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EURO AREA

FINANCIAL SECTOR ASSESSMENT PROGRAM

July 2, 2025

TECHNICAL NOTE

SYSTEMIC RISK ANALYSIS - NBFI

Prepared By
Monetary and Capital Markets Department

This Technical Note was prepared in the context of the Financial Sector Assessment Program (FSAP) in the euro area. It contains the technical analysis and detailed information underpinning the FSAP findings and recommendations. Further information on the FSAP program can be found at http://www.imf.org/external/np/fsap/fssa.aspx

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Glossary

AIF	Alternative Investment Fund
AIFMD	Alternative Investment Funds Management Directive
AUM	Assets Under Management
CIC	Complementary Identification Code
CP	Corporate Paper
CSA	Credit Support Annex
CUSIP	Committee on Uniform Securities Identification Procedures
EA	Euro Area
EC	European Commission
ECB	European Central Bank
EIOPA	European Insurance and Occupational Pensions Authority
ESMA	European Securities and Markets Authority
ESA	European Supervisory Authorities
ESRB	European Systemic Risk Board
ETF	Exchange-Traded Funds
EU	European Union
FSAP	Financial Sector Assessment Program
HY	High Yield
IG	Investment Grade
IM	Initial Margin
ISIN	International Security Identification Number
LCR	Liquidity Coverage Ratio
LEI	Legal Entity Identifier
LDI	Liability-driven Investment Funds
LMTs	Liquidity Management Tools
MIFID	Markets in Financial Instruments Directive
MMF	Money Market Funds
MtM	Mark to Market
NAV	Net Asset Value
NBFI	Non-Bank Financial Institutions
NCA	National Competent Authority
NPV	Net Present Value
NUS-CRI	National University of Singapore, Credit Research Initiative
ROW	Rest of the World
SFT	Securities Financing Transactions
SFTR	Securities Financing Transactions Regulation
SITG	Skin in the Game
TN	Technical Note
UCITS	Undertakings for Collective Investment in Transferable Securities
VM	Variation Margin

EXECUTIVE SUMMARY

This note discusses the assessment of systemic risks within Non-Bank Financial Institutions (NBFIs) as part of the Financial Sector Assessment Program (FSAP) for the euro area (EA). It outlines the assessment of counterparty credit risk related to Central Counterparties (CCPs) and the potential system-wide spillovers from NBFI liquidity distress with a focus on the investment funds sector. In addition, spillovers to and from the insurance sector to the fund sector were quantified based on detailed EA insurers' assets holdings and derivative positions.

The analysis of counterparty credit risk arising from CCPs' reverse repo positions indicates that potential losses, although modest in absolute terms, can be substantial compared to CCP capital. CCPs engage in reverse repos to manage cash received from clearing members as margin, generally applying lower haircuts on collateral than those used in their clearing business. While most CCPs experience limited losses (up to 20 basis points) in the stress tests, these losses can reach up to 120 percent of the CCP's own capital at risk, underscoring vulnerabilities in cases where skin-in-the-game is minimal.

The stress test on the investment fund sector quantified potential impacts on core markets and financial institutions arising from liquidity needs triggered by redemption shocks and margin calls. It included around 32,000 investment funds, representing about 70 percent of assets under management (AUM) of the EA fund sector, covering Undertakings for Collective Investment in Transferable Securities (UCITS), Alternative Investment Funds (AIF) and Money Market Funds (MMF). A sensitivity analysis shows the additional contribution of insurers facing margin calls on their derivatives positions.

The analysis measured potential spillovers in two market scenarios, which included plausible combinations of shocks. The two scenarios, featuring steepening yield curves, equity market corrections, and widening spreads in sovereign and corporate funding markets, differed in their liquidity shock assumptions as well as on the mitigating actions available to funds. Specifically, the stress tests considered two distinct market scenarios with time horizons of two days and two weeks. In the two-day scenario, share redemptions and asset sales are excluded, while in the two-week scenario, a decline in funds' net asset values induces investor redemptions. The analysis revealed that liquidity outflows could total EUR 16 billion in the two-day scenario which is concentrated in bond funds. This is comparable to the margin calls faced by EA funds in March 2020. In the two-week scenario, combined liquidity outflows are close to EUR 700 billion corresponding to an aggregate outflow rate of 4.7 percent of AUM, concentrated in equity funds.

Under the two-day scenario, the aggregate liquidity demand exceeds available liquidity, resulting in a shortfall of up to EUR 9.8 billion. Although repo borrowing could potentially mitigate this shortfall, its effectiveness is contingent on counterparties' willingness and ability to provide funding. Operational challenges limit many funds' access to the repo market, with the majority of repo counterparties located outside the EA. The liquidity shortfall translates, on average to 52 percent of variation margins due from in-scope funds to banks to be potentially at risk, which could trigger counterparty credit risk (CCR) losses.

In the two-week scenario, funds predominantly meet liquidity demands by liquidating assets, which amplifies the initial market shocks. The analysis shows that correlated strategies to fend off liquidity pressures could propagate stress to core financial markets and institutions creating financial stability risks. The estimated price impacts vary significantly based on the scenario specifics, with EA government bonds experiencing price impacts of between 12 and 350 basis points. The potential spillover effects could also influence non-EA markets due to the focus of EA funds on global investment, highlighting the interconnected nature of financial markets.

Financial institutions face varied impacts depending on how investment funds are assumed to react to liquidity demands. MMFs could encounter up to EUR 40 billion in redemptions, leading to significant asset liquidations. Insurance companies facing margin calls could further contribute to MMF redemptions for around 9 billion. The stress test indicates that if MMFs liquidate corporate paper (CP) after having exhausted their cash buffers, this could entail CP sales of up to EUR 26 billion with a majority issued by banks. Moreover, defensive actions by NBFIs could further amplify liquidity strains, resulting in outflows from bank deposits and a drop in the value of high-quality liquid assets (HQLA).

The analysis acknowledges that accurately assessing funds' liquidity demand in a stress scenario and their behavioral response would require additional granular information. This includes the use of liquidity management tools (LTM), redemption fees as well as the heterogeneity of the investor base. Also, information on liquidity lines with custodian banks, and instrument-level holdings across all funds.

The FSAP analysis underscores the importance of the authorities implementing an EU-wide liquidity stress test to assess systemic risk stemming interconnectedness within the fund sector and with other market participants. Such a comprehensive, cross-border approach should extend beyond the existing supervisory stress tests by national competent authorities (NCAs) and requires robust governance and tools to manage the data-intensive nature of the exercise. Adopting a system-wide perspective in liquidity stress testing is crucial for understanding intersectoral dependencies regarding funding and liquidity. However, significant data gaps and challenges in data sharing among EA/EU institutions hinder the depth of such analyses. Therefore, ESMA, in collaboration with the ESRB, the ECB and other European Supervisory Authorities (ESAs),[1] should continue to develop a tailored framework for system-wide liquidity stress testing that addresses the specificities and heterogeneity of the EA financial markets,

[1] ESAs consist of the European Banking Authority (EBA), the European Securities and Markets Authority (ESMA), and the European Insurance and Occupational Pensions Authority (EIOPA).

Table 1. Euro Area: Main Recommendations			
Recommendation	**Paragraph**	**Authorities**	**Timing[1]**
CCPs systemic risk analysis			
Regularly monitor risks in investments (non-default losses) by CCPs.	11	ESMA / NCA	ST
Close data gaps for Tier 2 CCP regarding investment positions, including on collateral received and currency.	11	ESMA	MT
Include risk from non-default losses in the next CCP stress test.	12	ESMA	MT
Investment fund sector systemic risk analysis			
Operationalize and conduct regular macroprudential EU-wide liquidity stress tests, including UCITS, AIF and MMF.	51, Box 1	ESMA	MT
Strengthen system-wide financial risk monitoring on a cross-country and cross-sectoral basis and conduct system-wide stress tests, including bank and nonbank sectors.	52	ESMA / ESRB / EIOPA / ECB / EC	MT
Ensure revised supervisory templates comprise the necessary information to conduct stress tests to meet the financial stability mandate, including: - Instrument level holdings; - Returns and flows with at least weekly frequency; - Use of liquidity management tools (LMTs); - Temporary borrowing arrangements and custodian bank; - Asset encumbrance, with source of encumbrance; - Funds redemption schedule; - Harmonized leverage.	26, 35, 38, 41, Box 1	ESMA / EC	ST
Conduct currency-specific liquidity stress tests for the most significant currencies (EUR, USD, GBP).	33	ESMA	MT
Conduct multi-period liquidity stress test.	23	ESMA	MT
Make proper data infrastructure and software tools available to economists and risk analysts.	Box 1	ESMA	ST
Ensure trade repositories improve the quality of transaction level data collected under European Market Infrastructure (EMIR) and Securities Financing Transactions Regulation (SFTR).	6	ESMA	MT

[1] I: immediately; ST: short term = less than 1 year; MT: medium term = 1–5 years.

INTRODUCTION[2]

1. The NBFI sector in EA encompasses very heterogenous institutions. Heterogeneity spans across business models and the complexity of the regulatory regimes. This Technical Note does not attempt to systematically cover all potential vulnerabilities but rather includes two targeted analyses, focusing primarily on CCPs non default losses and liquidity spillovers across funds, banks and insurers.[3]

2. Among NBFIs in the euro area, investment funds, insurance firms and CCPs are key players. Investment funds hold about a quarter of domestic financial assets, followed by insurance firms which hold about 11 percent, making those two groups the most significant non-bank investors.[4] The liquidity mismatches inherent in their business model can cause procyclical behavior, which may increase market volatility and is therefore important to monitor. CCPs are critical nodes in the financial system because they centralize and manage counterparty risk in derivatives and securities markets. Their interconnectedness with other market participants such as banks, asset managers and funds render them a critical financial market infrastructure. CCPs are therefore considered systemically important—at least within their own jurisdiction.[5]

3. Recent stress events highlighted the need for comprehensive liquidity stress testing. A system-wide liquidity stress test including investment funds, insurance companies, and money market funds (MMFs), is crucial for monitoring and mitigating systemic liquidity risks that can arise in interconnected financial markets. Liquidity challenges can propagate quickly and may lead to broader financial instability. Stress testing enables regulators and policymakers to take a forward-looking view and develop timely interventions to enhance the resilience of the financial system, as also highlighted in ESRB (2024). The interaction among liquidity-seeking market participants in a downward market could lead to amplification effects and feedback loops impairing financial stability, highlighting this topic as "macro-critical". At the same time, such exercise can inform the calibration of macroprudential policy action targeting NBFIs, in line with the recent European Commission's targeted consultation paper (EC, 2024).

4. The stress tests were conducted in close collaboration with ESMA. The two stress testing exercises discussed in this note, one on counterparty credit risk in CCPs and one on system-wide spillovers from funds' liquidity distress, were performed by the FSAP team in close collaboration with the relevant teams at ESMA. For those data points that could not be made available directly to the IMF team, ESMA staff ran the stress testing tool provided by IMF staff on their own platforms. In addition, spillovers to and from the insurance sector to the fund sector were quantified based on

[2] The authors of this note are Elisa Letizia, and Hannah Winterberg (all IMF). The analyses have benefitted from close collaboration with the staff of the European Securities and Markets Authority (ESMA), support from the staff of European Insurance and Occupational Pensions Authority (EIOPA) and discussion with staff of the European Central Bank (ECB)), and the euro area FSAP team.

[3] See e.g. IMF (2022), Chen and Kemp (2023).

[4] Pension funds hold 4 percent of total financial assets, representing twice the share held by MMFs.

[5] This is also reflected in CPSS-IOSCO (2012) guidance.

detailed EA insurers' assets holdings data shared by EIOPA. In the process of conducting the stress tests, IMF staff further reviewed the availability and suitability of data and systems at ESMA for stress testing purposes. For an overview of the markets structure as well as the regulatory frameworks we refer to the Technical Note on Investment Funds Regulation, Supervision and Systemic Risk Monitoring and to the Technical Note on Insurance Micro and Macroprudential Supervision.

CCP COUNTERPARTY CREDIT RISK ON REVERSE REPO

5. **The analysis evaluates the CCPs' counterparty credit risk in their reverse repo portfolios.** CCPs use reverse repos to invest the cash received from clearing members as margin. These positions are characterized, on average, by lower haircuts on the collateral received (government bonds) than what is applied by CCPs on similar collateral on their clearing business. This is in line with bilateral repo having generally low haircuts.[6] This might expose CCPs to potential losses if a counterparty default would occur at the time of market downturn, given that the collateral might not be sufficient to cover losses. Other concurring potential losses, stemming from the clearing business, are out of scope for this analysis. The analysis covers 16 CCPs authorized to clear in the EA regardless of their domicile, and uses data collected under the EU securities financing transaction regulation (SFTR)[7] for repo, and CCP supervisory reports, with reference date December 11, 2024. Time series of daily probability of default (PD) for counterparties are market-based and sourced from National University of Singapore, Credit Research Initiative (NUS CRI).[8]

6. **Reverse repo usage differs greatly across CCPs operating in the euro area.** Of the 14 EU CCPs, only seven CCPs reported reverse repos, mostly in non-EUR currencies (USD, GBP, and other EU currencies). EU CCPs have at most eight different counterparties, while third-country Tier 2 CCPs have up to 54 counterparties. While counterparties are typically large clearing members, there are instances of non-banks, non-members counterparties. The SFTR sample available to ESMA only covers trades reported by EU firms: for EU CCPs we rely on own transaction reporting obtaining 100 percent coverage, except for one EU CCP, which we exclude from the sample due to data quality limitations. We only have a partial view of Tier 2 CCPs' reverse repo exposures: after cleaning the data for outliers, we include in our sample trades representing no more than 29 percent of Tier 2 CCPs' reverse repo positions – this makes our loss estimate a lower bound. In this context, but also more broadly from a system-wide perspective, it would be important for ESMA to ensure trade repositories improve the quality of transaction level data (Table 1).

7. **We use an Expected Shortfall (ES) set-up to estimate the potential unexpected losses on CCPs' reverse repo portfolios.** We compute loss distributions combining historical simulations to capture the time-changing exposure of CCPs with the potential defaults of repo counterparties.

[6] See ESMA (2024a) and similar evidence on low haircuts for bilateral repos in the US in Kahn and McCormick 2025.

[7] Data provided were based on Trade-State tables. See Appendix V for a discussion on the data preparation.

[8] NUS CRI - https://nuscri.org/en/. The CRI PD estimates the default risk of publicly listed firms by quantitatively analyzing their financial statements, stock market data and macro-financial factors retrieved from various international data sources. NUS-CRI currently provides daily updated PDs on over 45,000 active exchange-listed firms globally. Given a survival period, the PD is constructed on a forward intensity function, whose inputs include the state of the economy (macrofinancial risk factors) and the vulnerability of individual obligors.

Historical simulations, spanning the period between January 2020 and December 2024, allow us to capture model-free dependencies in market movements across different tenors and currencies over a holding period of five days. For each day in the time series, we compute the potential conditional loss for each pair of CCP and counterparty as the difference between the discounted value of the collateral and the cash at maturity, assuming losses can be netted across positions of the same counterparty, but not across different counterparties. Loss given default after the collateral value is assumed to be 1, for lack of information on the treatment of such residual losses.

8. We approximate collateral revaluation using its duration and convexity. We map each bond used as collateral to the corresponding bond index, in terms of issuer country and tenor, to determine the relevant time series of yield over the historical simulation horizon.[9] We denote by $V_L(t)$ the value in denomination currency of a bond on any day t of the historical simulation, and $\Delta_{\mathrm{k}} y(t)$ the change in yield over the holding period of length k (i.e. between $t-k$ and t). Given the value of the portfolio in EUR at the cut-off date T, $V(T)$, we can approximate the change in value over the historical simulation with the following:

$$\Delta_k V(t,T) = V(t) - V(t-k) = V_L(T) \cdot \Delta^{\%}{}_k V(t,T)$$

$$\Delta^{\%}{}_k V(t,T) = \frac{\big(FX(t) - FX(t-k)\big)}{FX(t)} - \left(\mathrm{D} \cdot \Delta_{\mathrm{k}} y(t,T) - \frac{s}{2} \Delta_{\mathrm{k}} y(t,T)^2\right)$$

where $FX(t)$ is exchange rate to EUR at time t, D is the duration and s is the convexity at the cut-off date T. For each counterparty i we define the excess collateral C, accounting for the shock on FX on the $cash$ leg in a similar way as for the collateral leg (noting FX refers to the FX rate of the cash leg which might be distinct from that of the collateral):

$$C_{i,t} = V(T) - cash \cdot FX(T)\left(1 + \frac{FX(t) - FX(t-k)}{FX(t)}\right)$$

9. For each CCP, we consider all possible combinations of defaults of counterparties and compute the total loss. For a CCP with n_{cpt} counterparties, there are $2^{n_{cpt}}$ combinations of defaulting counterparties. We derive the joint probability of the combination $\mathbb{P}\big(u^{[k]}\big)$, based on individual counterparties' PD_i on a given day of the historical simulation, assuming defaults are independent.[10] Denoting with $u^{[k]}$, $n_{cpt} \times 1$ the vector of indicators of default for a given combination (i.e. $u^{[k]}{}_i = 1$ if counterparty i defaults):

[9] The change in yield for a given bond is determined by interpolating across the change in yield for the bond indices with tenors closer to its duration.

[10] While *conditionally* independent, based on each day's market conditions, default events might still be *unconditionally* dependent (i.e., when looking at the whole historical simulation) via their common dependence on market conditions, which is likely to be the case, by construction, given the way PDs are estimated.

$$\mathbb{P}(u^{[k]}) = \prod_{u^{[k]}_i = 1} PD_i \cdot \prod_{u^{[k]}_i = 0} (1 - PD_i)$$

The CCP loss in any given day is the sum of the conditional losses for defaulting counterparties. Losses over the historical simulation over n_{day} days are given by

$$\mathrm{L_k} = \underbrace{[[C + H \cdot S]^T]^-}_{\substack{conditional\ loss,\\ by\ counterparty,\\ by\ day}} \cdot u^{[k]} \qquad \mathrm{k} = 1, \dots, 2^{n_{cpt}}$$

where C is a matrix of size $n_{cpt} \times n_{day}$ of excess collateral for each counterparty and day in monetary amount; H, $n_{cpt} \times n_{sec}$ is the matrix of collateral posted across the n_{sec} collateral, in monetary amount in Euro at the cutoff date; S, $n_{sec} \times n_{day}$, matrix of percentage shocks $\Delta^{\%}{}_k V(t,T)$. The loss estimate is defined as the expected shortfall at level α across all combinations and all n_{day} days, assuming each day has equal weight. For our results we set $\alpha = 0.001$.

10. As an alternative metric, we consider the Cover-2 losses. In CCP risk management, cover-2 losses indicate the potential maximum losses from the default of two clearing members, and it is used to calibrate the size of the default fund. We translate this concept in our set up by considering the sum of the two largest conditional losses for each day. We define NDL-Cover-2 as the expected shortfall at level α across all days, assuming each day has equal probability. For our results we set $\alpha = 0.001$.

11. We compare each CCP's potential losses to their default fund and skin-in-the-game. Losses from CCP's own investments are part of non-default losses (NDL) and therefore are not absorbed via the CCP clearing waterfall.[11] In normal times, NDL, in line with principles of corporate finance, are supposed to be absorbed by equity.[12] In recovery, most CCPs have provisions in their plans which cap the maximum loss absorbed by the CCP and distribute the rest to members. The FSAP team could not access, directly or indirectly, information on CCPs' equity or yearly profit, therefore we used "skin-in-the game" (SITG), that is, CCPs' own capital, which is exposed to clearing member default losses, to proxy CCPs' loss absorption capacity. We further consider the default fund, whose size is closely related to Cover-2 losses in the clearing portfolio - this allows us to gauge how NDL from reverse repos compare to potential clearing losses. Going forward, ESMA should monitor this risk against CCPs' resources to absorb NDL, including by closing existing data gaps for Tier 2 CCPs (**Error! Reference source not found.**).

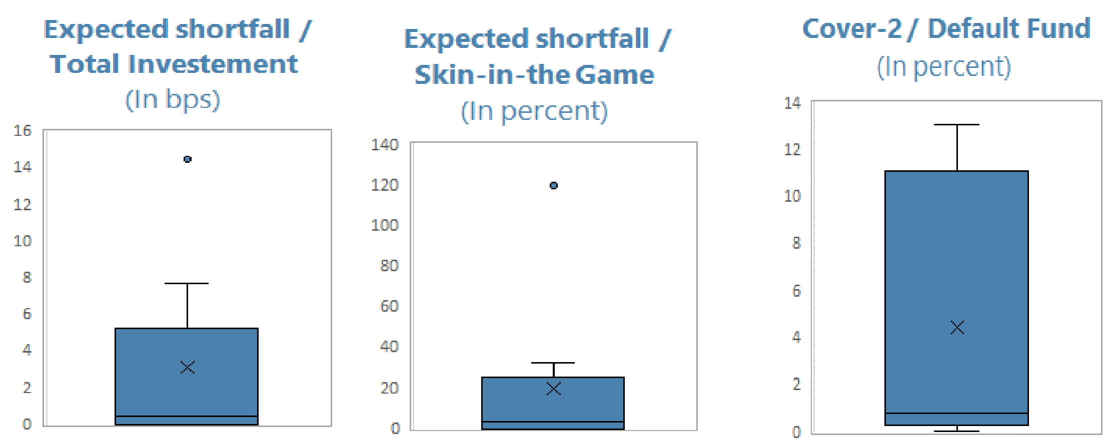
12. The analysis of CCR arising from CCPs' reverse repo positions showed that potential losses could be significant relative to CCP's own resources. In most cases the expected shortfall is modest when compared to the total cash investment, up to 15 basis points (bps) with some CCPs experiencing no losses (i.e., stressed collateral value is always above the cash leg). Losses are concentrated in just a few CCPs, characterized by relatively smaller skin-in-the-game compared to

[11] Regulation (EU) No 648/2012 (EMIR). Article 45. Default waterfall.

[12] FIA and ISDA (2020).

the default fund.[13] When compared to the skin-in-the-game, which we use as a proxy of the amount of losses to be absorbed directly by the CCP, we find that in some cases losses could consume a significant part of own resources, and in one case reaching 120 percent of the skin-in-the-game. This suggests that a significant portion of the estimated potential losses from CCR could be distributed to clearing members in recovery. Finally, we compare NDL-cover-2 to the default fund. We find that NDL-cover-2 could reach up to 13 percent of the default fund, with three CCPs exceeding 7 percent, so in a scenario of market downturn NDL could contribute to the spillovers from CCPs to the clearing ecosystem. Better estimates of NDL can help setting the appropriate level for recovery and resolution triggers, as well as inform whether CCPs own resources are sufficient if those triggers are met.[14] Against this background, ESMA should include losses from reverse repo and NDL more broadly as part of the regular CCP supervisory stress test (**Error! Reference source not found.**).

Figure 1. Euro Area: CCPs Counterparty Credit Risk on Reverse Repo



Sources: Bloomberg, ESMA; ESMA and IMF staff calculations.

SYSTEM-WIDE SPILLOVERS FROM NBFI LIQUIDITY DISTRESS

13. The FSAP team conducted a top-down macroprudential liquidity stress test on the fund sector. It also performed a sensitivity analysis on liquidity demands from derivative positions for the insurance sector and their impact on funding markets. In line with Adrian et al. (2020), the aim of the stress test is to identify financial vulnerabilities that can trigger systemic risk, spillovers to markets and other financial institutions, and the need of systemwide mitigating measures.

[13] According to Huang and Takáts (2020), relatively lower SITG can be considered a good predictor for CCP risk appetite. DF and SITG size vary greatly across CCPs. In our sample, the ratio SITG / DF ranges between 0.3 and 4.5 percent.

[14] FSB (2024a).

14. This workstream relates to recent and ongoing initiatives by several jurisdictions to conduct system-wide liquidity stress testing. For example, in 2024, the Bank of England conducted the System-wide Exploratory Scenario Exercise (SWES) (BoE 2024), a bottom-up exercise aimed to test the resilience of UK core markets by assessing the behaviors under stressed conditions with more than 50 market participants covering a wide range of business models. The exercise sourced information directly from participating entities about their reaction to a concerted stressed scenario and quantified second-round effects. Banks and CCPs were also considered in terms of potential liquidity they would demand or provide to NBFIs. The SWES provided a comprehensive view of the financial system's dynamics under stress, thereby allowing a proactive identification and mitigation of systemic risks and informing ongoing policy work to address vulnerabilities in market-based finance. At EU level, the Commission has extensively consulted on the possibility of introducing a SWES-like risk identification framework. Efforts are undergoing to understand how a system-wide stress test can be conducted in the EU building on the recent ESRB initiative.[15] Such exercises are particularly well suited to markets where interconnections and feedback loops are key, where key firms are at the edge of the regulatory perimeter, where behavioral assumptions are critical, or where there are significant data gaps.

A. Scope and Methodology

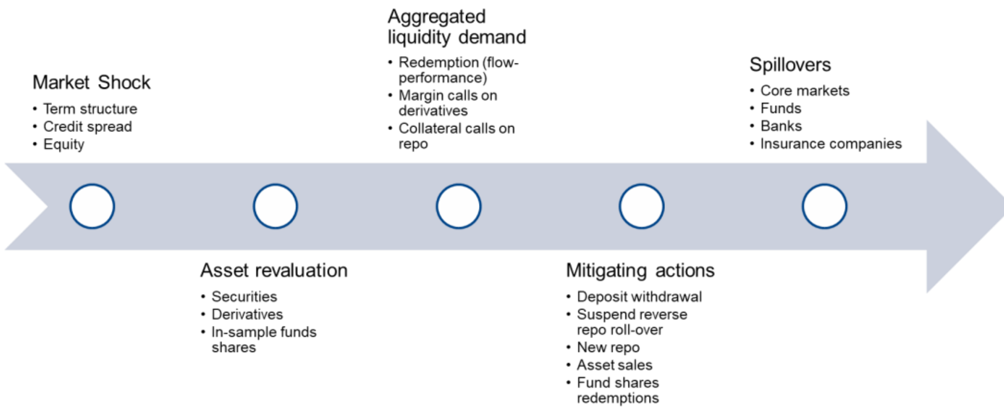
15. The analysis estimates the impact on EA core markets and financial institutions from investment funds' liquidity needs stemming from redemption shocks, margin calls on derivatives and collateral calls on repos. The FSAP team sourced granular holdings data and historical fund flows from Refinitiv Lipper for UCITS funds, while regulatory data were used for AIF and MMF by ESMA staff. Transaction level data collected under European Market Infrastructure Regulation (EMIR) and Securities Financing Transactions Regulation (SFTR) were used to identify entities' exposures in the derivative and repo markets, respectively. Market data on assets held by funds from sourced from the Markets in Financial Instruments Directive (MIFID), Haver and Bloomberg. The cut-off date for funds holdings is June 30, 2024, while transaction level data spans the period June 2023-June 2024. Data on derivatives and repos was collected for June 28, 2024. The analysis entails two steps (1) simulating cumulative outflows and inflows over the stress test horizon and comparing those to the available liquidity supply; and (2) measuring the spillover effects to core markets, funds, insurance firms, and banks. Figure 2 illustrates the approach, breaking down step (1) into four sub-steps.

16. In addition, the FSAP team quantified spillovers from the insurance sector to the MMF sector, due to margin calls on derivatives. The estimates relied on granular supervisory data collected under Solvency II and centrally accessible via EIOPA. Data refer to solo undertakings in a significant subset of EA jurisdictions, covering about 70 percent of EA insurance firms' total investments, with reference date 2024Q2. The FSAP team did not cover similar liquidity risk for pension funds (given their smaller size at 4 percent of EA financial assets), which will be the focus of the upcoming EIOPA's fifth stress test of occupational pension funds in Europe.[16]

[15] See Technical Note on Investment Funds Regulation, Supervision and Systemic Risk Monitoring.

[16] EIOPA launches Europe-wide liquidity stress test of occupational pension funds - EIOPA

Figure 2. Euro Area: Stress Test Approach and Timeline



Sources: IMF staff elaboration.

Sample overview

17. The sample includes over 32,000 funds domiciled in the EA across nineteen countries, thereby covering about 70 percent of AUM of the EA fund sector. The final sample includes approximately 13,000 UCITS funds, with AUM totaling EUR 7.1 trillion, representing a coverage of around 50 percent. Additionally, the sample comprises approximately 19,000 AIFs with an AUM of EUR 7.4 trillion and near complete coverage. Furthermore, we consider the impact on approximately 400 MMFs, which consist of both UCITS and AIFs, with an AUM of EUR 1.6 trillion and 90 percent coverage. Figure 3 illustrates the composition of funds' portfolio holdings by strategy. The figure shows the observed portfolio allocations align well with the funds' stated strategies.

18. The funds covered in this stress test jointly hold a significant asset position.[17] The largest asset category is equities, with EA equities and US equities amounting to EUR 1.19 trillion and EUR 2.12 trillion, respectively. Government bonds are also a main position, with total EA sovereign debt holdings valued at nearly EUR 700 billion, which compares to general consolidated government debt for the EA20 countries of 12.7 trillion Euros at the end of 2023. In-sample funds further hold US treasuries worth about EUR 281 billion, UK sovereign debt worth EUR 242 billion as well as other sovereign debt valued at roughly EUR 256 billion. In terms of corporate debt, in-sample funds hold EA (US, rest of the world (ROW)) corporate and bank debt valued at approximately EUR 1.18 trillion (EUR 554 billion, EUR 622 billion). Crossholdings of in-sample funds amount to about EUR 1.81 trillion, about 14 percent of the total AUM of all in-sample funds. In-sample funds further own exchange-traded funds (ETF) shares valued at EUR 186 billion and MMF shares worth EUR 117 billion (which compares to aggregate balance sheets of MMFs in the EA of EUR 1.7 trillion in 2024Q2). Finally, funds hold derivatives positions valued at EUR 2.01 trillion and

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[17] While the aggregate holdings of our in-sample funds do not exactly correspond to the values in the Investment Funds Balance Sheet Statistics the aggregate proportions fit to our observed coverage and the balance sheets do depict a similar composition. Minor differences result from the need of mapping between very granular data from Lipper and less granular data in AIFMD.

cash worth EUR 291 billion. The remainder, valued at approximately EUR 1.7 trillion, is distributed across various asset classes.

19. Funds' assets are grouped along several dimensions. Holdings' data for UCITS funds, available at the International Security Identification Number (ISIN)-level, require aggregation in baskets for computational efficiency and comparability to the AIF sample. The resulting asset segmentation can be found in Appendix IV. For sovereign bonds we consider four maturity buckets above one year, and the issuing country, grouping euro area members states by their credit rating. We treat bonds with less than one-year residual maturity as a separate basket, to recognize their limited liquidity. For corporate bonds and equities, we aggregate by region (EA, US, ROW), and for euro area we further separate bank bonds, and corporate bonds by rating (high yield (HY), or investment grade (IG)). We also consider funds' shares, differentiating between MMFs, which we treat as cash-like instruments so with high pecking order,[18] ETFs, which we assume are liquid and assign high pecking order before securities,[19] and other investment fund shares (OIF) which are positioned in the pecking order after securities. This results in 47 asset baskets, of which 30 flagged as eligible for General Collateral (GC) pooling and GC pooling extended.[20] For AIF reported data are presented in aggregate baskets which we adjust as needed to fit the asset categorization.[21]

20. The same segmentation is used for insurance undertakings. Solvency II data include ISIN-level information of insurers' investments, complemented with additional information on type of exposure, country, credit quality and encumbrance of the exposures. The reporting is thus well suited to be mapped to our segmentation, in particular to identify insurers' granular holdings of EA funds' shares and their liquidity supply more broadly.

21. Funds' total derivatives holdings amount to about 15 percent of AUM, highlighting the importance of including variation margin calls in our stress test. The derivatives exposures of the funds in the sample reveal a diversified portfolio with significant notional values across various instruments. The largest exposure is in interest rate swaps, amounting to approximately EUR 1.5 trillion, representing 14.9 percent of the total derivative notional exposure. This is followed closely by Interest rate futures at EUR 1.3 trillion (13 percent). Equity options and credit swaps also exhibit sizeable exposures of EUR 0.5 trillion (5 percent) and EUR 443 billion (4 percent), respectively. Equity swaps, with a notional amount of EUR 383 billion (4 percent), and interest rate swaptions at

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[18] See ESRB (2021) for discussion on the use of MMF shares as cash management vehicles by financial institutions.

[19] Consider, for example, Holden & Nam (2024), who analyze the relationship between an ETF's liquidity and the underlying market liquidity. They find that the higher liquidity of an ETF makes the ETF market attractive and conclude that the liquidity impact on the underlying market can go in both directions.

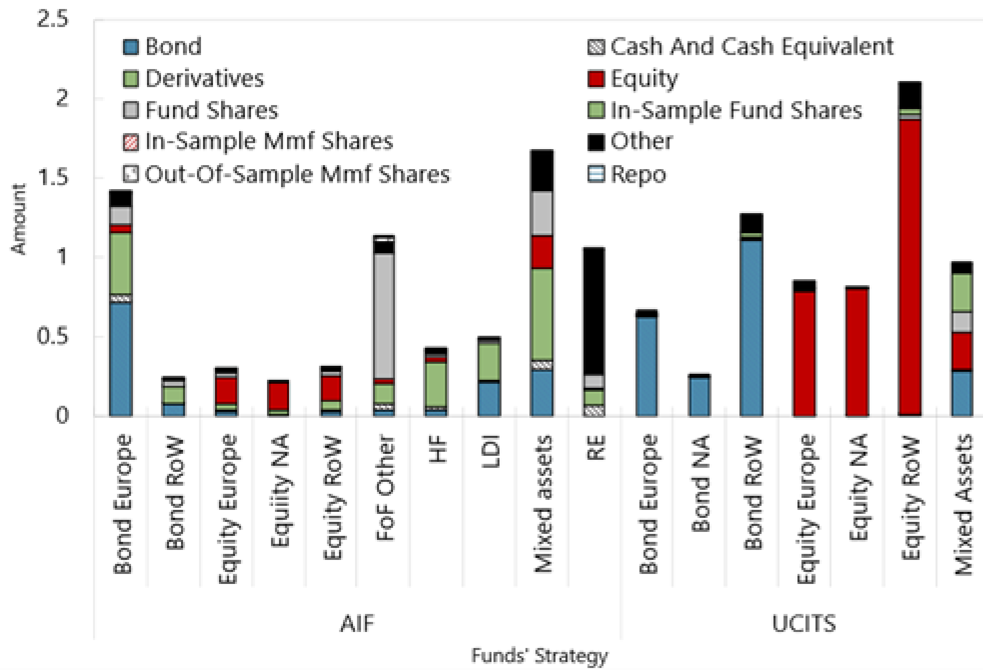
[20] We do not include specific asset categories for on-the-run securities, because depending on the country different types of bonds attain the benchmark status. Besides on-the-run securities, the cheapest-to-deliver into futures can be the most liquid, further, some countries frequently re-open selected issues, which makes the concept of the on-the-run less unique. Incorporating all listed peculiarities exceeds the level of dimensionality possible.

[21] When holdings are reported in a granular fashion, we split the components in smaller buckets according to weights in the associated index. Further, for example for the group of G10, non-EU bonds, we use the provided currency to split among US, UK, and Japanese bonds. This is equivalent to assuming LDI's holdings in GPB are only Gilt securities.

EUR 298 billion (3 percent), further illustrate the funds' involvement in derivative markets and the importance of incorporating margin calls into a fund stress test.

Figure 3. Euro Area: Investment Funds' Portfolio Allocation

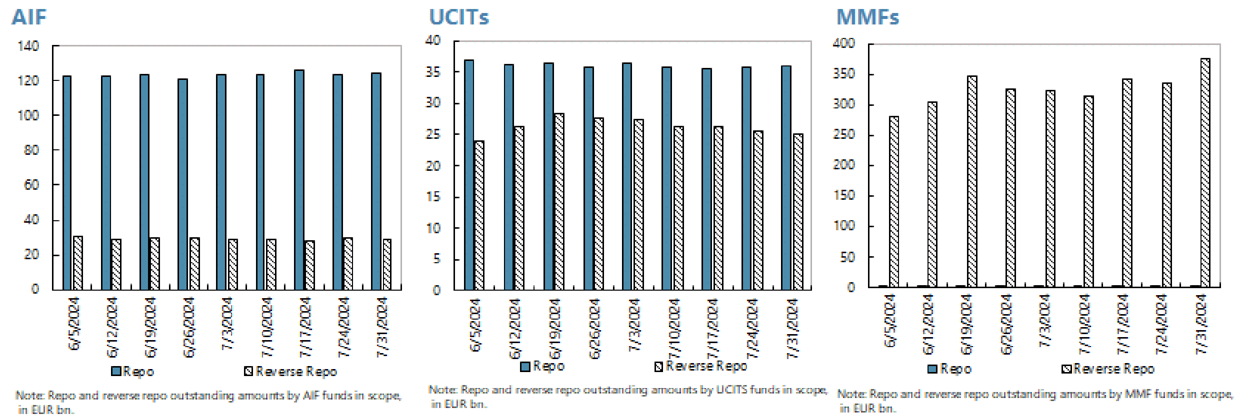
(Trillion euros)



Sources: Lipper, ESMA and IMF staff calculations.
Note: Includes strategies with at least 200 billion AUM.

22. Repo activities vary significantly across fund types (Figure 4). While AIFs mostly engage in repo borrowing (worth about EUR 120 billion in a typical week around our cut-off date, typically with UK banks), MMFs almost exclusively lend securities via reverse repo transactions. MMF's reverse repo activities are sizable, with outstanding amounts varying between EUR 300 and 350 billion in a typical week around our cut-off date. UCITS have a more balanced use of both repo types, but in general access the market to a smaller extent (with an average outstanding volume of repos/reverse repos around EUR 35/25 billion). In aggregate terms, 13 EA banks provide repo funding to funds in our sample, accounting for 20 percent of the volume, while the rest pertain to non-EA banks.

Figure 4. Euro Area: Repo Activities by Funds in Scope, Over Time and by Regulatory Type
(Billion euros)

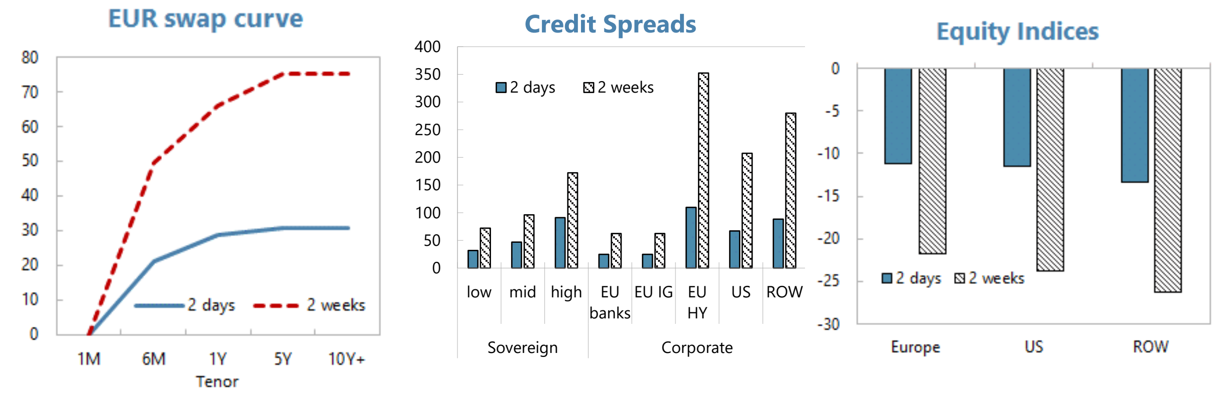


Sources: SFTR, ESMA, and IMF staff calculations.

Scenarios

23. We consider two market scenarios, with a two-day and a two-week horizon. The analysis focuses on a short time horizon, as episodes of liquidity distress tend to be short-lived and to avoid overlapping with the timeframe of regular portfolio rebalancing. Similarly to the methodology in the Technical Note on Stress testing the Banking Sector, the scenarios are calibrated based on an expected shortfall at 0.1 percent of market factors marginal distributions over the holding period of the scenario (i.e., two or 10 days). Shocks are applied instantaneously to the starting point of firms' balance sheets, and the cumulative valuation effect over the time horizon is quantified. The scenarios include the steepening of interest rate curves in major economies, equity price corrections and a widening in sovereign and corporate spreads (Figure 5). Under the two-day scenario, we simulate an increase of the swap curve by about 20 bps for the 6 months horizon and 30 bps for longer horizons. Under the two-week scenario, the swap curve shifts even further upward, by 50 bps for the 6 months horizon, by 65 bps for the 1-year horizon and 75bps for the 5 year and longer terms. Shocks of similar magnitude affect non-EUR swap curves. For sovereign exposures, the two-day scenario assumes an increase of 32 bps to the risk premium for low-risk sovereigns above the swap curve, as well as 47 bps for those sovereigns rated medium risk, and 91 bps for those governments regarded high risk. Under the two-week scenario, the values are 72 bps, 96 bps and 172 bps, respectively. We do not consider FX shocks. Actions and instruments available to institutions to meet their liquidity demand vary depending on the time horizon, as observed during the LDI crisis, so a day-by-day modelling of inflows and outflows would be warranted as it is the case in banks' ECB (2019) and CCP liquidity stress test ESMA (2024a), and was the case for BoE's SWES (BoE, 2024). The timeline of the FSAP was not conducive to model multi-period dynamics, so this caveat is mitigated by having two scenarios of varying lengths to capture dynamics with different horizons. Bearing this in mind and aligning funds' liquidity analysis to best practices in other sectors, ESMA should consider in the long term developing a multi-period framework.

Figure 5. Euro Area: Market Scenarios



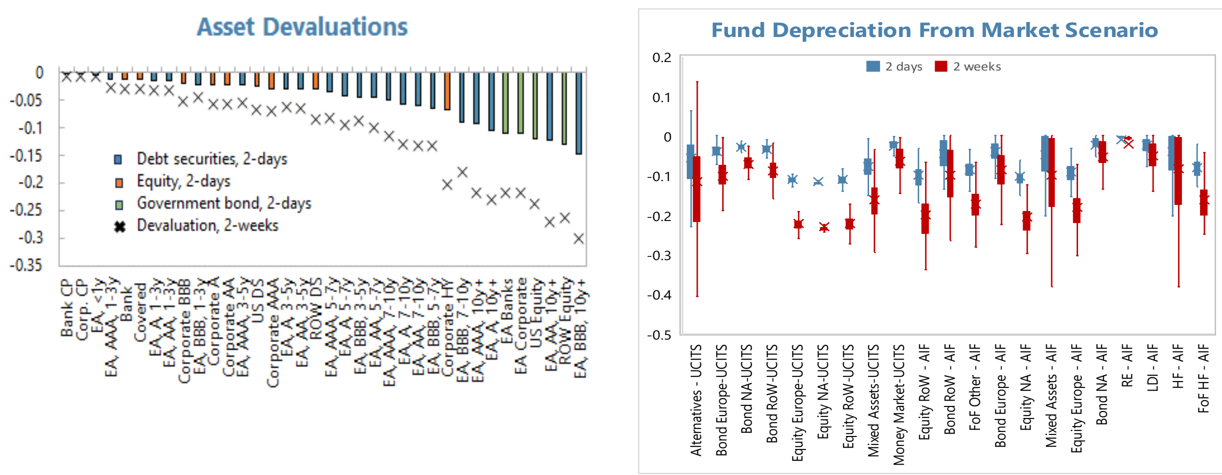
Sources: Bloomberg, AIFMD, EMIR, Lipper IM, IMF, and ESMA and IMF staff calculations
Note: In the spread charts, low,' 'mid,' 'high' refer to the bucketing of countries as in the macro scenario. 'IG' stands for Investment Grade, 'HY' for High Yield, 'ROW' for Rest of the world. For redemption shocks, we employ a flow-performance calibration approach, which estimates the expected outflow of funds given the projected fall in a fund's NAV following the market scenarios.

24. The shock is applied to funds' assets and is linear in all risk factors. Formally, the change in the value of asset i is given by:

$$\Delta A_i = A_i^0 \cdot \sum_k \alpha_{k,i} \cdot \delta_k$$

where A_i^0 denotes the asset value at the start of the exercise, $\alpha_{k,i}$ denotes its exposure to a risk factor, and δ_k measures the change in value of that factor (i.e. the scenario). The summation runs through all the k factors the asset i is sensitive to. For funds holding other funds' shares, we apply the corresponding fund devaluation to the share held, using the median for out-of-sample funds for which we do not have balance sheet information. For the residual asset category, we apply the median depreciation across other assets. For derivatives, the valuation impact is computed with the equations described in paragraphs 29 and 30, and Appendix III. Adding the effects to the overall depreciation at fund level allows to account for potential hedges that funds might have through their derivative positions which may offset the loss in their cash positions.

Figure 6. Euro Area: Market Scenarios Impact on Funds' Assets



Sources: AIFMD, Bloomberg, EMIR, Haver, Lipper IM; ESMA and IMF staff calculations.

Outflows

25. We employ flow-performance calibration to link redemptions to the market scenario (Table 2). Also known as a flow-return relationship, this approach estimates the relationship between negative fund returns and resulting outflows (see, for example, ESMA 2019, p.14). We apply a Fama-McBeth two-step approach to estimate the coefficients of the regression equation:

$$f_{i,t} = \alpha + \sum_{k=1}^{4} \beta_k \, f_{i,t-k} + \sum_{h=1}^{4} \gamma_h \, return_{i,t-h} + \theta_{i,t} X_{i,t} + \varepsilon_{i,t}$$

Where $f_{i,t-k}$ measures lagged fund flows and $X_{i,t}$ denotes log (AUM) as a control variable. The calibration is based on a fund homogeneity assumption, i.e., the sensitivity coefficient is estimated at the level of four fund sub-groups: Bond funds, Equity funds, Mixed strategy funds and Alternatives. We estimate the coefficients from UCITS monthly flows, between August 2019 and October 2024, because of data quality limitations in AIF reporting on flows. The range of coefficients is in line with previous FSAPs, such US (2020), India (2025). Given the short-term nature of the simulations, and the uncertainty embedded in the market scenario, we assume that cash withdrawn from the fund sector is temporarily deposited by investors into their bank, so we do not model flows between funds (see US (2020) for a possible approach to estimate such flows across fund strategies). For MMF only, redemptions are endogenously determined based on other funds and insurers' reaction to their liquidity outflows (see also paragraphs 34 and 37).

26. Additional data is needed to simulate a realistic picture of fund redemptions. First, we are not able to fully account for liquidity management tools (LMTs) due to the lack of data: we assume the transactions costs are fully borne by investors.[22] We highlight that data on LMTs would be very informative in this exercise and the modelling of the different available tools should be part of a comprehensive stress testing framework. At the same time, being LMTs in place during most of the period used to estimate the flow—performance sensitivities, they indirectly affect our stress test calibration. Second, we are not able to account for redemptions fees. Finally, different investor bases can result in heterogeneous redemption pressures on otherwise identical funds, an aspect that cannot be covered in this exercise since no data on investor composition is available (beyond the crossholdings of funds which we endogenize).

Table 2. Euro Area: Flow Performance Sensitivities, by Fund Strategy

Fund strategy	**Estimated flow-performance sensitivity γ_h**
Bond	0.79***
Equity	0.55***
Mixed	0.31***
Alternatives	0.52**

Source: Lipper and IMF staff calculations.
Note: For Funds-of-Funds the average coefficient of bond and equity funds is applied. For LDI funds we attribute the value of bond funds. For MMFs a flow-performance parameter of 0 is applied as MMFs are primarily used as a cash management tool, and liquidity demand from other funds is endogenously determined in the stress test. *** refers to p-values <1 percent, and ** to p-values < 5 percent.

27. We estimate collateral calls on repos used for funding purposes. Calls for collateral can appear under two scenarios: (i) for longer-term repos, when the collateral value falls below a pre-defined threshold, and (ii) for overnight repos in the form of roll-over risk. In the first case, either additional collateral needs to be posted such as to bring the value of collateral provided for the repo back above the threshold or cash should be partially returned so that the stressed collateral value covers the cash leg (deleveraging) – in both cases this translates into additional liquidity demand for the fund. In the aggregate, the repo market is known to have a small share of longer-term repos[23], so collateral top-ups are limited. To compute the additional liquidity needs, we follow the same approach described in paragraph 8. In the second case, the fund faces uncertainty whether it will be able to roll-over its repo funding, hence, there could be a need to rebalance, either by obtaining other (unsecured) funding or by selling assets – we do not model this behavior, assuming all repos are rolled over. This is in line with the findings of the BoE's SWES exercise, in which most banks were willing to roll-over existing repo but were reluctant to provide additional repo funding (BoE, 2024, p.35). We assume that those funds that engage in reverse repos, which are

[22] Claessens and Lewrick (2022) report that 80 percent of bond funds use swing pricing, which is a mechanism that passes the costs of redemption and purchase requests on to those shareholders whose orders caused the trades.

[23] Across the bilateral and cleared segments, 47 percent of the principal amounts traded are in overnight contracts. Two-thirds of the principal amounts traded are in term types shorter than one month. Comparing market segments, trades in the cleared segment tend to be shorter than those in the uncleared part (ESMA, 2024, p.6).

almost exclusively MMFs, do not roll-over reverse repos to conserve liquidity when the repo's terms allow for it.

28. We estimate variation margin calls on derivatives. Variation margin (VM) calls occur when the market value of a portfolio of derivatives (a netting set) decreases and are typically computed daily. To estimate margin calls, we compute the change in derivatives valuation, given the shocks in our scenarios. We focus on the contracts that are most used by investment funds, and we use a combination of market factor sensitivities and full repricing, depending on the contract type (refer to Appendix III for details). We do not consider initial margin (IM) calls.[24]

29. For a range of derivatives, we estimate the change in market value based on sensitivities to changes in the underlying asset prices. We follow this approach for equity options, bond futures, interest rate futures and CDSs. For equity options we use their deltas (which represents the sensitivity of the price of the option to changes in the underlying) to approximate the change in value:

$$\Delta V_{i,k} = \delta_k \cdot \Delta f(k)$$

where δ_k is the derivatives delta p, and $\Delta f(k)$ is the change in the corresponding underlying, from the market scenario. For bond futures, we use the basis point value (BPV) of the cheapest-to-deliver bond and the conversion factor to derive the impact of changes in rates on bond futures. For interest rate futures, the change in prices is determined by the change in the relevant forward rates (usually 3 months) after the shock.[25] For CDSs, the change in market value is given by the DV01 which is the change in the value of the CDS for a one-basis point change in the underlying spread. All sensitivities are retrieved from commercial providers. One caveat of this simplified approach is that we cannot capture the change in value of derivatives for market factors different from the underlying, mainly how interest rate would affect, for instance, equity derivatives due to change in the yield curve, as shown in Jukonis et al (2024) where contracts are repriced in full.

30. For equity futures, equity swaps and IRDs we use pricing tools that allow for a full repricing of each derivative. For interest rate derivatives (IRD), we use a pricing tool developed by ESMA, which takes several contract characteristics from EMIR reporting and market information on rates to price each IRD before and after the shock. The fixed leg is priced using the reported fixed rate in EMIR and using discount factors (derived from the risk-free curve based on OIS). The floating leg is priced using the forward curve of the underlying interest rate index and the discount factors.[26]

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[24] Initial margin calls can contribute to liquidity demand as well, especially in periods of high market volatility. To adequately account for them, one would have to determine (i) a margin model to approximate change in IM (ii) the basket of eligible securities. In our case, we relied on the finding form the BoE SWES (2025), that current level of IM are high, during a protracted volatility and recent crisis events, therefore we do not expect IM to contribute significantly to the shortfall. As noted in BoE (2025) this effect is bound to fade if the market would enter a period of relative low volatility, given that IMs are calibrated based on historical data. A liquidity stress test of derivatives market participants should ideally consider this channel to be applicable regardless of initial conditions.

[25] We follow Filipovic (2009).

[26] When some characteristics of the IRD were missing in EMIR, we assume that the underlying index was an overnight rate (SOFR for USD, ESTR for EUR and SONIA for GBP) and that the payment frequency was yearly.

For equity swaps, we calculate the net present value (NPV) of the equity leg (using equity futures and the relevant discount factors) and the NPV of floating leg (assumed to be based on an overnight rate set at the maturity of the contract). For equity swaps we take the maturity date as reported in EMIR when below one year; otherwise, we fix the maturity date as one year (as in Jukonis (2022)). The floating rate is therefore determined by the one-year overnight forward rate as of end-June 2024. We finally follow Jukonis (2022) and apply a spread of 2 percent to the floating rate. The change in market value of equity swaps is therefore a function of the change in the NPV of the equity leg (affected by the shock to underlying stocks and changes in the discount factors) and the change in the floating leg (affected by the change in the discount factors and in the forward rates following the interest rate shock). For equity futures, the change in market value is driven by market shocks and by the change in discount factors.

31. VM calls are then calculated for each entity in scope. For each fund with derivatives exposures, liquidity demand from margin calls is equal to the sum of VM over all its derivative positions across netting sets P_i. For the two-week scenario, margins received reduce the liquidity demand related to margin calls.

$$VM_i = \sum_{P_i} \sum_{k \in P_i} \Delta V_{i,k}$$

For the two-day scenario, we assume funds cannot net incoming margin with outflows, hence we sum across portfolios for which market value $\Delta V_{i,k}$ is negative.

$$VM_i = \sum_{P_i} \Big[\sum_{k \in P_i} \Delta V_{i,k}\Big]^{-}$$

32. For insurance undertakings, margin calls are computed based on the sensitivity derived from de Jong et al. (2019). Margin calls are derived for the two-week scenario only, and based on the VM estimates in Table 3, assuming the most relevant risk factor is the interest rate shock, and netting occurs on the whole position, across counterparties. In the table, results refer to a parallel shit of the curve – given the typically long maturity of insurers' swaps, the average shock of the last three points in the two-week scenario used a representative upward shift. For these institutions, we only consider VM as source of liquidity outflow, amounting to a total of EUR 34 billion, concentrated in very large (i.e. with size of total investments in the last quartile) Life insurance companies (49 percent), followed by very large Composites (27 percent).

33. The combined funds' outflow includes redemptions calibrated in the scenario, margin calls and repo collateral calls (Figure 7). In the two-day scenario, liquidity outflows originate largely from margin calls on derivatives, while redemptions are excluded as they are supposed to be met with T+2 settlement. In absolute terms, the largest outflows pertain to bond and mixed funds (both UCITS and AIF), i.e., EUR 6 bn and EUR 4 bn, respectively, while collateral calls are more muted, only affecting bond AIF and LDIs, with less than EUR 1 bn each. In relative terms, the most affected group of funds are the Alternative UCITS, for which liquidity outflows reach 2 percent of AUM. In the two-week scenario, redemptions dominate outflows. Redemptions represent 5 percent of initial system AUM, with heterogeneity by funds' strategies, due to different sensitivities, and funds' regulatory framework. AIFs show relatively lower redemption rates than UCITS with comparable strategies, because of less material asset devaluation[27] and longer redemption schedules (funds with redemption schedules above 10 days or close-ended funds do not experience redemptions in our set-up). The most affected funds, in both absolute and relative terms are Equity UCITS (16 percent redemption rate on average), followed by Alternative UCITS (10 percent redemption rate). The analysis combines outflows across currencies, but going forward ESMA should consider extending the framework to account for cross-currency aspects.

Table 3. Euro Area: 2018 Estimates of Total Liquidity Shortfall
(Billion euros)

Up-ward par-allel shift [bps]	Variation Margin		Cash positions				Cash and bonds positions				Cash, bonds and MMF shares positions		Cash, gov and corporate bonds and MMF shares positions	
			Cash available for IRS		Cash		Cash and AAA bonds		Cash and AAA/AA bonds					
	No net	*Net*	*No net*	*Net*	*No net*	*Net*	*No net*	*Net*	*No net*	*Net*	*No net*	*Net*	*No net*	*Net*
100	98.4	53.7	86.9	45.3	78.4	39.4	45.9	22.3	23.2	19.8	20.8	18.6	4.8	2.6
75	75.6	41.3	64.6	33.2	57.2	28.6	32.5	15.4	15.9	13.9	14.5	13.0	0.5	0
50	51.7	28.2	41.4	20.8	35.7	17.9	18.3	8.0	9.0	7.7	7.8	7.1	0	0
25	26.4	14.5	18.1	9.3	15.1	8.0	5.3	1.9	2.2	1.7	1.6	1.2	0	0

Source: EIOPA. De Jong et al. (2019).

Liquidity supply

34. Funds can obtain liquidity from a range of sources. To meet liquidity needs—such as margin calls or investor redemptions—funds can take a range of mitigating actions. These include: : (i) withdrawing bank deposits, (ii) allowing reverse repo positions to mature without renewal, (iii) redeeming shares held in money market funds (MMFs), (iv) redeeming shares from other liquid investment vehicles such as ETFs, or (v) selling portfolio assets. In addition, (vi) funds can borrow (secured via the repo market) to obtain cash. We do not account for committed or uncommitted liquidity lines with custodian banks due to lack of information on the size and conditions of such lines, as well as on the counterparty bank.

35. Funds can use eligible collateral to enter new repos, instead of outright sale, up to them reaching a specific leverage limit. For that ceiling on leverage, we consider three scenarios: (i) no additional leverage, (ii) additional leverage up to the highest ratio observed for that individual

[27] Lower asset devaluation could partially result from data gaps and exposures to asset classes not covered by the market scenario (e.g. real estate, unlisted equities).

fund in the last year, and (iii), additional leverage up to full encumbrance. For scenarios (i) and (ii) we look at funds with standing repo agreements during the last year. Establishing a relationship for repo is a time-consuming process, therefore, we only allow for that in scenario (iii), which can be seen as an upper bound of repo usage. We assume that funds will first use the repo market up to the fund- and scenario-specific limit to obtain cash before selling assets. We assume that repo eligible assets are used in reverse pecking order, i.e., posting eligible bonds with the worst selling potential first. As repo eligible we consider all assets that are eligible for the ECB GC Pooling or the ECB GC Pooling Extended repo baskets. For repo haircuts we apply the haircuts from the ECB's collateral framework as they were applicable on June 24th, 2024. When considering the leverage limit we account for existing synthetic leverage from funds' derivatives exposures. In the absence of a well-established method to measure synthetic leverage we use as a proxy the ratio IM/AUM.[28] Funds may only engage in new repo to the extent they have suitable collateral available, and their leverage from repo and derivatives is below the relevant threshold. Given the lack of a common definition of leverage, and some data quality limitations in the reporting of IM by funds, our estimate for synthetic leverage is a lower bound, so we might overestimate the ability of UCITS funds to engage in new repo.[29] This highlights the need for ESMA to determine a single definition for all fund types and include fund leverage in the revised regulatory templates (Table 1).

36. For funds' asset sales we consider both vertical (pro-rata) and horizontal (waterfall) slicing. Asset liquidation starts once all cash, cash-equivalent and repo resources have been exhausted. For a waterfall scenario, the ranks depicted in the asset segmentation in Appendix IV apply. When applying such a waterfall asset liquidation strategy, asset baskets with the same rank in the pecking order are liquidated at the same time, in a pro-rata manner. Both approaches exhaust liquid resources first. This limits the market impact of asset sales, but it does not account for a feature that has been observed in some stress periods, i.e., cash hoarding (consider, for example, Cera et al (2021)). Cash hoarding entails funds retaining their liquid positions, or even increasing them, during stress periods due to the anticipation of liquidity needs. Another aspect that we abstract from is a potential heterogeneous liquidation approach across funds under the scenario.

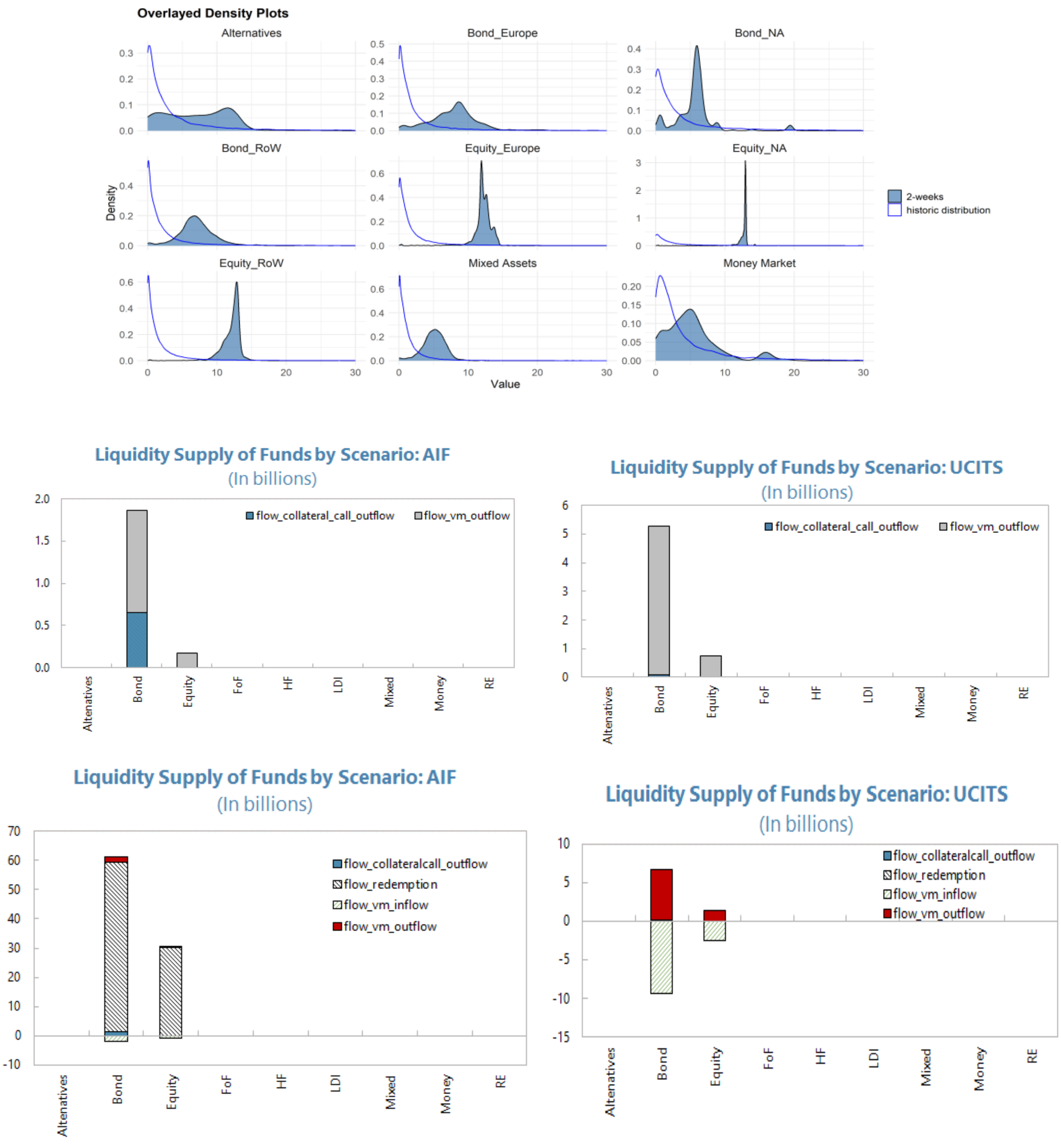
37. For MMFs and insurance companies we consider less heterogeneity. We assume MMFs meet redemptions by first using their cash buffer and cancelling maturing reverse repo, and then by liquidating assets pro rata to cover for the remaining liquidity needs, allowing them to meet redemptions while maintaining their portfolio composition and satisfying their liquidity requirements.[30] For insurers, given we focus on liquidity outflows from VM calls only, we assume they would first use their cash equivalents and MMF shares, treated as short-term cash management vehicles, to cover their liquidity demand, before selling assets, thus preserving their long-term, typically liability driven asset allocation.

[28] We follow the approach in Ianiro et al. (2022, 2025).

[29] For an alternative, more conservative, measure of leverage, see for example ESMA (2025).

[30] A waterfall approach could lead to a breach of liquidity requirements, and a full pro rata approach could force MMFs to sell a large amount of CPs, which, given the low absorption capacity of the market, could result in substantial NAV deviations. See ESRB (2021).

Figure 7. Euro Area: Funds' Liquidity Outflows, by Strategy



Sources: AIFMD, EMIR, Lipper IM, SFTR, and ESMA and IMF staff calculations.

38. **We exclude encumbered assets from the liquidation.** Sources of encumbrance include existing securities financing transactions (SFTs) (including repos), and IM posted for outstanding derivatives positions. For repo, SFTR data include the information on the asset at ISIN level, accounting for netting, which we map to our segmentation described in paragraph 19. Other SFTs were not included in the encumbrance estimate, due to data quality limitations. Funds use such

transactions to swap liquid assets with less liquid ones to enhance their returns, so we might overestimate funds' liquidity resources. For derivatives, for which counterparties report only the total IM posted, we assign IM to the set of eligible assets in a pro-rata manner. In terms of asset encumbrance, LDI and hedge funds (which are AIFs) stand out as being highly encumbered. About 38 percent and 35 percent of their government bonds are encumbered (Figure 8), reflecting an average that masks significantly higher encumbrance in certain funds. Most other fund strategies exhibit low encumbrance ratios. Accounting for asset encumbrance is important because, as Figure 8 illustrates, the business models of some fund types rely more on highly leveraged strategies than others. For example, the recent LDI episode has underlined the importance of accounting for encumbered assets. Therefore, information on asset encumbrance should be part of supervisory templates.

39. We estimate the effect of asset sales on markets using power-law price impact functions. Power-law functions have been found to model the decline in price following a sale order in several asset segments.[31] They require as input the sales amount q, and some parameters defining the market depth D for each asset (segment). Market depths are a function of volatility and traded volumes.[32] For volatilities, we estimate GARCH (1,1) for each asset basket, based on the time series of total return, between January 1, 2020, and October 28, 2024, and we take the median across the time series. For volumes we consider security-level information as reported in MIFID transparency calculations.[33] We first re-scale volumes to account for the shorter horizon of our scenario (two weeks instead of six months in the public data) then we normalize by the outstanding volume of each ISIN. These calibrations on the asset basket level are unavoidable in our setup but may underestimate the market impact compared to recent periods of liquidity distress, such as the LDI crisis, due to the averaging across all assets in each basket. For example, in the LDI crisis, the market distress resulted from a small subset of Gilts with long-dated maturities, where LDI had a large market footprint. In our setup, these would fall under sovereign bonds with more than 10 years remaining maturity for all sovereigns with the same ranking. Due to averaging effects, these larger groupings imply a smaller market impact. To avoid such averaging effects, instrument-level holdings would be needed for all funds, the collection of which is one of our key policy recommendations (Table 1).

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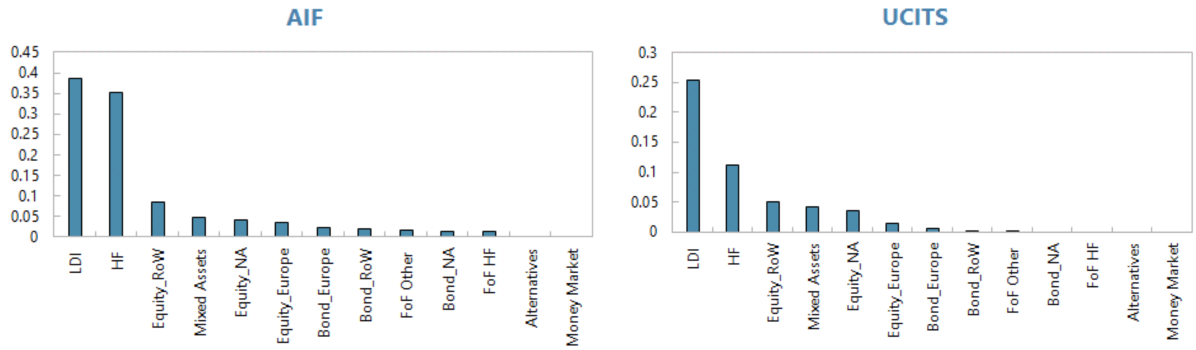
[31] See Bouchaud (2010).

[32] See Roncalli (2021a, 2021b).

[33] Annual transparency calculations for non-equity instruments

Figure 8. Euro Area: Sovereign Bond Encumbrance by Fund Type



Sources: ESMA and IMF staff calculations.

Simulations Assumptions

40. Behavioral and scenario assumptions are summarized in Table 4 and 5. Funds' behavioral responses to liquidity shock have relatively small influence on the resilience of a fund per se, but they are critical for assessing the second-round impact on asset price dynamics and on other institutions. We consider four configurations of assumptions for each scenario to mitigate the uncertainty in terms of funds' response in terms of mitigating actions. In the two-day scenario, we exclude asset sales from the liquidity supply coherently with the exclusion on redemptions due to the T+2 settlement constraint. This implies funds can only use cash and MMF shares to meet margin calls. In the two-week scenario, funds can use all available assets to satisfy liquidity demands.

Table 4. Euro Area: Assumptions for the Two-Day Scenario

Scenario	1	2	3	4
Leverage limit	Full encumbrance	Historical	Not applicable	
Asset liquidation	Waterfall, up to MMF shares			Pro-rata, up to MMF shares
Reverse repo	Not rolled over, if maturity < 2 days			
Maturing repo	Rolled over, with collateral call			
New repo	Yes, up to leverage limit		No	
Margin netting	No			
Horizon	2 days			
Redemptions	No			

Source: IMF staff calculations.

Table 5. Euro Area: Assumptions for the Two-Week Scenario

Scenario	5	6	7	8
Leverage limit	Full encumbrance	Historical	Not applicable	
Asset liquidation	Waterfall			Pro-rata
Reverse repo	Not rolled over if maturity < 10 days			
Maturing repo	Rolled over, with collateral call			
New repo	Yes, up to leverage limit		No	
Margin netting	Yes			
Horizon	2 weeks			
Redemptions	Yes			

Source: IMF staff calculations.

B. Results

Two-Day Scenario: Assessing Funds' Preparedness to Meet Margin and Collateral Calls

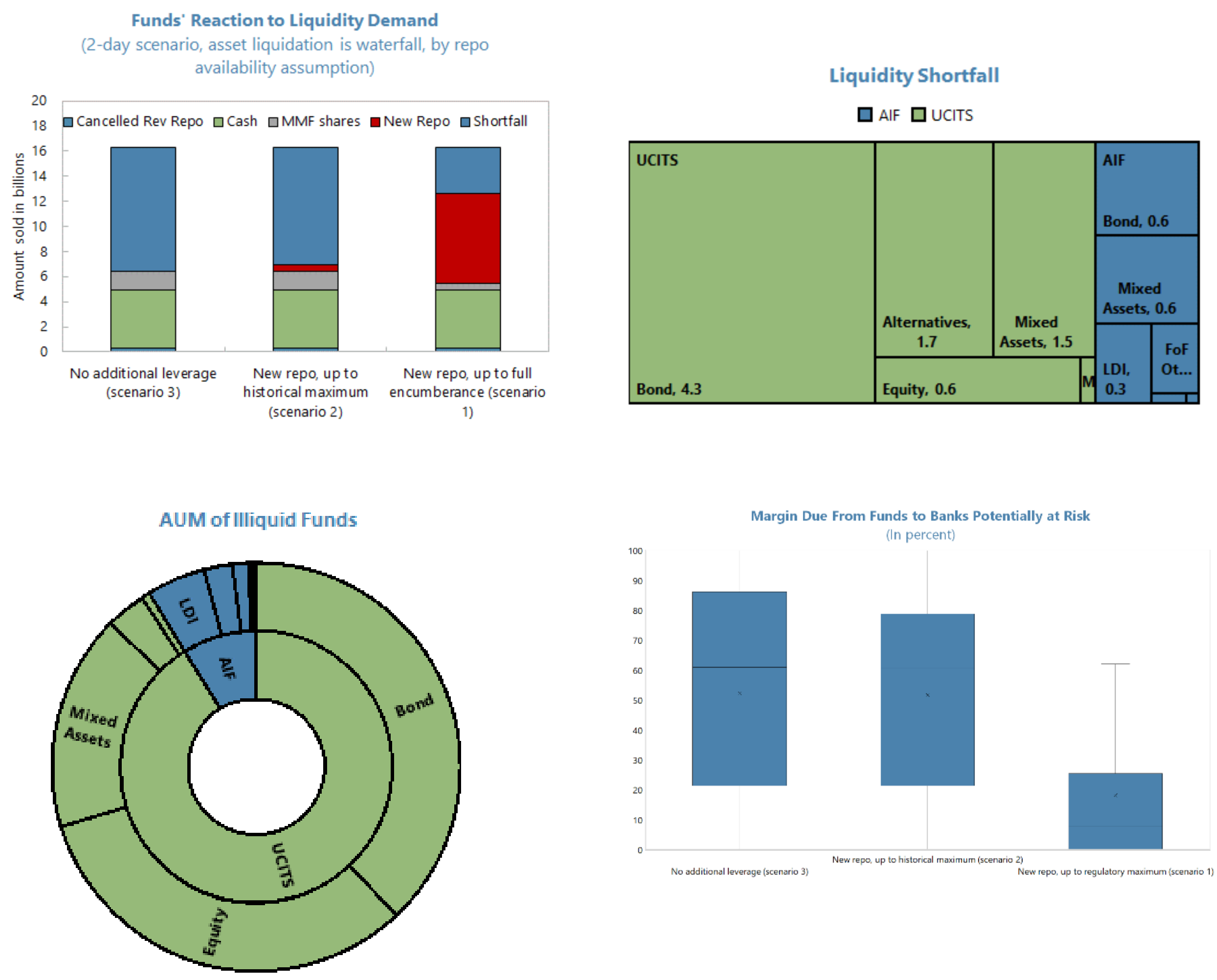
41. Under the two-day scenario, available liquidity is not sufficient to meet aggregate liquidity demand, resulting in a shortfall of up to EUR 9.8 billion (Figure 9). Funds with insufficient liquid buffers, which in this scenario are made of cash and MMF shares, hold EUR 1.6 trillion in AUM, or 11 percent of the sample. Among these funds potentially missing margin calls, UCITS funds are by far the most represented, accounting for 91 percent of the AUM. In absolute terms Bond UCITS funds contribute the most to the sector figure, in terms of shortfall (EUR 4 billion), and in terms of AUM of corresponding funds, EUR 0.6 trillion, equivalent to 28 percent of AUM for Bond UCITS. Alternatives UCITS are the most vulnerable funds to liquidity demand from margin and collateral calls: 47 percent in terms of AUM of funds with this strategy face a liquidity shortfall in the scenario. Among AIF, LDI funds are the most vulnerable, with 15 percent in terms of AUM facing potential liquidity distress in case of margin and collateral calls. Our findings would be mitigated by the market practice of funds having standing credit lines with their custodian banks (up to 10 percent of AUM), which they may be able to access to cover, at least in part, the shortfalls resulting from the scenario. No data on such credit lines were available for this stress test, which would be highly relevant and is therefore a central recommendation (Table 1).

42. Funds' actions have knock-on effects on EA MMFs and banks. In this scenario, UCITS and AIF collectively redeem between EUR 1.4 and 1.8 billion in MMF shares, depending on the assumption in terms of liquidation strategy, corresponding to aggregate 0.1 percent redemption rate for EA MMF.[34] For EA banks that are counterparties in derivatives transactions, funds liquidity shortfall would imply missed incoming margin calls. In this scenario, an average (median) 52 (65) percent of variation margins due from in-scope funds to banks, would be potentially at risk. Banks

[34] See Ghio et al. (2024) for a discussion on how margin calls in various sectors drive MMF flows.

are more likely to hold neutral position in the market, acting as dealers,[35] hence missed margin calls can have implications in terms of liquidity, as banks are still due variation margin for the trade mirroring the funds' positions. If banks liquidate the funds' positions due to missed variation margin calls, this would trigger CCR losses, as was the case for banks exposed to Archegos.[36] This CCR channel is factored into the solvency-liquidity analysis shown in the Technical Note on Stress testing the Banking Sector.

Figure 9. Euro Area: Two-Day Scenario



Sources: AIFMD, Bloomberg, EMIR, Haver, Lipper IM, SFTR; ESMA and IMF staff calculations.

43. Access to repo could help mitigate liquidity shortfalls in short time horizons. This would increase funds' leverage by 1.2 percentage points when funds can increase their repo positions up to the historical limit, or 3.8 percentage points, when the limit is set to full encumbrance for leverage. But this is contingent on the willingness and ability of counterparties to

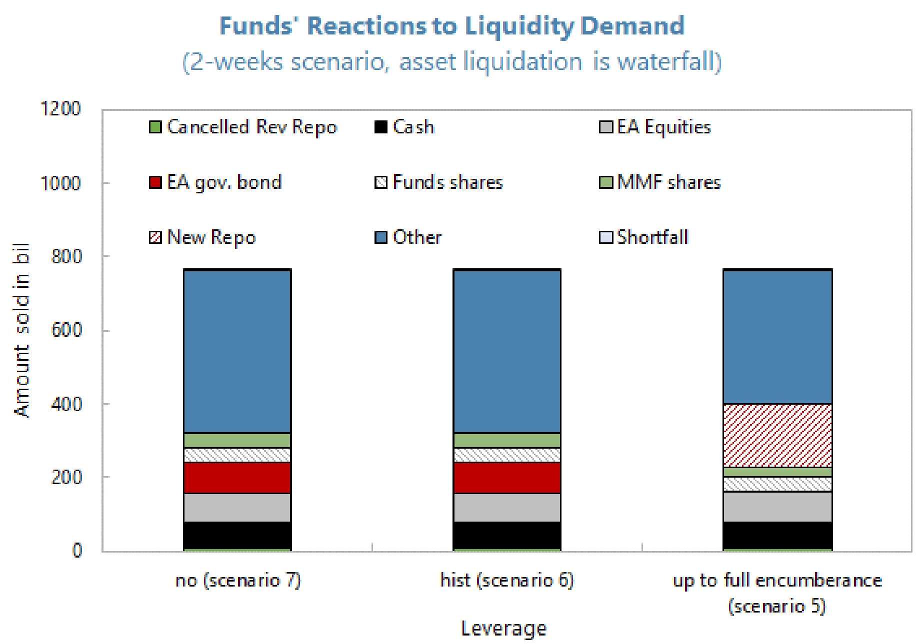
[35] See Boneva et al. (2019) and Lenoci and Letizia (2021) for some examples of banks' role as dealers in various derivatives segments.
[36] See Jukonis (2022) for more detailed modelling of this potential channel between NBFI and banks.

provide funding.[37] Available eligible unencumbered collateral could cover up to EUR 7 billion. However, most funds do not use repo and there are operational hurdles to set up repo activity for funds. For those that do, currently around 80 percent of the existing repo transactions are with counterparties outside of the EA. Outside of the scope of actions considered in the stress test, funds may be able to borrow on an unsecured basis, to the extent such liquidity is available from the banking sector at times of stress.

Two-Week Scenario: Assessing Liquidity Spillovers Across Markets and Institutions

44. In the two-week scenario, funds meet the liquidity demand mostly by selling assets, affecting core markets and amplifying the initial market shock. Financial markets and institutions are affected via different channels, depending on investment funds' behavioral reaction to meet their liquidity demand. Due to the broad set of assets that are available for liquidation in this scenario, aggregate shortfall is limited to less than EUR 0.5 billion (or less than 0.1 percent of total liquidity demand) and pertains to funds representing less than 0.2 percent of AUM in our sample. Rather than assessing the resilience of funds, this set of simulations focuses on identifying spillovers that may affect core markets and financial institutions.

Figure 10. Euro Area: Two-Week Scenario



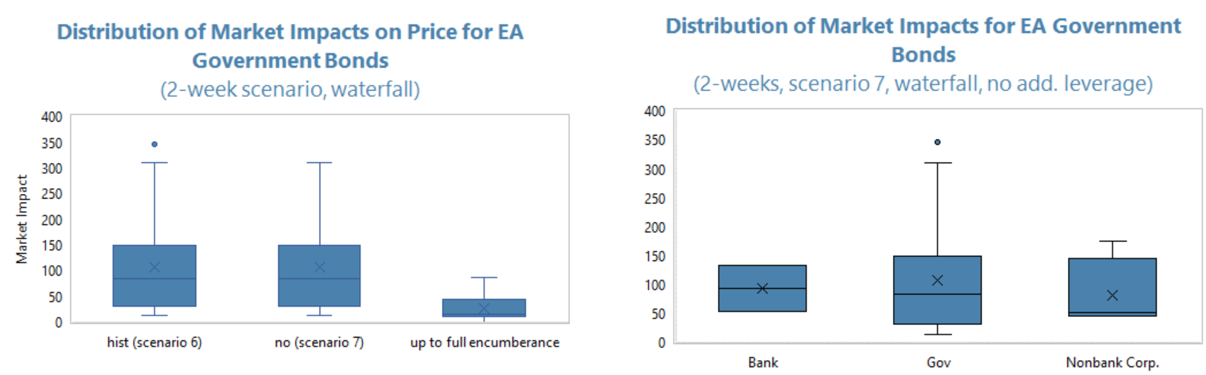
Sources: AIFMD, Bloomberg, EMIR, Haver, Lipper IM, SFTR; ESMA and IMF staff calculations.

[37] For example, see Kotidis and van Horen (2018), He et al. (2022), Gerba and Katsoulis (2024) for a discussion on how leverage ratio and liquidity coverage ratio requirements might affect banks willingness and ability to extend repo funding. It may be difficult for funds to shape new relationships with repo dealers in times of distress, since as Hüser, Lepore and Veraart (2024) highlight most institutions rely on previously used counterparties in times of crisis.

Impact on Core Markets

45. The estimated price impact varies across securities and depends strongly on the defensive actions taken by funds. The market impact is affected both by the liquidity of the asset and its rank in the pecking order.[38] Price impacts on EA government bonds range between 12 and 350 bps, depending on rating and maturity, translating into a yield impact of up to 40 bps. For corporate bonds, price impacts ranged between 45 and 174 bps. Bank unsecured and covered bonds would decline by up to 110 and 54 bps, respectively. Significant spillovers may impact non-EA markets and entities due to the global focus of a significant portion of the EA investment fund sector. Similarly to the two-day scenario, the impacts fall significantly under the counterfactual assumption that funds access the repo market to avoid selling into a stressed market. However, borrowing (even if secured) imposes additional leverage on remaining fund shareholders, up to an additional six percentage points in the scenarios considered. This is an effect that recent regulations, and especially liquidity management tools (LMTs), seek to avoid. No data are available on the prevalence and details of LMTs, which would be highly relevant to this analysis. At the same time, the framework used here could support the calibration of LMT to mitigate such effects at system level (see IMF (2022))

Figure 11. Euro Area: Spillovers to Core Markets



Sources: AIFMD, Bloomberg, EMIR, Haver, Lipper IM, SFTR; ESMA and IMF staff calculations.

Impact on Financial Institutions

46. Second-round impact of funds asset sales affects financial institutions holding similar assets. Price impact would reduce insurance assets values by an additional 58-63 bps, the lower bound being associated with waterfall liquidation. The price falls become limited to 10 bps if funds engage in repo up to their available collateral (i.e. up to full encumbrance), instead of outright sales. The value of HQLA bonds in banks' balance sheet could decline a further 80 bps on top of the decline in the market scenario. Since the effect of these sales is not driven by fundamentals, but by

[38] IMF (2022) found that during stress periods, such as during the COVID-19 market turmoil, funds appear to follow a pecking order of liquidation, in line with the assumptions in this stress test.

market illiquidity, the price decline is expected to be temporary,[39] so rather than affecting the solvency positions of other institutions, they matter mainly for liquidity. This aspect is accounted for in the liquidity stress test presented in Technical Note on Stress testing the Banking Sector. Both insurers and banks have ample stock of liquid assets that can be monetized over the two-week horizon, so this channel is not material at this juncture but could become more significant in a changing liquidity environment.

47. Funds often hold MMF shares as cash management instruments, so they can transmit their liquidity distress to this segment with knock-on effects on the CP market. When funds liquidate assets following the assumed pecking order and do not take more leverage, EA MMFs face up to EUR 40 billion in redemptions (or around 3 percent redemption rate, 59 percent of redemption hitting VNAV MMF), which implies that funds liquidate about two-thirds of their total EA MMF holdings as illustrated in Figure 12. This translates in MMFs having to liquidate around EUR 21.5 billion in CP, of which EUR 19.2 billion are issued by banks. The secondary market for these securities is OTC and its depth is very limited. [40] With a majority of securities having a term of 182 days, a large share is held to maturity. During the March 2020 "dash-for-cash" episode it was reported that MMFs in liquidity need approached banks to buy back their issued CP (ESRB, 2020).[41] It follows that even small amounts of CP sales can be difficult in times of distress. Our stress test results are comparable in magnitude to recent stress events, such as the March 2020 turmoil,[42] where the CP market almost froze. Discount on asset sales could also trigger NAV deviations, which could create further outflows for MMFs, including those offering a stable NAV such as Low Volatility Net Asset Value MMFs (LVNAVs).

48. At the same time, insurers could further contribute to the MMF redemptions due to VM calls. In this scenario, VM would sum up to around EUR 34 billion, which would trigger an additional EUR 9 billion in MMF shares redemptions, 53 percent from composites, and 44 percent from life insurance undertakings. Under the same liquidation assumptions as the previous paragraph, this could contribute an additional EUR 5.9 billion in CP sales by the MMF. This channel would be mitigated if EA insurers could, in line with their CSA, use their bond holdings or other eligible assets to cover such variation margin calls on bilateral derivatives positions, as it was found in BoE (2024). The FSAP team did not conduct market intelligence to assess the extent of this practice by EA insurers, so the more conservative assumption was preferred.

49. Investment funds' liquidation of other investment funds strongly depends on the liquidation pecking order. Under the assumption of waterfall liquidation, most investment funds have sufficient higher ranked assets to avoid selling their shares of other investments funds (total sales of other UCITS and AIFs are around 2 to 2.3 percent of funds' inventory of these shares).

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[39] For a distinction between permanent and temporary market impact see for example Bouchaud et al. (2009)

[40] See ECB (2023), FSB (2024c) for in depth description of EA short-term securities markets.

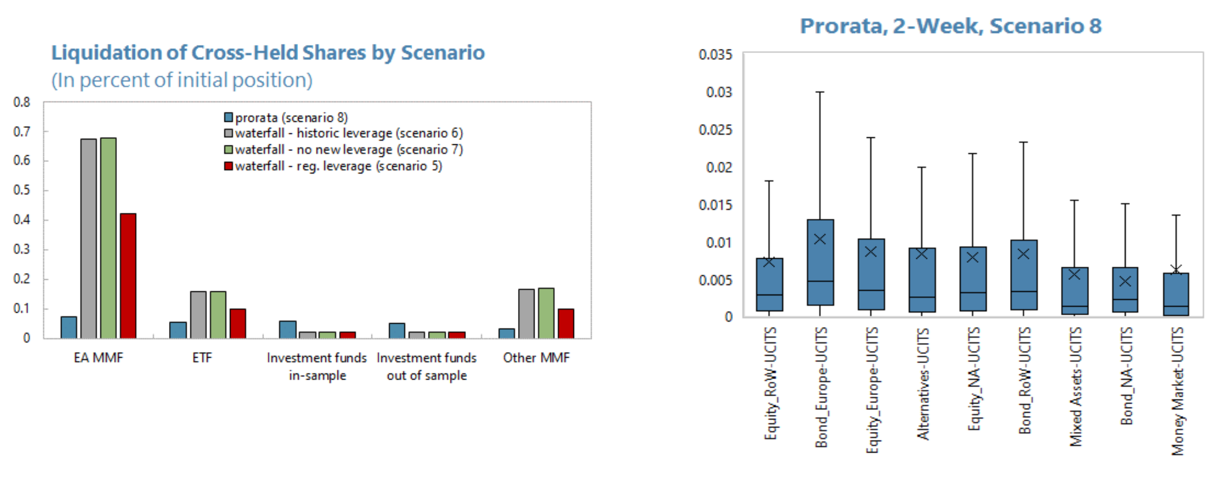
[41] Such buybacks might be withheld in times, if banks are constrained as well, at the same time other trading activities may take place in venues outside the European Union with no information on liquidity patterns or investor behavior.

[42] See ECB (2020).

However, when asset sales are assumed to take place on a pro rata basis, investment funds also face redemptions from other investment funds more frequently, with funds redeeming around 5-6 percent of their aggregate inventory. These cross-redemptions cause up to an additional 0.5 percentage points of redemptions, with bond funds being most impacted.

50. Liquidity pressures from funds to bank deposits appear manageable in aggregate. Deposits outflows would amount to up to EUR 70 billion, when funds use cash before starting asset sales, corresponding to an average 45 percent runoff rate. LCR requirements assign 25 percent weight to "operational deposits" and 100 percent to "excess operational deposits" and "non-operational deposits". On average, banks report above 90 percent of NBFI deposits as "excess operational deposits" or "non-operational deposits", which would indicate the potential risk for runoff by investment funds is already considered in the LCR calculations. Should banks assign these exposures to "operational deposits", the LCR would underestimate the potential liquidity outflow. At the same time, repo outflows from cancelled reverse repo would amount at most to EUR 0.86 billion and potential new repo between EUR 0.93 and EUR 4.14 billion, for the 13 EA banks which already have repo trades with EA funds, depending on the leverage assumption.[43] Also, deposit outflows from funds occur in a stressed market environment featuring additional HQLA valuation impacts from funds' defensive actions reducing banks' counterbalancing capacity. No information was available to systematically match funds to their custodian bank, so further work on mapping individual
fund-bank relationship across markets should be considered to identify potential imbalances in liquidity distribution in the banking sector following fund activities, and to estimate the potential supply for secured or unsecured liquidity from banks which could support funds in time of distress.

Figure 12. Euro Area: Spillovers to Other Financial Institutions in the Two-Week Scenario



Sources: AIFMD, Bloomberg, ECB, EIOPA EMIR, Haver, Lipper IM, SFTR; ESMA and IMF staff calculations.

[43] The low figure stems from the fact that many funds only trade with non-EA banks.

C. Conclusions

51. The findings from the NFBI liquidity stress test reveal material gaps to meet aggregate demand in a two-day market shock scenario and significant knock-on effects on core EA funding markets and institutions over a two-week scenario. In a two-day scenario, unmet margin calls by NBFIs could trigger CCR losses for banks. Over two weeks, defensive actions by NBFIs may amplify funding market shocks, weakening the solvency and liquidity of financial institutions through second-round effects. The analysis underscores that correlated strategies to fend off liquidity pressures could propagate stress to core financial markets and institutions creating financial stability risks. These findings support FSB's ongoing efforts to enhance liquidity preparedness for margin and collateral calls for NBFIs (FSB, 2024d). The FSAP results highlight the importance of ESMA conducting EU-wide liquidity stress tests of the EU fund sector. These should include UCITS, AIF and MMF and focus on the systemic risk from both direct and indirect interconnectedness—within the fund sector and with other markets participants, including the cross-border links—, thus going beyond the scope of supervisory stress tests conducted by NCAs. System-wide stress tests can also help calibrate CCR losses from banks' exposures to NBFIs. A sensitivity analysis shows insurers would contribute to the liquidity demand with knock-on effects on MMF, due to margin calls on their derivatives. Being the exercise data and resource intensive, strong governance and tools would need to be put in place to support the work on a regular basis. Regular stress tests would strengthen system-wide financial risk monitoring on a cross-country and cross-sectoral basis and would contribute to system-wide stress tests at EU level.

52. Taking a system-wide perspective in liquidity stress testing helps reveal intersectoral dependencies in terms of funding and liquidity. The system-wide view complements the sector specific stress tests already conducted by NCA and ESAs and could inform the calibration of risk buffers to strengthen resilience and address systemic risk. Still, significant data gaps and hurdles in granular and comprehensive data sharing across EA/EU institutions limit the scope and depth of a system-wide liquidity analysis. ESMA, alongside ESRB and other ESAs should continue to jointly develop a framework for system-wide liquidity stress testing tailored to the EA financial markets specificities and sectors heterogeneity.

Box 1. Euro Area: Ensuring Data and Tools are Fit-For-Purpose

The FSAP risk analysis highlights some areas for improvements for funds supervisory data. The ongoing work at ESMA to revise and harmonize supervisory templates across fund segments presents a unique opportunity to overcome current data limitations and ensure ESMA (and NCAs) can meet its financial stability mandate. This box provides input on how funds reporting could be enhanced going forward to support stress testing and systemic risk analysis more broadly. AIFMD already requires relatively detailed data, but some gaps exist, for example regarding the granularity of asset holdings, so the revision would ensure better usability and quality of the data. For UCITS data collection is currently fragmented at the level of member states, with different standards and limited access for ESMA. Further work on improving data quality of transaction-level data collected under EMIR and SFTR should also be considered

All funds should be identified by LEI, in line with FSB recommendations of global LEI adoption.[1] For each fund, additional information should include the investment strategy, with a sufficient and economically meaningful granularity, and the custodian bank with standardized information on committed and uncommitted temporary borrowing arrangements. Information on shares' primary currency would help identify potential FX mismatch, while redemption schedules and fees by share class, as well as footprint in terms of investors' location and sector (jointly) would help identify potential segments more prone to redemptions.[2] Standardized data on LMTs, available to each fund including their triggers, would be critical to assess potential liquidity risk and mitigants, and could be complemented by automatic notification to ESMA/NCAs when such tools are activated.

Fund holdings should be collected at instrument level, at least at quarterly frequency. Instrument level information allows identifying portfolio overlaps and segments with a high concentration of fund holdings. Beside standard identifiers for assets, such as ISIN and CUSIP, report could include ancillary asset information regarding currency, asset type, country of exposure, credit quality, average traded volume (for example the CIC categories in Solvency II reports) to limit reliance on commercial data providers and ensure availability of harmonized information on assets for which market information is scarce. Asset exposures, both short and long positions, need to be complemented by information on their encumbrance including the source by activity.

Static balance-sheet and fund information should be complemented by risk sensitivities. Data on collateral received and posted, risk sensitivities of the derivatives portfolio to relevant market factors (e.g., DV01 for IRDs, CS01 for credit derivatives etc.) would ease the estimation of contingent liquidity needs. Further, data should include a harmonized definition of leverage, ideally with contribution of each activity (repo, derivatives, etc.). Results of standard univariate stress tests (e.g., impact on NAV of equity markets down/up by 5 percent) would also provide standardized information that could be compared and aggregated across funds. Such data requirements and risk metrics are also consistent with recent FSB draft proposals related to NBFI leverage (FSB 2024b).

Funds returns and flows should be measured at higher frequency. High frequency data on funds returns and flows, by share class, is crucial to identify investor sensitivity to market conditions that could trigger liquidity outflows. In the past, episodes of liquidity distress were short-lived, so higher frequency data are better suited to identify vulnerabilities and market dynamics during these episodes. Frequencies of returns and flows data should be in line with the redemption frequencies offered to investors. To ease reporting burden, such data could be reported alongside holdings report, with the possibility for ESMA or NCA to request more timely information in periods of stress, similarly to what occurs for banks liquidity templates.

If similar data are collected for other purposes, ESMA should ensure definitions and identifiers are harmonized to be able to combine information across datasets. For example, similar funds holdings data are already reported to NCBs for the purposes of the statistical reporting to the ECB.[3] Data centralization and harmonization can help current need for data sharing across member states and EU authorities. It can also support future work in the context of system-wide stress testing, under the ESRB mandate, where funds data might need to be combined with supervisory data from other financial sectors.

Box 1. Euro Area: Ensuring Data and Tools are Fit-For-Purpose (Concluded)

Granular data require ad-hoc ICT tools and capacity available to teams conducting financial stability analysis and stress testing across business areas. Given the size and the complexity of the data, ESMA's ability to leverage data to meet its financial stability mandate crucially depends on the possibility for experts to access adequate tools, in line with recommendations in Box 2.1 IMF (2023).

[1] FSB (2012)
[2] Cai et al. (2025)
[3] Regulation (EU) 2024/1988 of the European Central Bank of 27 June 2024 concerning statistics on investment funds and repealing Decision (EU) 2015/32 (ECB/2014/62) (ECB/2024/17) (recast)

Appendix I. Stress Testing Matrix (STeM)

CCP counterparty credit risk on reverse repo		
Top-down by IMF, in collaboration with ESMA staff		
1. Institutional Perimeter	Institutions included	• 14 EU CCPs + 2 Tier 2 CCPs
	Market share	• 100 percent
	Data and baseline date	• SFTR, CCP supervisory return, 2024 Q4
2. Channels of Risk Propagation	Methodology	• Type of exposures considered: bilateral reverse repo • Conditional loss based on stressed collateral value • Historical simulation over 5 years (2020-2024), Holding period of 5 days: based on portfolios at the cut-off, cumulative distribution function of conditional losses is computed for each CCPs by sampling from past 5 years market conditions, with equal weights for each day. Unlike a parametric set up, historical simulation does not assume a specific distribution of returns and correlations. The holding period of 5 days reflects common regulatory practice for VAR set up in risk management, and represent the time it might take for the CCP to monetize the collateral after default of counterparty. • Total loss for each day in the historical simulation based on all possible combinations of conditionally independent defaults of counterparties. Probabilities of default for counterparties are based on National University of Singapore, Credit Research Initiative - https://nuscri.org/en/.
3. Risks and Buffers	Risks	• Counterparty credit risk
	Buffers	• Skin in the game and default fund
5. Reporting Format for Results	Output presentation	• Expected shortfall at 0.1 percent • Cover 2

<table>
<tr><th colspan="3">System-wide Liquidity Stress Test</th></tr>
<tr><th colspan="3">Top-down by IMF, in collaboration with ESMA staff</th></tr>
<tr><td colspan="3">The scope of the analysis includes the liquidity demand from UCITS (using commercial Lipper data), AIF, and MMF (using AIFMD and MMF Regulation data, in cooperation with ESMA) as well as the interaction of their joint activities in the bond, repo and derivative markets. In the process, a cooperation with ESMA also allows analyzing margin requirements using transaction-level derivatives and repo data. The analysis quantifies spillover effects on core funding markets, banks and other investment funds as well as money market funds. It further incorporates additional liquidity demand on these money market funds from insurance companies (using data provided by EIOPA).
The scope of the analysis has been limited by the data access granted. For a fully-fledged system-wide liquidity stress test further channels and assets need to be incorporated. First, the system-wide analysis excludes certain types of interactions because data could not be accessed in one location and could not always be exported at the level of granularity required. Second, the analysis does not fully incorporate the interactions of funds and banks due to limited data availability, for example, the channel of credit line usage could not be analyzed because access to the AnaCredit credit registry was not granted. Third, the level of granularity in terms of asset holdings reported did not allow for the identification of cross-holdings in all cases.</td></tr>
<tr><td rowspan="3">1. Institutional Perimeter</td><td>Institutions included</td><td>• 13,000 (EUR 7.1 tr) UCITS funds with holdings data in Lipper, 19,000 (EUR 7.4 tr) AIF and around 1,000 (EUR 1.5 tr) MMF
• EA insurance undertaking from a significant subset of EA jurisdictions,
• Banks: 109 EA Significant institutions</td></tr>
<tr><td>Market share</td><td>• Funds: 50 percent of assets under management of UCITS Funds, over 90 percent of open-ended AIF, and over 90 percent of MMF
• Insurers: around 70 percent of EA insurers total investment
• Banks: Around 99 percent of the banking sector assets</td></tr>
<tr><td>Data and baseline date</td><td>• 2024: Q2 for stock
• 2020–2024 for time series of market variables</td></tr>
<tr><td>2. Channels of Risk Propagation</td><td>Methodology</td><td>• Liquidity measure based on cash and high-quality liquid assets
• Models of market depth to integrate second round effect coming from sales of assets, considering illiquidity of assets – calibrated based on MIFID trading disclosures
• Limited incorporation of intersectoral linkages via deposits</td></tr>
<tr><td rowspan="2">3. Risks and Buffers</td><td>Risks</td><td>• Severe redemption shock, with additional liquidity needs arising from margin calls on derivatives and collateral calls on repo
• Funding liquidity (liquidity outflows) and inability to sell assets to cope with redemptions
• Market liquidity leading to second round price effects
• Margin calls leading to second round liquidity effects
• Liquidity demand from funds to banking sector</td></tr>
<tr><td>Buffers</td><td>• Stock of liquid assets, cash, and reverse repo positions</td></tr>
</table>

System-wide Liquidity Stress Test (Concluded)		
4. Tail shocks	Size of the shock	• Market scenario calibrated based on expected shortfall at 0.1 percent of market factors marginal distributions over the holding period of the scenario (i.e., 2 or 10 days). Historical data covered the period January 2008 - October 2024. • Redemption shock calibrated based on historical net flows and returns data and linked to the market scenario • Second round effects coming from price effects due to sales of assets
	Sensitivity Analysis	• Access to repo market

Appendix II. AIF Data

1. Under the AIFMD, Alternative Investment Fund Managers (AIFMs) are required to report periodic information on the exposures of the Alternative Investment Funds (AIFs) they manage. Exposures are reported on an aggregated basis by asset type, covering categories such as equity instruments, debt securities, derivatives, physical assets and real estate, and cash. The reporting also includes a breakdown by geographical area and economic sector. AIFMs must report leverage, capturing exposures arising from direct investments and the use of derivatives.

2. The framework applies to a broad range of AIF types, classified according to the fund's predominant investment strategy: hedge funds, private equity funds, real estate funds, fund of funds, and 'other' AIFs that do not fall under a standard classification. These 'Other' AIFs include equity funds, fixed income funds, commodity and infrastructure funds, and a further residual category corresponding to mixed vehicles. LDI (Liability-Driven Investment) funds are also categorized as 'Other' AIFs. For the purposes of our analysis private equity, commodity and infrastructure funds are disregarded.

Identification of AIFs strategies

3. The classification procedure, with the exclusion of LDIs, assigns an investment strategy to each fund based on asset type and geographical investment focus (Table A. 1). Funds categorized as "Equity fund" or "Fixed income fund" are further differentiated based on their regional exposure, determined by whether the share of net asset value (NAV) allocated to specific geographic areas exceeds a 50 percent threshold. For example, equity funds with over 50 percent of NAV allocated to Europe are classified as "Equity Europe," while those with predominant exposure to North America or the rest of the world are assigned corresponding regional labels. A similar approach is applied to fixed income funds.

4. Additional strategy labels are assigned to fund types that do not fall under the standard equity or fixed income categories. These include mixed asset funds, fund of hedge funds, and other types of funds of funds. Alternative asset classes are identified using a separate variable indicating the fund's predominant type, with real estate and hedge funds labelled accordingly.

Table A. 1. Euro Area: AIF Strategies Classification

Equity Europe – AIF	Fund is an equity fund and over 50 percent of NAV is in Europe
Bond Europe – AIF	Fund is a fixed income fund and over 50 percent of NAV is in Europe
Equity RoW – AIF	Fund is an equity fund and over 50 percent of NAV is in rest of world

Table A. 1. Euro Area: AIF Strategies Classification (Concluded)

Bond RoW – AIF	Fund is a fixed income fund and over 50 percent of NAV is in rest of world
Equity NA – AIF	Fund is an equity fund and over 50 percent of NAV is in North America
Bond NA – AIF	Fund is a fixed income fund and over 50 percent of NAV is in North America
Mixed Assets – AIF	Fund is categorized as “Other fund”
FoF HF – AIF	Fund is categorized as “Fund of hedge funds”
FoF Other – AIF	Fund is categorized as “Other fund of funds”
RE – AIF	Fund’s predominant type is “Real estate”
HF – AIF	Fund’s predominant type is “Hedge fund”
Mixed Assets – AIF	Fund has no predominant type or strategy assigned
LDI – AIF	Long-Driven Liabilities-driven investment funds are identified based on supervisory information and are further distinguished in USD, GBP and EUR depending on the type of assets they invest in.
Source: ESMA	

Reconstruction of AIF balance sheets

5. Stylized balance sheets for AIFs are reconstructed based on reported portfolio-level exposures. Given the limited granularity of regulatory reporting under the AIFMD framework—particularly the absence of detailed asset-level holdings—the methodology adopts a top-down approach. The reconstruction provides a harmonized view of AIF portfolio composition across asset classes and regions.

6. The exercise estimates net exposures, understood as the difference between long and short positions, and applies a rules-based allocation framework to approximate the structure and risk profile of AIF portfolios. Asset class exposures, especially in the case of fixed income securities, are allocated using representative benchmark index weights. It does not aim to replicate actual fund-level portfolios but rather to generate a consistent representation of AIF exposures.

7. The AIFMD reporting provide the breakdown between sovereign bonds with maturity up to 1 year and above 1 year. Sovereign bond exposures are classified by region and allocated across credit ratings and maturities:

- EA sovereigns:

    - Derived from reported EU government bond exposures, adjusted to exclude an assumed 10 percent share attributed to non-EA countries reflecting aggregate sector bond holdings by country.
    - Allocated across credit ratings (AAA, AA, BBB) and maturity buckets (e.g., 1–3 years, 3–5 years, etc.) using following weights from EA bond indices:
- Other G10 sovereigns:
    - For LDI funds denominated in USD or GBP:
        - Entire exposure allocated to U.S. or U.K. sovereign bonds.
        - Maturity split follows fixed benchmark weights:
    - For other funds:
        - Residual G10 exposure assigned to U.K. (non-LDIs) and Japan and sovereigns using stylized proportions.
- Rest-of-world (RoW) sovereigns:
    - Composed of net positions in non-G10 bonds and reallocated portions of EU sovereign exposure not attributed to the EA.

8. **Debt securities are disaggregated by issuer type (financial vs. non-financial) and credit quality (investment grade vs. high yield)**, based on the info reported in the AIFMD reporting template.

- EA financial institution exposures:
    - The total net exposure is allocated using EA NAV share.
- EA non-financial corporate exposures:
    - Divided between investment grade and high yield categories.
    - The EA portion of investment grade exposures is further disaggregated using weights derived from representative Euro corporate bond indices.
- U.S. and RoW exposures:
    - U.S. debt securities are estimated using the share of NAV allocation to north America.
    - RoW calculated as the residual after subtracting EA and U.S. allocations.

9. **Equity exposures are estimated based on aggregate positions and allocated by region and sector:**

- Regional allocation: Determined using fund-level NAV shares by geography (EA, North America, RoW).
- EA equity:
    - Further disaggregated into:

        - Financials (primarily banks).
        - Non-financial corporates.
- North America and RoW: Allocated using remaining NAV shares.

10. Real estate exposures are derived from reported holdings in physical property:

- Total real estate: Aggregated across all types of physical real estate assets.
- Regional allocation:
    - Based on shares of NAV.
    - Separate estimates produced for:
        - EA.
        - North America.
        - RoW.

11. Remaining exposures are grouped into four categories:

- Cash and cash equivalents: Includes deposits and other cash and cash equivalents (excluding government securities).
- Commercial paper: Identified and classified separately.
- Collective investment undertakings (CIUs):
    - Includes:
        - Money market funds (MMFs).
        - Exchange-traded funds (ETFs).
        - Other fund structures.
- Residual exposures:
    - Captures all other holdings, such as:
        - Structured finance products (e.g., ABS, MBS, CDOs).
        - Private equity and infrastructure.
        - Art, collectibles, and other physical assets.

These components are necessary to ensure the balance sheet reflects the full investment scope of AIF portfolios.

Table A. 2. Euro Area: List of Sovereign Bond Indices Used

Indices
ICE BofA AAA Euro Government Index - Full market value
ICE BofA 1-3 Year AAA Euro Government Index - Full market value
ICE BofA 3-5 Year AAA Euro Government Index - Full market value
ICE BofA 5-7 Year AAA Euro Government Index - Full market value
ICE BofA 7-10 Year AAA Euro Government Index - Full market value
ICE BofA 10-15 Year AAA Euro Government Index - Full market value
ICE BofA 15+ Year AAA Euro Government Index - Full market value
ICE BofA AA Euro Government Index - Full market value
ICE BofA 1-3 Year AA Euro Government Index - Full market value
ICE BofA 3-5 Year AA Euro Government Index - Full market value
ICE BofA 5-7 Year AA Euro Government Index - Full market value
ICE BofA 7-10 Year AA Euro Government Index - Full market value
ICE BofA 10-15 Year AA Euro Government Index - Full market value
ICE BofA 15+ Year AA Euro Government Index - Full market value
ICE BofA 0-1 Year US Treasury Index - Full market value
ICE BofA 1-3 Year US Treasury Index - Full market value
ICE BofA 3-5 Year US Treasury Index - Full market value
ICE BofA 5-10 Year US Treasury Index - Full market value
ICE BofA 10+ Year US Treasury Index - Full market value
ICE BofA 0-1 Year UK Gilt Index - Full market value
ICE BofA 1-3 Year UK Gilt Index - Full market value
ICE BofA 3-5 Year UK Gilt Index - Full market value
ICE BofA 5-10 Year UK Gilt Index - Full market value
ICE BofA 10+ Year UK Gilt Index - Full market value
ICE BofA 1-3 Year Japan Government Index - Full market value
ICE BofA 3-5 Year Japan Government Index - Full market value
ICE BofA 0-1 Year Japan Government Index - Full market value
ICE BofA 5-10 Year Japan Government Index - Full market value

Source: ESMA.

Appendix III. Modelling the Impact of Shocks on Derivatives

1. We use two approaches to model the impact of market shocks on the mark-to-market (MtM) value of the derivatives positions to calculate the VM calls to be posted or received.

Sensitivity analysis

2. For equity options, credit default swaps and bond futures, a sensitivity analysis is performed. The impact on the MtM value of the position is calculated using the sensitivity of the derivative to changes in the underlying. This approach is simple to implement but only considers market shocks to the underlying and hence does not consider changes in the risk-free rate.

3. Equity options. For listed equity options (equity indices and single stocks), we retrieve the delta (δ), i.e., the sensitivity of the option price to changes in the underlying from commercial providers, using the ISIN of the option reported in EMIR. The MtM change is given by:

$$\Delta MtM_{equity\ options} = N \cdot \Delta S \cdot \delta$$

Where N is the notional and ΔS is the change in stock prices stemming from the market scenario.

4. Credit default swaps. For single name and index CDS, the estimated change in MtM value is given by the DV01 of the CDS, which represents the change in the value of the CDS for a one-basis point change in the underlying spread for the reference entity. CDS DV01 are retrieved from commercial data sources using 5Y CDS as reference. The MtM change is given by:

$$\Delta MtM_{CDS} = N \cdot \Delta Spread \cdot DV01$$

Where N is the notional and $\Delta Spread$ is the change in credit spreads for reference entities stemming from the market scenario.

5. Bond futures. For sovereign bond futures, the change in the market value of the position is calculated using the sensitivity of the cheapest-to-deliver bond (basis point value) to changes in interest rates and the conversion factor, which considers the remaining maturity and coupon of the bond. Basis point value and conversion factor are retrieved from commercial data sources. The MtM change is given by:

$$\Delta MtM_{Bond\ future} = \frac{N \cdot \Delta IR \cdot BPV}{CF}$$

Where N is the notional, and ΔIR is the change in interest rates stemming from the market scenario, BPV is the change in the future price for a one basis point change in interest rates and CF is the conversion factor.

6. Short-term interest rates futures (STIR). For those futures, typically on 3-Month reference rates (SOFR or ESTR), the prices are defined by:

$$P = 100 - \frac{n}{12} R_{forward}$$

Where $\frac{n}{12}$ is the maturity of the future (1/4 for 3-Month futures) and $R_{forward}$ is the forward rate at the maturity of the future. The MtM change is given by:

$$\Delta MtM_{STIR} = N\left(R_{forward,0} - R_{forward,shock}\right)$$

Where $R_{forward,0}$ is the forward rate as of the reference date (end June 2024) and $R_{forward,shock}$ is the new forward rate once the market scenario is applied to the interest rate curve.

Full repricing

7. For equity futures, equity swaps and interest rate swaps, a full repricing of the derivatives positions is used. This approach is more complex but allows to model all the changes in the risk factors (changes to the underlying but also changes to risk-free rates).

8. Equity futures. For single stock and index futures, the value of the futures at time 0 is given by:

$$F_0 = S_0 e^{(r_0 - d)T}$$

With S_0 the value of the underlying stock, r_0 the risk-free rate over the maturity of the future T and d the dividend yield (which is set equal to zero). The MtM change is given by:

$$F_1 - F_0 = (1 + \alpha) S_0 e^{r_1 T} - S_0 e^{r_0 T}$$

Where α is the shock from the market scenario ($\alpha < 0$) and r_1 is the new risk-free rate after the shock. Since our time horizon is short (two days or two weeks), we ignore the adjustment to the maturity of the futures ($T_1 = T$ instead of $T_1 = T - 2\ weeks$).

9. Equity swaps. We model equity swaps as two different legs. The equity leg is based on the future performance of the underlying stock:

$$PV_{asset}(t) = \frac{S_t - S_0}{S_0} N * D$$

With D the discount factor over the maturity of the swap and S_t is the future price of the stock ($S_t = S e^{rT}$). The other leg is a floating leg where the swap buyers pay a floating rate to its counterparty (e.g. 1M ESTR rate):

$$PV_{float}(t) = N \cdot D\left(R_{forward} + s\right)$$

Where $R_{forward}$ is the forward rate and s is the spread, set up equal to 2 percent as in Jukonis (2022). We assume that all equity swaps are bullet swaps where cash flows are exchanged on a single date. The value of the swap is equal to:

$$PV_{swap}(t) = PV_{asset}(t) - PV_{float}(t)$$

And the MtM change is given by:

$$\Delta MtM_{equity\ swap} = PV_{swap}(shock) - PV_{swap}(baseline)$$

Hence the change in MtM value is determined by shocks to the underlying stock and shocks to the discount factors and the forward rate. Equity swaps underlying are retrieved using the reported ISIN in EMIR. We use the maturity of the swap as reported in EMIR except when the maturity is above one year. In those cases, we set up the maturity equal to one year, to consider the possibility of reset dates over the maturity of the contract (see Jukonis (2022) for a discussion).

10. Interest rate swaps. In those swaps the buyer pays a fixed rate and receives a floating rate at regular frequencies over the life of the derivatives. The value of the swap is given by:

$$IR\ Swap = \underbrace{\sum_{t=0}^{T} f_t N D_t}_{floating\ leg} - \underbrace{\sum_{t=0}^{T} r N D_t}_{fixed\ leg}$$

Where D_t are the discount factor and f_t are the forward rates. The discount factors are derived from the risk-free curve (based on overnight index swaps on SOFR, ESTR and SONIA for respectively USD, EUR, and GBP swaps). We use EMIR data to retrieve the characteristics of the swap (notional, maturity date, fixed rate, payment frequencies of floating and fixed leg and day count convention). The MtM is given by the difference in the value of the swap after shocks are applied and the initial value:

$$\Delta MtM_{IRS} = PV_{IRS}(shock) - PV_{IRS}(baseline)$$

Appendix IV. Asset Segmentation

Table 1. Euro Area: Asset Segmentation

Rank	Asset	Country group	Maturity	Instrument type
1	Cash and cash equivalent	Total	Total	Cash and cash equivalent
1	Reverse Repo - more than 2 and less 10 days remaining maturity	Total	<10 d	Repo
1	Reverse Repo – less 2 days remaining maturity	Total	<2 d	Repo
1	Reverse Repo – above 10 days remaining maturity	Total	>10 d	Repo
2	- one item each -	-	-	MMF shares
2	MMF residual	ROW	Total	Out-of-sample MMF shares
3	ETF	Total	Total	Fund shares
5	Sov EA AAA 3t5	EA	1-5 y	Bond
5	Sov EA AAA 5t7	EA	> 5 y	Bond
5	Sov EA AAA 7t10	EA	> 5 y	Bond
6	Sov EA AAA 10p	EA	> 5 y	Bond
7	Sov EA AAA 1t3	EA	1-5 y	Bond
8	Sov US 3t5	US	1-5 y	Bond
8	Sov US 5t10	US	> 5 y	Bond
9	Sov US 10p	US	> 5 y	Bond
10	Sov US 1t3	US	1-5 y	Bond
11	Sov EA AA 3t5	EA	1-5 y	Bond
11	Sov EA AA 5t7	EA	> 5 y	Bond
11	Sov EA AA 7t10	EA	> 5 y	Bond
12	Sov EA AA 10p	EA	> 5 y	Bond
13	Sov EA AA 1t3	EA	1-5 y	Bond
14	Sov GB 3t5	ROW	1-5 y	Bond
14	Sov GB 5t10	ROW	> 5 y	Bond
15	Sov GB 10p	ROW	> 5 y	Bond
16	Sov GB 1t3	ROW	1-5 y	Bond
17	Sov EA A 3t5	EA	1-5 y	Bond
17	Sov EA A 5t7	EA	> 5 y	Bond
17	Sov EA A 7t10	EA	> 5 y	Bond
18	Sov EA A 10p	EA	> 5 y	Bond
19	Sov EA A 1t3	EA	1-5 y	Bond
20	Sov EA BBB 3t5	EA	1-5 y	Bond
20	Sov EA BBB 5t7	EA	> 5 y	Bond
20	Sov EA BBB 7t10	EA	> 5 y	Bond
21	Sov EA BBB 10p	EA	> 5 y	Bond
22	Sov EA BBB 1t3	EA	1-5 y	Bond
23	Sov JP 3t7	ROW	> 5 y	Bond
23	Sov JP 7t12	ROW	> 5 y	Bond
23	Sov ROW 3t5	ROW	1-5 y	Bond

Table 1. Euro Area: Asset Segmentation (Concluded)

23	Sov ROW 5t10	ROW	> 5 y	Bond
24	Sov JP 12p	ROW	> 5 y	Bond
24	Sov ROW 10p	ROW	> 5 y	Bond
25	Sov JP 1t3	ROW	1-5 y	Bond
25	Sov ROW 1t3	ROW	1-5 y	Bond
26	Sov EA U1	EA	< 1 y	Bond
27	Sov US U1	US	< 1 y	Bond
28	Sov GB U1	ROW	< 1 y	Bond
28	Sov JP U1	ROW	< 1 y	Bond
29	Sov ROW U1	ROW	< 1 y	Bond
30	Sov EA non-Vanilla	EA	Total	Bond
30	Sov GB non-Vanilla	ROW	Total	Bond
30	Sov JPROW non-Vanilla	ROW	Total	Bond
30	Sov US non-Vanilla	US	Total	Bond
31	DS Covered EUR	EA	Total	Bond
32	DS Bank EUR	EA	Total	Bond
33	DS Corp EUR AAA	EA	Total	Bond
34	DS US	US	Total	Bond
35	DS Corp EUR A	EA	Total	Bond
35	DS Corp EUR AA	EA	Total	Bond
35	DS Corp EUR BBB	EA	Total	Bond
36	DS Corp EUR HY	EA	Total	Bond
37	DS ROW	ROW	Total	Bond
38	DS Bank CP	EA	< 1 y	Bond
38	DS Corp CP	EA	< 1 y	Bond
39	Eq EA Banks	EA	Total	Equity
39	Eq EA Corp	EA	Total	Equity
39	Eq ROW	ROW	Total	Equity
39	Eq US	US	Total	Equity
42	-one item each-	-	-	In-sample investment fund shares
42	Out Of Sample Fund	Total	Total	Out-of-sample investment fund shares
-1	Derivatives	Total	Total	Derivatives
-1	Other	Total	Total	Other
-1	RE DE	EA	Total	Real Estate
-1	RE ES	EA	Total	Real Estate
-1	RE FR	EA	Total	Real Estate
-1	RE IT	EA	Total	Real Estate
-1	RE JP	ROW	Total	Real Estate
-1	RE OEA	ROW	Total	Real Estate
-1	RE ROW	ROW	Total	Real Estate
-1	RE UK	ROW	Total	Real Estate
-1	RE US	US	Total	Real Estate

Source: IMF staff calculations.

Appendix V. Repo Data Preparation

1. Trade-state is a 'stock' representation of the data, insofar as it captures the state of a transaction at the end of a reporting date.

- Scope: Repo and repo equivalents (i.e., buy-sell-back transactions) where one of the counterparties was in the list of funds in scope. For CCPs, where the trade involved EU CCPs, we considered only the reports from the CCPs, whereas for trades involving non-EU CCPs we had to rely on the reports from European clearing members. For funds, we consider trades reported by in-sample funds.

- Data preparation: The sampling procedure included the pairing of double-sided transactions, and their deduplication – in this regard, in case of double reporting, the quantitative fields contained the average of the information reported (e.g., notional amount, collateral amount).

- Outstanding repos: For each reference date, we considered outstanding contracts, i.e., repos with a start date at or before the reference date and maturity after the reference date. Cleaning procedure: a range of checks were applied to this data, including outlier identification methodologies, the removal of stale records and records with implausible collateral-to-loan ratios. For more information on the cleaning procedure, see also section Statistical methods in the ESMA (2024b).

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