressure withdraws deposits from a bank, the liquidity stress shifts to the bank (Figure 3). This means that resilience in one sector can directly create challenges for another, even if the originating sector passes its own stress test. Only integrated systemwide exercises, combining liquidity stress tests across sectors, can accurately evaluate the financial system's resilience. The ultimate outcome also depends on how redeemed funds are reinvested: if moved from investment funds to banks, overall system liquidity may be preserved; if shifted to assets outside the domestic system (e.g., gold or foreign stablecoins), liquidity leaves the domestic market, possibly triggering second-round effects like exchange rate depreciation.[12] As with any systemwide analysis, results are sensitive to behavioral assumptions—especially regarding the order in which sectors liquidate assets—so the tool stresses the importance of multiple scenario and sensitivity analyses rather than reliance on a single assumption.

[11] The initiative began in 2009, completed its second phase in 2022, and is expected to begin its third phase, with continued annual monitoring. The recent progress report (FSB-IMF, 2022) stated that challenges remained in securities financing transaction data, securities statistics, sectoral accounts, and cross-border exposures of nonbank corporations, among others.

[12] Such second-round effects are not part of the Excel-based too, but a separate module can be easily added to incorporate such effects following, for example, the approach in MILD.

Figure 3. Domestic Propagation of Balance-of-Payment Shocks: Example—Banks and Investment Funds



Source: Oura, 2022

The tool is especially effective in analyzing the interplay between financial system stability and external vulnerability. Systemwide liquidity loss can originate from capital outflows or domestic shocks that prompt both domestic and foreign investors to shift assets abroad, transmitting stress through interconnected sectors. This dynamic often serves as a primary channel for stress amplification in many EMDEs and small open AEs without a reserve currency. When such shocks strains key financial institutions and markets, central banks may provide liquidity backstops to avert a systemic crisis. However, if liquidity stress is driven by capital flows, it results in FX liquidity outflows, regardless of the level of dollarization.[13] Consequently, the central bank's capacity to respond—whether through FX liquidity support to financial institutions or direct FX market intervention—is ultimately limited by the level of international reserves. This underscores the IMF's (IMF, 2014a, 2016, 2022a) call for tailored analytical frameworks for AEs that explicitly link financial stability risks with assessments of external stability in IMF country surveillance.

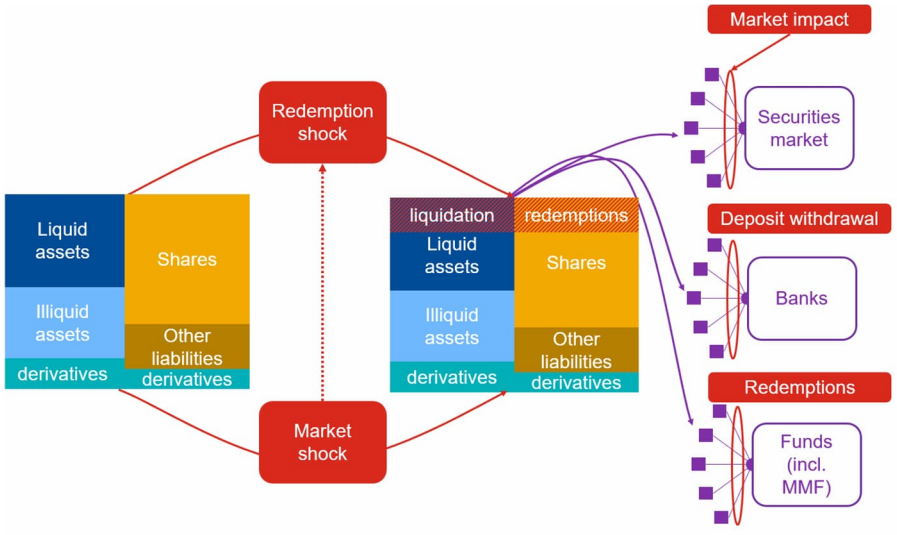
[13] If investors are switching from local currency denominated domestic assets to foreign assets, FX demand occurs when investors exchange sales proceeds (in local currency) for foreign currency to purchase foreign assets.

Market Impact from Investment Funds Liquidity Distress (MILD)

MILD aims to provide a structured and operational way to assess liquidity vulnerabilities in the investment fund sector and the systemic spillovers to financial markets from funds. It is motivated by the structural liquidity mismatch of open-ended funds, which offer frequent redemptions while holding assets that may be costly to liquidate under stress. MILD goes beyond a narrow investment fund stress test that examines fund-level resilience against redemptions (first-round effects) and investigates the second-round effects from funds' distress—namely, how asset price markets are disrupted as funds under redemption stress liquidate their potentially illiquid assets. Within the IMF, an internal dashboard is linked to global investment funds and securities price data and delivers timely analytical outputs with little additional costs, supporting regular financial surveillance and FSAPs.

The model has similar structures to the approaches developed by national authorities, which have converged over time, as discussed in the literature review. It is a modular, scenario-based stress testing framework built on highly granular fund- and asset-level data (Figure 4). It combines (i) redemption shocks calibrated using parametric assumptions, historical flows, or estimated flow-performance relationships; (ii) optional market shocks applied to asset valuations; and (iii) detailed modeling of asset liquidity, liquidation pecking orders, and mitigating actions such as short-term repo borrowing. Funds' liquidity demand is translated into asset sales under alternative behavioral assumptions (e.g., waterfall, pro-rata, or mixed strategies), after which market impact functions map sales volumes into price declines for specific asset segments. The resulting outputs—liquidity shortfalls, assets sold, market price impact, and losses to funds and other sectors—are presented as distributions and ranges across scenarios and assumptions, making MILD particularly useful for systemwide risk identification, sensitivity analysis, and policy discussions on fund behavior and market resilience.

Figure 4. Stylized Representation of the Framework



Source: Letizia and Zhang, forthcoming

However, MILD is not designed to ensure full systemwide consistency or capture all feedback effects and also face limitations similar to other systemwide tools. As a partial-equilibrium framework, it does not model general-equilibrium dynamics, strategic interactions among all market participants, or endogenous policy responses from central banks or treasuries. Unlike the Excel-based systemwide liquidity tool, MILD does not track how redeemed funds are reinvested, and instead focus on incorporating the direct second-round effects. Results hinge on behavioral assumptions and parameter choices—especially for redemption patterns, liquidation strategies, and market depth (volatility and trading volumes)—which are critical for estimating price impacts but often subject to uncertainty and data gaps. Where liquidity parameters are unavailable or markets are illiquid, second-round effects may be understated. Additionally, investor behavior, liquidity buffer usage, and repo funding are simplified representations of complex real-world dynamics. Therefore, MILD outputs should be viewed as scenario-based indicators of vulnerability and amplification, not as point forecasts, and are best interpreted alongside expert judgment and complementary analyses. Overall, MILD is useful for identifying fund vulnerabilities and market spillovers under alternative behavioral and market-impact assumptions. Its outputs should be read as scenario-based indicators, given their sensitivity to data quality, redemption calibration, liquidation behavior, and market-depth assumptions.

FSAP: Common Approach and Country-Specific Adaptations

While FSAP applications share a common scenario-based, top-down methodology for tracing liquidity needs and cross-sector spillovers, their scope and implementation are tailored to jurisdiction-specific financial structures, vulnerabilities, and available data. The country analyses should therefore be read as combining a common analytical framework with local data and institutional features, as well as staff assumptions and hypotheses where empirical evidence is limited.

Early work

Several IMF country works tackled systemic liquidity risk assessment well before systemwide stress testing tools were made available. The 2017 Luxembourg FSAP and Article IV consultation examined liquidity contagion effects between banks and investment funds, focusing on the spillovers from investment funds that face substantial redemption to banks when the stressed funds liquidate domestic bank deposits. The Article IV consultation with Andorra, Mauritius, and Sweden[14] discussed international reserve adequacy to withstand FX liquidity stress from the financial system using bank liquidity stress testing results, including a stressed liquidity coverage ratio (LCR).

Some of these analyses led to operational policy recommendations. Andorra's, Mauritius', and Sweden's examples led to recommendations to build up more international reserves so that the central bank could play the of lender of last

[14] Policy actions in Sweden in the past decade provide an interesting case of redesigning some aspects of LCR and international reserve management to better support withstanding cross-border FX liquidity shocks. While Sweden is not a dollarized economy, banks rely substantially on US dollar and euro cross-border wholesale funding. The Riksbank strengthened its international reserves with external borrowing and bilateral central bank swaps during the GFC and the COVID-19 crisis. However, it started to build net reserves more recently and set the currency structure of international reserves to match the FX liquidity needs. It also guided banks to satisfy Swedish krona, euro, and US dollar LCRs separately with diversification requirements of HQLA to avoid the concentration of liquid assets in Swedish-covered bonds.

resort (LOLR) role. The 2018 Armenia FSAP and IMF lending program recommended changing the design of reserve requirements based on the systemwide FX liquidity concept without laying out quantitative details. Armenia has a floating exchange rate regime and faces relatively high levels of dollarization. While banks' main liquid asset buffers are central bank reserves, they must satisfy their reserve requirements in local currency, even for the portion earmarked for FX deposits, creating significant FX liquidity mismatches. The FSAP recommended changing this rule so that banks satisfy their FX reserve requirements in FX. While currency composition of reserve requirement typically receives little attention when examining the design of requirement as a monetary policy and liquidity management tool, it plays a critical role in setting the structure of banks' liquid asset buffer.[15]

Systemwide analyses

Example of key issues by the stages of financial system development

The Excel-based systemwide liquidity stress testing tool has been applied in several technical assistance missions covering low-income economies, emerging markets and high-income commodity exporters, and has been used to identify and illustrate the different systemwide risks each group of countries face:

- ***Low-income country***. In this example, the country has large twin deficits financed mostly by official-sector loans and grants to the government, but foreign investors also directly invest in local currency government bond markets. The financial system is dominated by commercial banks, small, and dollarized. Therefore, main aggregate liquidity risks could arise from scenarios with public finance stress that leads to more extensive external financing needs, FX deposit run by residents, and exit by foreign investors from the local-currency government bond market, which led to FX market intervention to curb excessive volatility in the past. Results show that the system (including the central bank) can withstand aggregate FX liquidity stress unless there is a generalized panic run on domestic FX deposits or external financing needs for the government jumps. Nonetheless, financial dollarization and thin FX liquid asset buffers of banks make the banking sector vulnerable. Recommendations include strengthening banks' FX liquid buffers by allowing banks to satisfy reserve requirements earmarked to FX deposits in hard currency and to hold global safe assets if FX LCR is introduced.[16]

- ***Emerging market economy***. The tool was applied to a few EMs with some or notable external vulnerability. Their cases are represented by the illustrative example explored in Oura (2022)—a hypothetical Emerging Market (EM) with substantial external borrowings—especially by sovereigns, NFCs, and banks to a lesser extent—and partial dollarization. In the example, nonbank financial intermediation and capital markets are underdeveloped, and banks and NFCs have a large footprint in the financial system. Changes in global financial conditions and capital outflows are key aggregate liquidity risks. Capital outflow shocks could transmit noticeably across domestic sectors because NFCs have substantial FX deposits at domestic banks, and banks' FX HQLA are largely FX reserve deposits at the central bank. NFCs are the most vulnerable sector, as they have more significant FX liquidity mismatches than the other sectors. The extent of contagion effects from NFCs depends

[15] In contrast, some countries consciously use currency requirements of reserve requirements to strengthen international reserves and for liquidity management purposes. For example, the central bank of the Republic of Türkiye introduced a policy allowing banks to fill their reserve requirement for domestic currency deposits in FX and gold, but not vice versa, in the early 2010s. Such policy boosts gross but not net international reserves.

[16] Banks are not allowed to invest in foreign assets for fear of investing in risky assets.

critically on their pecking order of asset liquidation, because NFCs have both foreign assets and domestic FX deposits. The resilience of the banking sector depends more on NFCs' behavior and the degree of panic run by the household sector than the direct impact of capital outflows. Similarly, banks have global safe assets and FX reserve deposits at the central bank. If they primarily use reserve deposits, it could reduce international reserves substantially. The central bank may reduce the FX reserve requirement ratio to increase the usable FX liquid asset buffers for banks before considering Emergency Liquidity Assistance (ELA). Also, it should monitor and survey the composition of liquid assets buffers of banks and NFCs, motivation to hold those assets, and contingent liquidation plan.

- ***High-income commodity exporter.*** In this case, the country has a large current account surplus and net positive international investment position. Most of the foreign assets are held by the sovereign wealth fund, separated from the international reserves of the central bank. The financial system, dominated by banks, is usually awash with liquidity from oil export receipts, and the central bank issues papers to absorb liquidity. However, the system has been hit by a few stress episodes related to oil price swings, among others. The central bank adopts a fixed exchange rate regime that requires a high share of central bank money to be backed by international reserves, which means both local currency and FX liquidity stress impact the central bank balance sheet and international reserves (El Hamiani Khatat and Veyrune 2019). Indeed, in some stress episodes, the central bank had to ask to boost its capital and corresponding international reserves to the SWF. The mission suggested that the central bank consider introducing more contingent, temporary flexibility with the backing requirement of central bank money by international reserves. It also recommended using during distress episodes the reserve requirement ratio, which had been held constant throughout the cycle, because the policy tool's main objective was to fill in the lack of deposit insurance rather than liquidity and monetary management objectives. Moreover, given these constraints for the central bank to play the role of LOLR, introducing preemptive prudential measures such as FX LCR is essential. Staff also recommended understanding better the driver of a recent increase in banks' foreign asset holdings, which could mitigate the contagion effects on the central bank.

Application and enhancement of Excel-Based systemwide analysis tool

A more extended version of the tool was applied in recent FSAPs using additional granular and often confidential data in several EMs and small open AEs. FSAPs usually have access to detailed supervisory reporting data—especially detailed LCR data—for banks and certain types of NBFIs, which helps improve exercises' accuracy.

Philippines

The 2021 Philippines FSAP assessed the liquidity linkage between banks and NFCs due to temporary loan moratoria introduced during the COVID-19 crisis. It supplemented BSA with supervisory data of banks and financial statements of publicly traded NFCs to obtain more details about liquid asset buffers, funding instruments, and their maturities. Loan moratoria stop debt service cash inflows from banks and outflows from NFCs for the firms that applied to the program. The key assumptions representing the two sectors' linkage are NFC loan refinancing rate—a banks' choice variable—and NFCs' asset liquidation decisions. While LCR assumes low refinancing rates to preserve liquidity for banks, this exercise also examined higher refinancing rates in addition to moratoria.

This case is an example where NFCs—outside of the perimeter of prudential regulation—could be systemically important for financial stability. NFCs' liquidity positions weaken as the scenario assumes drops in earnings because

of the lockdown, but loan moratoria could relieve some pressures. Moratoria, at first, seems to shift liquidity away from banks to NFCs. However, NFCs may need to tap into their liquid assets buffers if they do not use moratoria, earning shocks (i.e., aggregate liquidity shock) are large, and banks reduce loan refinancing rates to conserve their liquidity. If NFCs primarily liquidate domestic bank deposits, then liquidity stress will be transferred to banks even without moratoria. Staff recommended that the central bank use its new macroprudential power given by amended central bank law, which allows it to seek information from any entities in the country.

Chile.

The 2021 Chile FSAP work used institution-level data of banks, mutual funds, and pension funds and showed institution-level vulnerabilities in addition to aggregate risks. The Chilean financial system has sizeable pension and mutual fund sectors that provides substantial wholesale bank funding and corporate credit. The system experienced a systemic liquidity stress in 2019 as retail investors switched funds and reallocated their portfolio away from long-term domestic fixed-income assets to foreign assets in an unprecedented manner due to advice from social-media-based financial advisors. The portfolio reallocations and redemptions put significant pressure on bank and corporate bonds as well as the Chilean peso, and the central bank responded by expanding the collateral framework for liquidity operations to include unsecured bank bonds and intervened in the FX spot market to curb excess volatility. Bank funding risks were heightened by the lack of a functioning secured interbank lending market to backstop wholesale funding.

Liquidity stress tests of banks, pension, and mutual funds highlighted continued vulnerability to similar events. The FSAP recommended improving pension fund regulation and investment options to promote long-term investment and minimize excessive switching, strengthening the mutual fund liquidity management framework, introducing bank liquidity stress tests, facilitating the development of the interbank repo market, and strengthening central bank collateral and ELA framework.

Türkiye.

The 2023 Türkiye FSAP took place during episodes of macrofinancial volatility where the central bank took unusual measures to secure international reserves (i.e., FX liquidity). The economy suffered from persistently high inflation, that increased to almost 80 percent in mid-2022 and marked depreciation of the Turkish Lira. FX liquidity risks had risen along with deposit dollarization and low international reserves of the central bank. A substantial nexus existed between the central bank and commercial banks, whose FX assets held at the central bank were about double the readily available FX gross international reserves and gold holdings of the central bank in mid-2022.[17] Moreover, almost three-quarters of central bank FX liabilities were owed to domestic banks in the form of deposits or swaps. This alone was larger than total central bank FX reserves assets and was a large share of banks' FX liquid assets.

Using the enhanced Excel-based tool, the FSAP closely examined vulnerability to a tail-risk scenario capturing FX liquidity risks and accounting for the interdependence between the central bank and commercial banks. Bank liquidity stress test adjusted starting point HQLA and LCR, including only the central bank's readily available FX liquidity—excluding gold, non-hard currency FX, SDRs, among others. Systemic FX liquidity stress tests assessed the impact of stress stemming from NFCs, households, and general government on banks and the transmission to central bank international reserves, incorporating large off-balance FX swap positions of banks vis-à-vis other sectors. These tests

[17] Readily available FX gross international reserves refer to the portion of the central bank's foreign exchange reserve assets that can be deployed immediately to meet banks FX liquidity needs, excluding less liquid or encumbered components such as gold, SDR holdings, non-hard-currency assets, and reserves tied up through certain swap or deposit arrangements.

found banks can withstand moderate FX liquidity stress but highlighted the vulnerability to severe FX liquidity outflows, which could potentially drain central bank international reserves to low levels.

Iceland.

The 2023 Iceland FSAP examined resilience against systemic liquidity events driven by both domestic and global factors, including the capacity of the central bank to provide FX liquidity backstop. As a small open economy with a large financial sector with active cross-border transactions, Iceland is vulnerable to aggregate FX liquidity shocks if foreign investors take out deposits or sell off Icelandic assets. Its financial system is dominated by a concentrated banking system, and it also has a rich NBFI sector including pension funds and investment funds. Without a reserve currency, the central bank's ability to provide FX liquidity backstop is limited to international reserves.

FSAP applied the Excel-based framework to capital outflow scenarios. The exercise included FX deposit withdrawals by nonresident and resident nonfinancial sectors, asset reallocation of pension and investment funds, and exits from international bonds issued by Icelandic entities. FX liquidity stress to domestic NBFIs and nonbank sectors could easily spill over to banks if stressed segments liquidate their local bank deposits to fill their respective liquidity gaps. The exercise indicated that single-factor stress on each liquidity risk factor included in the capital outflow scenario alone is unlikely to exhaust banks' FX liquidity buffer. Only a combination of severe stress on each factor could push banks into FX liquidity shortage. Yet, the central bank had enough international reserves to fill in banks' FX liquidity shortage, partly because the central bank greatly boosted their gross international reserves with external borrowing. More than 40 percent of the gross international reserves were funded by external borrowing.

India

The 2024 India FSAP analyzed links among banks, Non-Banking Financial Company (NBFCs), and bond funds. NBFCs are finance companies reliant on wholesale funding and bank loans and usually provide loans focusing on certain segments (e.g., infrastructure, microfinance, consumers, etc.) Past distress episodes stemmed from concentrated credit risks in the infrastructure sector. In the mid-2010s, defaults by power companies triggered a banking crisis, heavily impacting state-owned banks. Later, major NBFCs defaulted on short-term borrowings after credit stress from infrastructure lending that reduced cash inflows, worsened by low liquid asset buffers under limited regulation. Bond funds—key NBFC financiers—reallocated away from NBFC debt, further straining liquidity. During the pandemic, loan moratoria, closure of major bond funds, and heavy redemptions from bond funds by institutional and corporate investors intensified NBFC liquidity stress. In response to these events, the authorities implemented various reforms, including liquidity regulations for bond funds and set up industry-pre-funded Corporate Debt Market Development Fund (CDMDF) with government backstop that can provide liquidity to corporate bond market during distress episodes.

The sectoral and systemwide liquidity analysis confirmed persistent vulnerabilities. NBFCs' concentrated exposures to structurally vulnerable infrastructure sector—shifted from banks even more—low liquid asset buffers, reliance on wholesale funding, periodic bond fund redemptions tied to tax and bill payment cycles, central bank collateral policies limited to sovereign bonds, and banks' reluctance to lend to stressed NBFCs even with central bank support. CDMDF could facilitate funds' liquidation of corporate bonds, but the firepower was not sufficient to respond to all sales pressures. However, given India's relatively closed capital account, liquidity stress mainly affects how liquidity is distributed, rather than causing aggregate losses or FX shortages unlike other EMs.

Bespoke Analyses

Mexico

The 2022 Mexico FSAP[18] substantially enhanced the tool to gauge the impact of capital outflows from local sovereign bond markets on the rest of the domestic financial system (Figure 3). Mexico's financial system is well integrated with global capital markets with significant foreign direct investments (FDIs) to NFCs and direct foreign investment in domestic sovereign bond markets. Mexican financial assets, including the peso, are also traded as proxy assets representing the EM asset class. Domestic banks and NBFIs (especially investment funds, pension funds, and insurers) are exposed to common assets—especially sovereign debt securities, and counterparty risk via direct lending and repo operations. NFCs are exposed to offshore refinancing risks, though they also have substantial foreign assets.

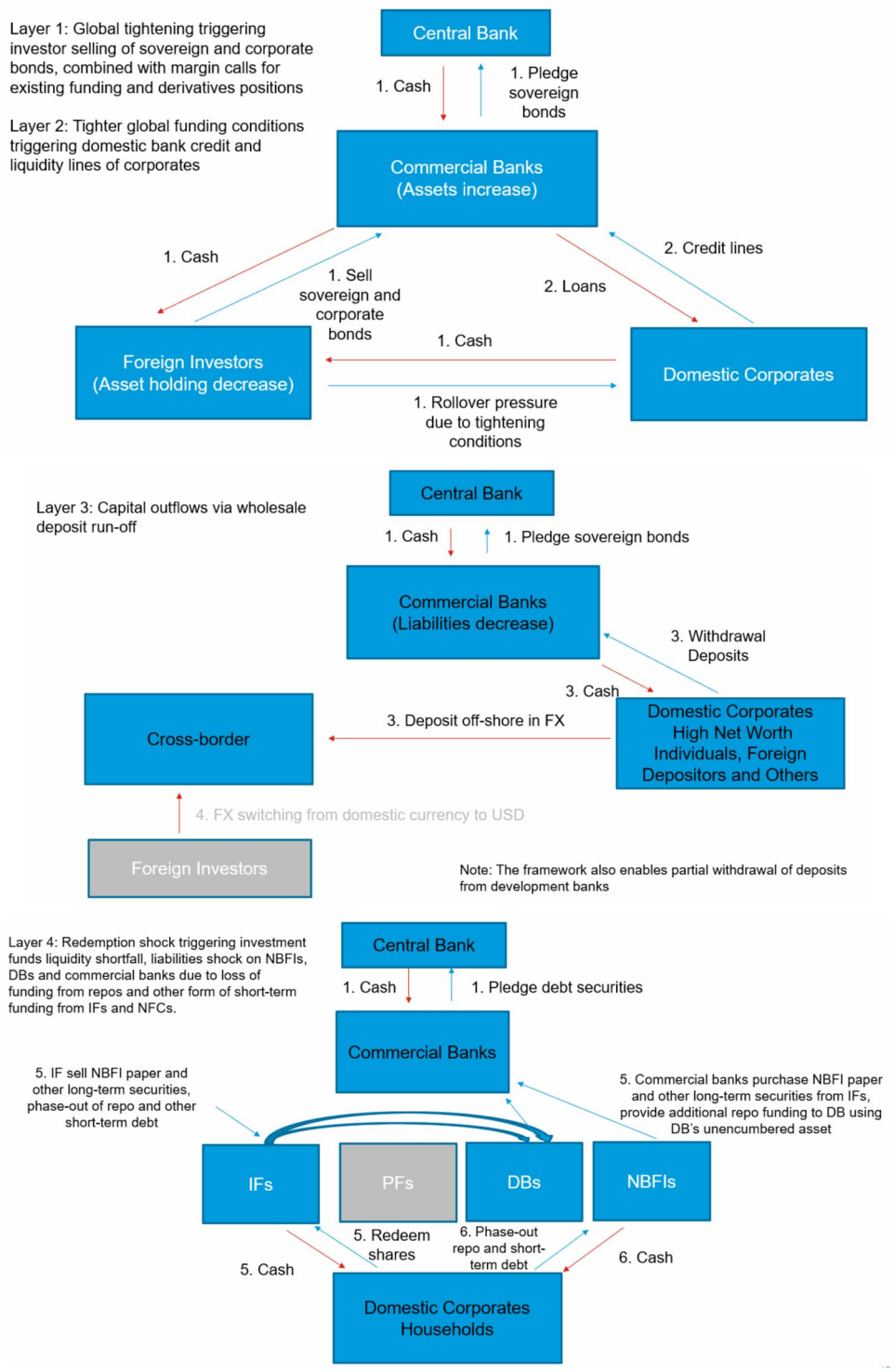
Against this backdrop, the FSAP examined a capital outflow scenario from local sovereign bonds and its impact on bond valuation and liquidity needs across domestic sectors. Capital outflows reduce bond valuation and cause liquidity needs to fill in margin calls from repo and derivatives positions.[19] The FSAP used highly granular BSA data, including institution-level data for commercial and development banks and some NBFIs, their detailed exposure to local sovereign bonds (cash, repo, and derivatives), contingent claims such as credit lines, and detailed liquid asset buffer information (including unencumbered securities that are not pledged as collaterals for secured funding and some derivative transactions).

They also examined the sensitivities of the results to specific assumptions. Assumptions are generated as sets of correlated shocks to key asset prices and available funding under the same qualitative capital outflow scenario—as well as to the second-round effects from further asset price declines due to fire sales. Stressed institutions are assumed first to liquidate cash, then phase out short-term funding, and finally pledge unencumbered securities for secured borrowing. The exercise also examined an alternative pecking order of liquidation within each step (e.g., which assets to pledge first). Overall, various sensitivity and liquidity policy experiments show commercial banks' central role in ensuring the liquidity of the financial system by backstopping the liquidity needs of all other agents while signaling potential vulnerabilities in development banks when facing market behavioral constraints under stress.

[18] See also the working paper detailing the methodology by Ding, Laliotis, and Toffano (2024).

[19] The exercise reflects the regulatory framework and market practices prevailing in 2022. Mexico's margin requirements for non-centrally cleared OTC derivatives entered into force in 2025 and could affect margin-call and liquidity dynamics in future stress scenarios.

Figure 5. Mexico: Design of Systemwide Liquidity Analysis



Source: IMF, 2022b Mexico FSAP, technical note on systemic risk analysis and stress testing.

By comparison, a comprehensive systemic liquidity analysis has been more challenging to conduct in AEs because of the complexity of their system. AE systems tend to have a much richer nonbank financial intermediation sector and complex financial instruments. As a result, the BSA matrix could be partial—missing critical linkages among NBFIs as in the US—or insufficient—missing much off-balance sheet information (such as derivatives and associated margin calls, repos, credit lines, structured funding, securitized assets, and leveraged exposures). At the same time, large, highly granular data are available for specific segments in some countries—such as individual security-level holding data for investment funds, banks, and in some cases, insurers, which are helpful to measure contagion effects through common exposures. FMI-collected activity-based data could offer unique perspectives, but they have never been used in FSAPs due to their confidentiality and complexity. Still, there have been recent efforts to enrich systemic liquidity analyses in AE FSAPs.

France, Ireland, and Sweden

The 2019 France FSAP provided extensive network analysis focusing on risks from common exposures among banks, mutual funds, and insurers. The French financial system mainly consists of banks, insurers, and investment funds, many of which are connected under a financial conglomerate structure. Most conglomerates are internationally active, with diversified assets and liabilities across sectors and borders. Against this backdrop, the French authorities initiated long-term data gap initiatives to better understand the interconnectedness across sectors and within financial groups. At the time of the FSAP, the authorities had constructed the data set showing security-level exposures in marketable securities (covering both domestic and foreign securities) for banks, insurers, and funds. The FSAP team used this unique data and applied network analyses to identify key characteristics of the interconnectedness, focusing on direct exposures and common exposures measuring similarities of balance sheet counterparts.

The exercise found that all three sectors increased exposure to NFCs and French sovereign bonds in the 2010s. Banks and insurers reduced common exposures since the 2012 FSAP. At the same time, funds diversified their counterparties by increasing their cross-border exposures but following the same pattern, increasing common exposures and, therefore, vulnerability to systemic risk. Also, funds' domestic exposures are concentrated in funding from insurers and investment in bank bonds, escalating interconnectedness in the system. The 2022 Sweden and 2022 Ireland FSAPs included similar interconnectedness analyses, including the Sweden FSAP's work to gauge the price impact of investment funds' fire sales. While these exercises were not systemic liquidity stress tests, they provided useful background information to design future stress testing exercises and priorities for additional data building.

United States

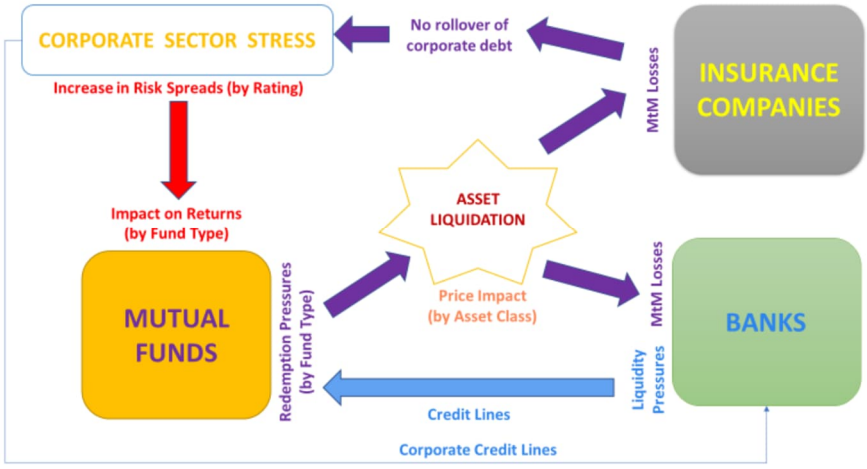
The US financial system has a rich NBFI sector and complex financial instruments, including large mutual fund and money market fund sectors that are prone to redemption and market risks. Also, capital markets are deep and broad—even credit risks are actively traded as securitized loans and credit derivatives by a range of banks and NBFIs, escalating the importance of contagion through common exposures. Over half of the financial intermediation takes place outside of the banking system, and the role of nonbank financial intermediation has grown visibly since the GFC. NFCs actively finance in markets, and risks from NFC debt (e.g., leveraged loans, high-yield and private debt markets, and related products such as collateralized loan obligations (CLOs)) were one of the main risks highlighted in the 2020 U.S. FSAP.

The FSAP conducted numerous sectoral stress tests, including banks, insurers, mutual funds, money market funds, and NFCs, and connected them to gauge contagion effects (Figure 4). Building on these sectoral results, the

FSAP also assessed the transmission of the risks from NFC debt across the financial system, focusing on an instant market shock lasting a month and leading to immediate asset liquidation. A BSA-like analysis showed that direct exposures to the US corporate sector are concentrated among NBFIs, while banks' exposures are mostly term loans and credit lines. Accordingly, NBFIs would suffer larger direct losses from corporate debt market distress events than banks. Stress on NBFIs, especially mutual funds, spills over to other segments through direct linkages (such as liquidity stress to banks that provide credit lines to stressed mutual funds) and indirect linkages (such as second-round effects on corporate debt spreads due to mutual funds' asset liquidation, which intensifies initial marked-to-market losses from corporate securities to other corporate debt investors).

The analyses showed that asset liquidation by mutual funds could lead to significant price impacts, especially on EM and high-yield bonds. While their impact on systemically important banks' capital is limited, the marked-to-market losses could have a non-negligible impact on some NBFIs. At the same time, the FSAP emphasized the potential sensitivity of the results to alternative market behaviors (such as the order of asset liquidation), model and estimation uncertainty about fire sales-price impact relationships, and systematic mispricing of risks—all of them could both over- and underestimate the total impact.

Figure 6. United States: Schematic of the Systemic Liquidity Risk Transmission Mechanisms



Source: 2020 US FSAP, technical note on risk analysis and stress testing in the financial sector.

Euro Area

This exercise advances systemwide risk analysis by incorporating a wider range of financial institutions, margin calls from derivatives, and collateral calls from repos (Figure 5). It includes investment funds (such as hedge funds, LDI funds, and Undertakings for Collective Investment in Transferable Securities (UCITS)), insurers, banks, and MMFs. It goes beyond standard fund stress tests by jointly modeling margin calls, repo haircuts, redemptions, and asset sales, and

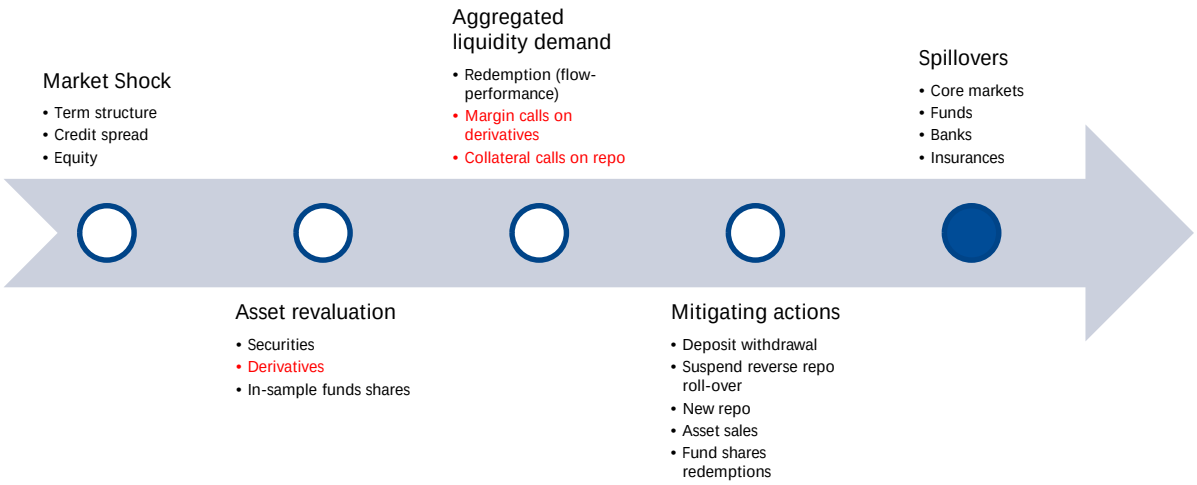
by quantifying second-round price impacts that feed back into OFIs. Notably, it distinguishes between immediate (two-day) and short-term (two-week) dynamics to capture constraints arising from T+2 settlement where margin and collateral calls have to be met instantly, while the proceeds of asset sales and redemptions materialize only after two days. This approach, which uses transaction-level supervisory data for securities, repos, and derivatives to trace interconnectedness, sets it apart from prior analyses that exclude off-balance sheet transactions, making the results more relevant for macroprudential surveillance and policy design.

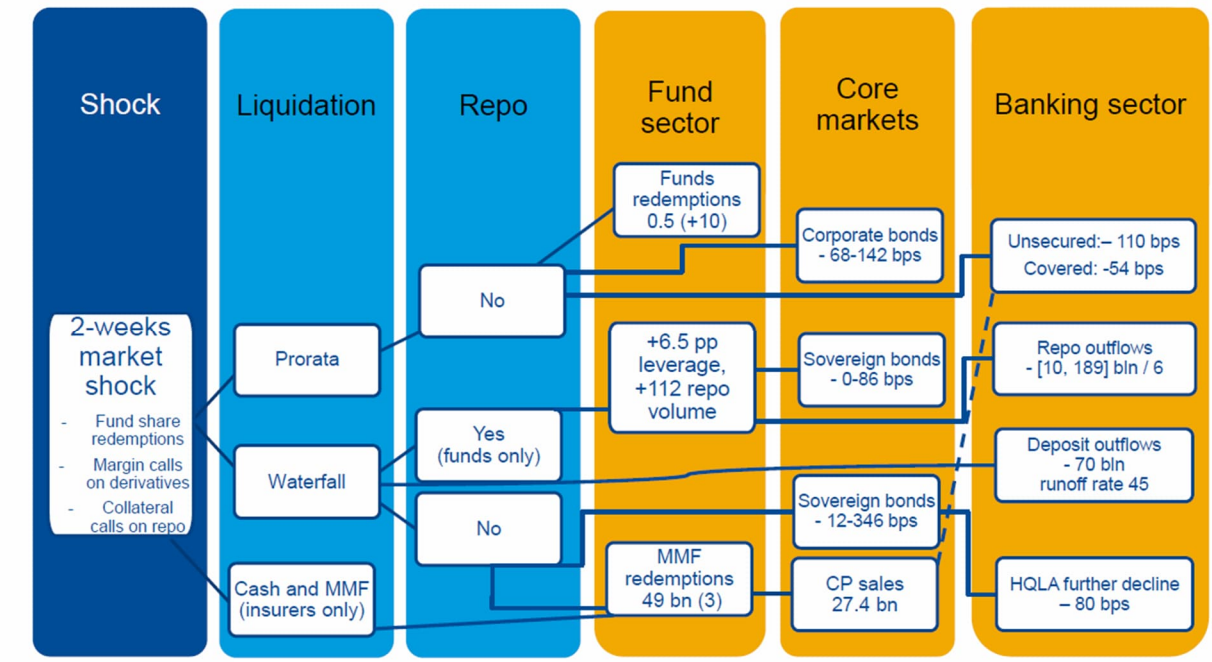
The analysis shows how liquidity stress originating in investment funds can propagate across the financial system through multiple, reinforcing channels. Initial shocks—driven by market price declines, margin calls, and investor redemptions—force funds to draw on cash buffers (bank deposits and MMF shares), liquidate or repo assets, and adjust derivatives positions. These actions transmit stress to core funding and securities markets, particularly sovereign, bank, and corporate bond markets, where concentrated sales depress prices and reduce market liquidity. Because euro-area funds hold globally diversified portfolios, spillovers are not confined domestically but can quickly extend cross-border, amplifying volatility in global fixed-income markets.

Central spillover channels differ across sectors. Banks are affected through several channels: potential missed derivative margin calls from stressed funds increase counterparty credit risk; repo market strains reduce funding availability; and deposit withdrawals due to fund redemptions weaken bank liquidity positions. MMFs play a pivotal amplifying role, as they provide repo liquidity (reverse repo) to funds but may themselves face large redemptions, since many institutions hold MMF shares as cash equivalents, leading to sales of commercial paper and short-term bank debt assets that tighten wholesale funding conditions—echoing dynamics observed in March 2020. Insurers contribute to spillovers mainly through liquidity needs from margin calls on derivatives and valuation losses on asset holdings, which can reinforce procyclical asset sales and increase funding pressures elsewhere in the system.

Second-round effects materially magnify initial shocks (Figure 5). Asset sales by funds and spillover sales by MMFs and insurers generate endogenous price impacts, raising yields and spreads and increasing further margin and redemption pressures in a feedback loop. While aggregate solvency impacts on banks and insurers remain contained as market stress is presumed temporary, the analysis highlights that liquidity shocks can propagate rapidly and non-linearly through interconnected balance sheets and markets, even in the absence of large defaults. The findings underscore that NBFI liquidity distress is a systemic, not sectoral, phenomenon, reinforcing the need for systemwide monitoring, coordinated stress testing across sectors, and policies aimed at reducing procyclicality and excessive reliance on market liquidity under stress.

Figure 7. Euro Area: Schematic of the Systemic Liquidity Risk Transmission Mechanisms





Source: 2025 Euro Area FSAP, technical note on risk analysis and stress testing in the financial sector.
Note: The range of market and price impacts reflects alternative behavioral assumptions for stressed sectors.

Key Takeaways

FSAP experience underscores the need to tailor systemwide liquidity analysis to each jurisdiction's financial structure, vulnerabilities, and data availability. The applications above show that key risk drivers, institutions, markets, regulations, trading practices, and behaviors vary widely across countries and over time. In less complex and more externally exposed economies, the Excel-based approach has helped trace how capital outflows, FX liquidity pressures, and nonfinancial-sector behavior transmit stress through domestic financial linkages and affect central banks' capacity to provide backstops. The central participants also differed markedly—ranging from pension funds in Chile and NBFCs in India to foreign investors in Mexico's local-currency sovereign bond market, central bank reserves in Türkiye, and nonfinancial corporates in the Philippines. In more advanced, market-based systems, applications have increasingly focused on bank–NBFI interlinkages, common exposures, fire-sale dynamics, derivatives and repo-related margin and collateral calls, and stress transmission through core funding and securities markets. Given system complexity and persistent data gaps, truly comprehensive systemwide analysis remains challenging for both the IMF and national authorities; most exercises therefore focus on specific instruments or sectors.

These exercises were presented as exploratory, reflecting wide uncertainty around system resilience and its measurement, as in similar work by national authorities. Results were highly sensitive to assumptions about market participants' behavior, the specification and calibration of fire-sale price dynamics—particularly difficult to estimate in crisis conditions—the perimeter of institutions and instruments covered, and the scenarios considered (see the Way Forward section). Accordingly, most exercises avoided firm resilience assessments and instead focused on identifying key transmission channels, systemic actors, data gaps, safety-net arrangements, and priorities for future analysis. Unlike sector-specific bank solvency or liquidity stress tests, systemwide analyses lack agreed hurdle rates—that is, quantitative indicators and thresholds for determining whether institutions or the system "fail" the test—including for institutions such as hedge funds. Moreover, systemic liquidity stress can arise even when institutions meet regulatory requirements. For example, a bank may satisfy the Liquidity Coverage Ratio, calibrated over one month, and the Net Stable Funding Ratio, calibrated over one year, yet still lack sufficient same-day cash to meet derivatives margin calls. While prior vulnerability analysis helps identify the risks and channels to examine, the stress test adds value by quantifying their potential scale and propagation under alternative, internally consistent scenarios. These scenarios may be historically grounded or deliberately more severe and exploratory, so their results are conditional rather than probabilistic assessments.

As a result, recommendations have generally been "soft," focusing on methodological advances, stronger supervision, and closing data gaps. Unlike bank stress tests, requiring participants to raise capital or liquidity buffers in response to systemwide vulnerabilities may not necessarily strengthen overall resilience. If vulnerabilities are concentrated in certain investment funds, for example, requiring them to hold larger liquid assets could create new spillover channels, depending on the assets held. Greater holdings of bank deposits could strengthen fund-bank linkages, while larger holdings of sovereign securities could amplify second-round fire-sale effects in sovereign bond markets. Similarly, requiring funds to establish contractual credit lines with banks could transfer liquidity risk to the banking system. The international financial stability community, including leading central banks and regulators, has not yet reached an agreed solution for managing systemwide liquidity risks, including the appropriate role of central bank backstops.

Way Forward

Systemwide liquidity stress testing tools that capture interconnectedness across sectors and institutions remain experimental, partly due to data gaps. Effective risk analysis depends on cross-sectoral interconnectedness data

among banks, NBFIs, and, when relevant, non-financial or public sectors. Data on NBFIs, particularly lightly regulated entities, is incomplete (see Table 1). Efforts like the G20 data gap initiatives[20] have prompted countries to collect sector-aggregate flow-of-funds by counterpart, such as IMF's BSA data (IMF 2015). FSB's more segmented data are available for many jurisdictions, but these provide only high-level mapping and lack depth for systemwide analysis. They also often miss key some cross-border transactions—important for hedge funds incorporated in tax havens—and off-balance sheet items like derivatives, repos, credit lines, and other contingent assets or liabilities. National supervisors may gather activity-based information from transaction-level data held by FMIs, but processing these is resource-intensive and technically complex, as shown in the Euro Area FSAP.[21] Additionally, integrating sectoral data is difficult in many places due to its highly confidential nature, hindering cross-agency collaboration.

In the near term, the IMF and some national authorities are leveraging available but often underused data, along with bottom-up exercises, to address information gaps. Two main top-down approaches are used to shed light on the dark corner of finance, such as hedge funds and private finance. The first utilizes confidential counterparty data from regulated entities, especially banks, which can help map significant NBFI activities, identify banks' concentrated or common exposures to them, and assess spillover risks to banks, for example by using regulatory data on large exposures as in Valderrama and Varghese (2026). The second approach relies on transaction-level data collected by FMIs to monitor margin and collateral calls under stress scenarios and pinpoints which agents might face substantial credit or liquidity losses. While full resilience analysis requires institutional-level data on liquidity and capital buffers and available credit/repo lines—currently feasible only for regulated entities—mapping risk concentrations remains a valuable tool for identifying markets and institutions that could trigger systemwide stress. This approach will require significant collaboration with national authorities beyond FSAP, as it relies on highly confidential data that the IMF cannot directly access and involves labor-intensive big data management.

Another challenge in establishing robust systemwide liquidity stress testing is the significant influence of behavioral factors, which are difficult to pin down. Decisions are the results of a complex and continuous optimization process across a wide range of markets and products that are difficult to model in a reduced and realistic way. In addition, during periods of stress psychology-driven behavior can materially affect market outcomes, as demonstrated in behavioral finance and economics literature (see Hirshleifer 2015, building on foundational work by Kahneman and Tversky, 1979), and can give rise to outcomes that are difficult to predict. As illustrated in the examples detailed in previous sections, the way each agent responds to liquidity stress is crucial in determining the extent of liquidity contagion effects. While theoretical frameworks offer guidance, actual behavior could be different and hard to estimate, especially since it varies across agents, over time, and across jurisdictions. Consequently, FSAP exercises typically examine a range of behavioral assumptions to identify key parameters that significantly affect results and also rely on expert judgment from market surveillance and discussions with national supervisors. Increasingly, bottom-up exercises are helping to address this gap; for instance, the 2025 Euro Area FSAP partially relied on behavioral patterns observed in the

[20] The initiative began in 2009, completed its second phase in 2022, and is expected to begin its third phase, with continued annual monitoring. The last progress report (IMF-FSB, 2022) stated that challenges remained in securities financing transaction data, securities statistics, sectoral accounts, and cross-border exposures of nonbank corporations, among others (see website: https://www.imf.org/en/News/Seminars/Conferences/g20-data-gaps-initiative).

[21] Other examples of such analyses include Fache, Jukonis, Letizia, and Gravanis (2020), who examine European derivatives transaction data; Hüser, Lepore, and Veraart (2024), who analyze the Gilt repo market; and Jukonis, Letizia, and Rousova (2022), who examine the impact of derivatives collateralization on investment funds' liquidity risk. Paddrik, Rajan, and Young (2020) and Levels, et al. (2018) examine contagion in the credit default swap (CDS) market using activity-based data from clearinghouses. Huang, Menkyeld, and Yu (2021) modeled interconnectedness through CCP.

BoE's SWES. Lessons from these bottom-up exercises can then inform advanced behavioral modeling, like agent-based models (ABMs), helping to build more empirically grounded stress-testing models.[22]

Behavioral assumptions should also reflect market microstructures, transaction types, and clearing arrangements from a systemwide perspective. As seen in the Euro Area case, factors such as margin and collateral calls, settlement cycles (T+2), and the role of FMIs—whether trades are cleared by CCPs or remain bilateral—can materially affect the outcome. These practices differ widely across jurisdictions, institutions, and instruments, and are often opaque, with even CCP margin formulas lacking full transparency (BCBS, CPMI and IOSCO, 2022, FSB 2024). As money markets shift from interbank to instruments like repos and derivatives involving more participants, including NBFIs, understanding these details becomes more important. Furthermore, CCP rules and stress tests typically focus on CCP stability, which may not align with systemwide risk objectives. In systemic shocks, stress can originate from CCP members or large clients—as seen in the Archegos case—even when CCPs remain resilient. Therefore, CCP stress testing—on its own or as a part of systemwide analysis—should evolve to incorporate systemwide perspectives, as demonstrated in the BoE's recent SWES (BoE, 2024).

Moreover, agents' actions must be consistent in a systemwide analysis, which requires deviating from standard sectoral stress testing assumptions. Systemwide risk analysis requires combining sectoral analysis with adjusted parameters to ensure behavioral consistency across agents. For instance, it is unrealistic to assume that household investors simultaneously redeem from all investment funds and withdraw from all banks, as their funds must remain within the system (unless moved to options like gold, crypto assets, or foreign assets that are "outside" of domestic financial systems). In standard liquidity stress tests, banks exiting the stress with ample liquid asset buffers are generally interpreted as a positive outcome. In a system-wide setting, however, such outcomes may amplify contagion and generate spillovers if they arise from precautionary liquidity hoarding that constrains funding to other institutions or sectors. In investment fund liquidity stress tests, even if funds remain resilient due to their liquid asset buffers, drawing down deposits from banks simply shifts the liquidity stress from funds to banks. A further distinction relative to standard sectoral stress tests is that these exercises generally assume broadly adverse impacts across all participating institutions, albeit to differing extents. In contrast, system-wide exercises allow for heterogeneous outcomes, whereby some institutions or entire sectors may benefit under specific scenarios.

In this context, when comparing systemwide exercises, it's crucial to clarify what defines the "system."[23] In IMF analyses using the Excel-based tool, the system usually includes the entire economy—including nonfinancial and public sectors. In tailored exercises, like the Euro Area FSAP and national authorities' bottom-up approaches, the system often refers to private financial institutions. Each approach has merits: broader sector coverage suits high-level, aggregate analyses, while simplified sectoral and institutional coverage is necessary for modeling complex instruments like derivatives and repos. For global liquidity analysis, including all major jurisdictions may be required. Ultimately, the system's scope should match the main questions, data availability, and practical constraints.

[22] An ABM is a simulation-based approach that allows economic and financial system dynamics from the bottom up based on individual agents, including firms, households, banks, NBFIs, and sovereigns, as needed. Some agents follow optimized rules while others could follow more heuristic behavioral rules because of bounded rationality and other factors emphasized in behavioral finance literature.

[23] The inside-outside (or public and private) theory of money (Gurley and Shaw, 1960; Lagos, 2006) helps clarify liquidity consistency. Inside money typically means private money like bank deposits, repos, and MMF shares, while outside money represents sovereign liabilities, such as currency and treasury bills. The distinction depends on how the "system" is defined—such as domestic or global. For example, global liquidity arises from the interaction between private money and public money (global safe assets, central bank swap lines), as described by Goldberg (2024). Brunnermeier and Niepelt (2019) incorporated these cross-border concepts and links to financial stability risks from runs into their model.

Technical challenges also arise in estimating sale-price dynamics in highly illiquid markets with sparse trading. These estimates are crucial for assessing second-round effects from asset liquidation at potentially fire-sale prices. However, standard methods usually rely on asset price volatility, which may be nearly zero in markets with infrequent trades. For example, the 2024 India FSAP investment fund analysis excluded spillover effects from sale-price dynamics due to limited corporate bond trading, because they led to counterintuitive findings, where price impacts were greater in actively traded sovereign bond markets than in smaller, illiquid corporate bond markets. In cases where standard price-impact methods are not suitable due to illiquid markets, an equilibrium approach that infer prices by matching supply and demand, may provide more reliable results, as explored by some authorities.

Conclusion

The IMF has made significant progress in developing top-down systemwide risk analysis—an important frontier for financial stability—over the past decade. This approach is crucial for assessing systemic risks from NBFIs and their spillover effects to banks, other NBFIs, and across borders given their systemwide interconnectedness. Methodological advances have been published and applied in FSAPs. Early applications for less complex EMDEs helped to identify areas for improvement and demonstrated how stress test results can inform policy recommendations on systemic liquidity. Recent work has focused more on NBFIs, market finance, and new liquidity risks from margin and collateral calls for more complex systems, aligning with FSB's current initiatives (FSB, 2024b). Enhanced access to transaction-level data, enabled by post-GFC reforms of financial market infrastructures like CCPs and data repositories, has supported this progress.

Further progress is needed to strengthen analytical capabilities for assessing near-term financial stability risks related to NBFIs and their interconnectedness. For instance, a deeper understanding of the risks associated with the increasing prevalence of hedge fund basis trades—financed through repo transactions amid rising public debt in core markets—is essential in some core markets (see BIS Quarterly Bulletin, December 2025, and the October 2024 GFSR). Such evaluations will increasingly depend on transaction-level data collected by FMIs, supplemented where possible by partial entity or counterparty data reported by regulated institutions. Bottom-up exercises are another valuable approach. All these methods demand significant resources and underscore the importance of close, ongoing collaboration with national authorities, potentially requiring a multi-year engagement that extends beyond the FSAP timeline.

Yet, developing systemwide analysis tools is still a useful and informative endeavor. Given the challenges, systemwide risk analysis is usually not suited to draw strong conclusions about the resilience of the system upon shocks. Nevertheless, these exercises are useful in identifying potential weak links, critical data gaps, priorities for strengthening or streamlining supervisory and reporting frameworks, areas for improving data sharing and cross-agency coordination, and regulatory features that could be adjusted to better support system-wide stability. It can also help identify industry rules and practices that could help one sector's resilience but possibly at the cost of the system, such as margin practices.

Annex I. Coverage of NBFI and FMIs in recent FSAPs

Table I.1: Coverage of NBFI and FMIs in recent FSAPs—Stress Tests, Regulation and Supervision (2020–2025)

FSAP	Solvency Stress Test	Liquidity Stress Test	Systemwide Analysis	Supervision and Regulation
2025 Azerbaijan			X	
2025 Canada	IC, PF	IC, PF	X	IC, PF, IF
2025 China			X	IC, Markets, IF, FMI, NBFC
2025 Euro Area	CCP	IF	X	IC, IF, Markets, FMI
2025 France		IF		IC, Markets
2025 India	NBFC	NBFC, IF	X	NBFC, IC, Markets, IF
2025 Switzerland	IC			FMI, IC, Markets
2024 Japan	IC	IC, IF	X	IC, IF, CCP
2024 Luxembourg	IC	IC, IF	X	IF, IC
2024 Netherlands	IC, PF	IC, PF	X	IC, PF, Markets
2024 Spain				FMI
2023 Belgium	IC	IC, IF	X	IC, FMI
2023 Botswana	IC, PF		X	
2023 Iceland	PF	PF	X	PF
2023 Jordan			X	FMI
2023 Sweden		IF	X	FMI
2023 Türkiye			X	IC, PF
2022 Germany				FMI, IC
2022 Ireland	IC	IC, IF	X	IC, IF
2022 Mexico			X	
2022 South Africa			X	IF, IC, PF
2022 U.K.	IC	IC, IF		CCP, IC, IF
2021 Chile		IF, PF	X	IF, PF, IC
2021 Philippines			X	
2021 China—Hong Kong SAR		IF		CCP, FMI, IC, Markets
2020 Korea	IC			IC, Markets
2020 U.S.	IC	IF, IC	X	FMI, IC, IF, Markets

Note: IC = Insurance Companies, PF = Pension Funds, IF = investment Funds, NBFC = Non-Bank Financial Corporates, CCP = Central Counterparties, Markets = Securities Markets, FMI = Financial Markets Infrastructure (includes CCPs, Central Securities Depositories, payment systems). Including assessments undertaken by the World Bank for joint FSAPs.

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