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# SWEDEN

## FINANCIAL SECTOR ASSESSMENT PROGRAM

May 2023

## TECHNICAL NOTE ON RISK ANALYSIS AND STRESS TESTING OF THE FINANCIAL SECTOR

This Technical Note on Risk Analysis and Stress Testing for the Sweden FSAP was prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed on March 31, 2023.

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March 31, 2023

# TECHNICAL NOTE

## RISK ANALYSIS AND STRESS TESTING OF THE FINANCIAL SECTOR

Prepared By
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This Technical Note was prepared by IMF staff (Elisa Letizia and Etienne Yehoue (MCM), Svetlana Vtyurina (EUR) and Massimo Ferrari (short-term consultant), under the supervision of Tommaso Mancini-Griffoli, in the context of the Financial Sector Assessment Program in Sweden. It contains technical analysis and detailed information underpinning the FSAP's findings and recommendations. Further information on the FSAP can be found at http://www.imf.org/external/np/fsap/fssa.aspx

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# Glossary

| | |
|---|---|
| BMA | Bayesian Model Averaging |
| CB | Central Bank |
| CBC | Counter Balancing Capacity |
| CCB | Capital Conservation Buffer |
| CCPs | Central Clearing Counterparties |
| CET1 | Common Equity Tier |
| COREP | Common Reporting Templates |
| CRR | Capital Requirements Regulation |
| DE | Debt-to-Equity |
| DSR | Debt Servicing Ratio |
| EaD | Exposure at Default |
| EBIT | Earnings Before Interest and Taxes |
| EDF | Expected Default Frequency |
| ESRB | European Systemic Risk Board |
| FI | Finansinspektionen |
| FSAP | Financial Sector Assessment Program |
| FVTOCI | Fair Value Through Other Comprehensive Income |
| FVTPL | Fair Value Through Profit and Loss |
| GDP | Gross Domestic Product |
| GFC | Global Financial Crisis |
| GFM | Global Macrofinancial Model |
| HQLA | High-Quality Liquid Assets |
| ICPF | Insurance and Pension Funds |
| ICR | Interest Coverage Ratio |
| IRB | Internal Risk Based |
| IRRBB | Interest Rate Risk in the Banking Book |
| LGD | Loss Given Default |
| LMT | Liquidity Management Tools |
| MMI | Money Market Instruments |
| NAV | Net Asset Value |
| NBFI | Non-Bank Financial Institutions |
| NFC | Non-Financial Corporations |
| NII | Net Investment Income |
| NPL | Non-Performing Loans |
| NSFR | Net Stable Funding Ratio |
| PD | Probability of Default |
| PPM | Premium Pension Authority |
| RAM | Risk Assessment Matrix |
| RCR | Redemption Coverage Ratio |
| ROA | Return on Assets |
| ROE | Return on Equity |
| RWA | Risk-Weighted Assets |
| SEK | Swedish Krona |
| SIB | Systemically Important Banks |
| QE | Quantitative Easing |
| WEO | World Economic Outlook |

# EXECUTIVE SUMMARY

**Sweden's financial system has weathered the COVID-19 pandemic well.** Strong macro-fundamentals, regulatory capital buffers exceeding minimum requirements by a wide margin, ample liquidity reserves of banks, and prompt market liquidity support measures by the authorities helped the financial system exit the COVID-19 crisis without a significant impact on profitability, including loan portfolio losses.

**Tighter monetary conditions will test the financial system.** High corporate leverage and household debt create structural and cyclical risks to the financial system. Residential and commercial mortgages constitute the largest part of banks' loan portfolio, and most loans have variable interest rates. An adverse scenario was designed by staff to test the impact of shocks on the system, including a rise in term and risk premiums due to a de-anchoring of inflation expectations, continued shortages due to supply chain constraints, persistently high energy and food prices, lower real estate prices, and—importantly—a period of negative growth.

**Corporate sector and banking system solvency stress tests based on the adverse scenario indicate pockets of vulnerabilities due to exposure to CREs and low risk weight density of banks.** An interest rate increase and a fall in earnings reduces interest coverage ratio (ICR) to below one in 20–35 percent of medium and large CREs, impairing their ability to service debt. The banking sector solvency stress tests suggest that overall capital would decrease by over 620 bps following the adverse scenario. While banks have high capital buffers, as measured by CET1/REA, low risk weights imply that these buffers are not as high measured in SEK, which would limit banks absorption capacity during systemic crises, especially since internal models do not fully capture feedback and amplification effects of CRE exposures.

**Banks' exposures to CREs could rise if market funding dried up, with further risks to the financial system and macro-financial stability.** CREs have increasingly funded themselves on markets, relying on short-term debt. If funding markets dried up, CREs are likely to draw down bank credit lines and to request further loans. Banks could oblige, in the hope of supporting their larger clients. Further shocks, however, could erode bank capital significantly.

**Banks have ample liquidity and could withstand severe liquidity shocks.** The liquidity stress tests reveal that banks' central bank reserves shield them from mild to severe liquidity shocks. However, some vulnerability might arise from banks with committed credit lines to corporates, and sizeable derivative exposures for horizons above 1 month.

**The liquidity stress test performed on investment funds points to significant pressures.** Up to 25 percent of funds considered in the analysis could experience a liquidity shortfall following an adverse shock**.** Vulnerabilities are found in portfolios which are either not sufficiently diversified or heavily exposed to unrated or poorly rated debt securities. If liquid assets are not sufficient to cover redemptions, funds could trigger fire sales, especially if their portfolios are invested in securities with limited market depth. Limited data does not allow a proper study of the effect of such redemptions on asset prices.

**Given the identified vulnerabilities and shortcomings, several adjustments are recommended to improve monitoring, quantification, and mitigation of risks** (Table 1). Structural models for household and CRE corporate stress tests should be developed to complement bank stress tests. For example, Finansinspektionen (FI) could build their granular stress tests of CREs into their bank stress testing models. As more granular data on households becomes available, alternative modelling approaches should be applied to capture spillovers to consumption and corporate profitability. FI should also develop infrastructure to assess contingent liquidity risks from derivatives exposures for the largest banks. Investment funds should be required to offer redemption terms that are more aligned with the liquidity profile of their portfolio. Price- and quantity-based measures should be deployed as a second line of defense. FI should provide guidance on liquidity stress tests for the fund industry; develop and adapt the stress testing framework and monitoring tools to conduct market wide liquidity risk analysis.

**Table 1. Sweden: 2022 FSAP—Key Recommendations**

| | Authority | Priority |
|---|---|---|
| **Systemic Risk Analysis** | | |
| Enhance the comprehensiveness and periodicity of CRE data (e.g., on rents, vacancies, and transaction prices) and to integrate multisource data into a single database | FI | Immediate |
| Use CRE stress tests to inform banks solvency assessment | FI | Immediate |
| Consider alternative modelling approaches to capture the spillover to consumption and corporates profitability while more granular data on households become available | FI | Short-term |
| Develop tools to analyze banks' contingent liquidity risks from derivatives and corporate exposures | FI | Short-term |
| Require asset managers to perform regular liquidity stress tests for different market scenarios, and review and challenge such liquidity stress tests | FI | Medium-Term |
| Complete their analytical framework to assess market impact of collective funds' reaction to episodes of stress | FI | Medium-Term |
| Improve quality and granularity of the information collected especially for funds (e.g., monthly flows, and returns), monitor the duration-times-spread of funds invested in non-liquid asset classes, improve liquidity tracking of specific asset types (e.g., debt instruments issued by CRE companies), and maintain adequate information on assets in institutions' portfolios | FI | Short-term |
| Require investment funds to offer redemption terms that are more aligned with the liquidity profile of their portfolio (e.g., notice periods); consider price- and quantity-based measures as a second line of defense (e.g., swing pricing and gates); and provide guidance on liquidity stress tests. | MoF. FI | Medium-Term |

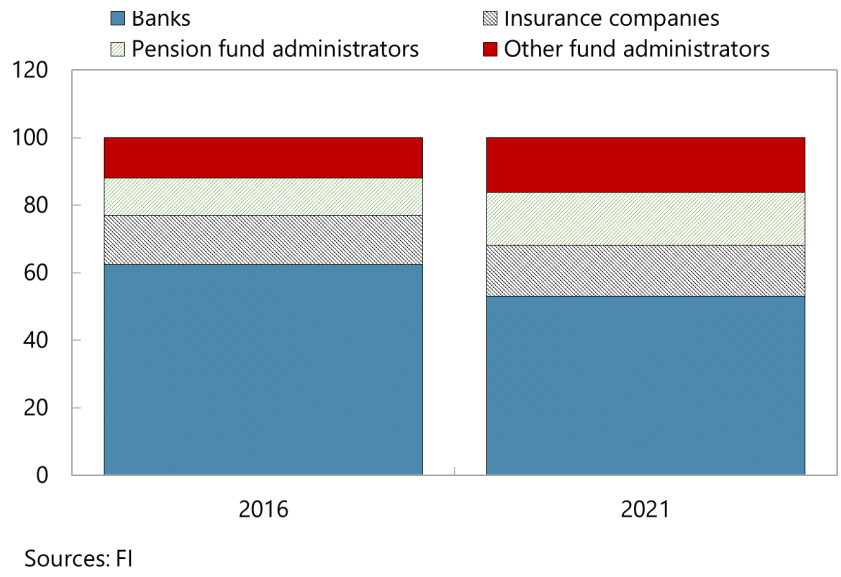
# INTRODUCTION

## A. Financial System Structure

### Banks

**1. The banking system is large and highly concentrated yet its share in the domestic financial system is shrinking, owing to the rapid growth of the NBFI (Non-Bank Financial Institutions) sector** (Figure 1). The banking sector assets were around 300 percent of Gross Domestic product (GDP) at end-2021, with the five largest banks—Svenska Handelsbanken (SHB), SEB and Swedbank, as well as Nordea and Danske Bank's Swedish branches and mortgage companies—accounting for over seventy-five percent of deposits and lending. Domestic lending is predominant in the banks' assets, constituting 64 percent.

**Figure 1. Total Assets of Financial Sector (In Percent)**




Sources: FI

**2. Banks' profitability is driven in equal parts by net interest, fees, and commission income** (Figure 2)**.** For interest income, banks benefit from low funding cost on their covered bond issuances and from having large portfolios of mortgages, 65 percent of which being repriced within one year. This has so far allowed banks to pass-through increases in market funding costs to customers by adapting the administered rate.[1] As high market concentration limits competition, banks control the

[1] The mortgage repricing is not linked to a reference rate but set by the bank every resetting period based on own calculations. The average spread for mortgages is published by FI, for households to be able to compare if their mortgages have been repriced fairly. Customers can decide to move their mortgage to other institutions if they deem the rate not aligned with market.

ability to increase fees and commission income. In recent years, this increase mostly stems from fees collected for asset management and payment services.

**3. Large banks finance mortgage loans mostly by issuing covered bonds.** These reached SEK 2,500 billion as of June 2021.[2] Insurance companies and pension funds are major domestic investors in these bonds, as are investment funds and the banks themselves. Given the small size of the government bond market, these instruments are used for liquidity purposes by many financial institutions, due to their low credit risk.[3] The Riksbank holds about 20 percent of the total outstanding volume of SEK covered bonds.[4]

**4. Banks also rely significantly on foreign wholesale funding and their share of foreign assets has also increased**. Reserves held at central banks represent by far the largest share (67 percent) of Counter Balancing Capacity (CBC). Swedish banks depend on international markets and domestic NBFIs for their mortgage funding via covered bonds. The systemically important banks (SIB) have significant exposures to the Nordic-Baltic region, with 20 percent of assets committed to the region. [5]

**5. The largest banks are highly exposed to residential and commercial real estate.** Mortgages constitute about fifty percent of banks' lending portfolios (with significant heterogeneity among banks, some being focused on residential real estate), while loans to non-financial corporates constitute another 30 percent of their balance sheets. In the corporate portfolio, over SEK 750 billion are loans to CREs (around 7 percent of total assets), of which half represents loans extended to micro firms (typically specialized in the residential segment), and 15 percent to the largest listed CREs.

### Non-Bank Financial Institutions (NBFIs)

**6. NBFIs are growing and expanding credit to Non-Financial Corporations (NFCs) and individuals**. Insurance and Pension Funds (ICPF) together hold more than 150 percent of GDP in assets, while investment funds have almost tripled in size since 2015. All NBFIs have large equity portfolios (about 110 percent of GDP for investment funds, and 40 percent of GDP for ICPF), but also are increasingly investing into the corporate bond market (on average around 12 percent of their assets under management), but with high heterogeneity owing to the concentration into the fixed income funds. Credit provision by non-bank fintech lenders is also increasing, mainly for mortgages and consumer credit. Mortgages provided by non-bank fintech amount to around 2 percent of the total stock of mortgages. Many fintech companies are offering payment and transfer services

[2] See in the Financial Stability Report 2021_2.

[3] Covered bond are typically highly rated due to the requirements in over-collateralization and the further protection afforded from BRRD, which excludes these instruments from bail-in and makes bond holders the most senior creditors in case collateralization is not sufficient.

[4] The Riksbank's purchases of securities | Sveriges Riksbank

[5] In this context, we refer to the Nordic-Baltic region, excluding Sweden, hence it includes Denmark, Estonia, Finland, Latvia, Lithuania, Norway.

(around 105 companies of around 450 active fintech as of November 2021) and are starting to compete with banks in niche segments.

## Securities Markets

**7. Sweden's securities market is the thirteenth largest in the world.** It hosts one of the thirteen European Union Central Clearing Counterparties (CCPs)—Nasdaq clearing—which clears cash equity, fixed income, and interest rate, equity, and commodity derivatives, mostly for members across the Nordic-Baltic region.

**8. Investment funds play a significant role in providing access to the corporate bond market for a broad investor base.** (Figure 3). Between December 2017 and December 2021, they have experienced a robust growth, and the total assets of Swedish investment funds have increased by 54 percent. Equity funds have seen an exceptional growth in value of 70 percent, but also other type of investments have registered sustained performances (about 50 percent for short-term bond funds and 30 percent for long-term bond and mixed funds). This long-term trend temporarily reversed only during the Covid-19 market stress, when open-end funds collectively lost 17 percent of their value (25 percent for long-term corporate bond funds).

**9. Swedish households are direct owners of investment funds, also via the indirect investments made through platforms and Social Security Funds** (Figure 3).[6] Besides the high participation in equity funds, the households are a large group of unit holders of funds investing in corporate bonds.[7] Overall, the use of leverage by investment funds is limited, with 50 percent of the investment vehicles having both a commitment and a gross leverage of 100 percent.[8]

**10. Swedish corporates have also taken an important advantage of market financing over the past decade.** The share of market funding out of total credit jumped from less than 15 percent in 2013 to about 45 percent in the first quarter of 2022. Factors facilitating this development include: (i) low interest rates, making it difficult for investors to obtain yield from low-risk assets, (ii) relatively higher funding cost of borrowing from banks for large corporates compared to market funding—at least until 2015 (Figure 3). Other factors, such as easy access to the EU funding market played a role in attracting investors from Euro area countries and growth of investment funds channeled savings from households.

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[6] Social Security Funds are associated with the Premium Pension Authority (PPM). 2.5 percent of the pensionable income is compulsory paid to the funded pension scheme. Individuals can decide to invest their premium into investment funds or in a special collective investment undertaking set up by the government. Contributions are invested with the Premium Savings Fund. The PPM is responsible for the operation of the premium pension system.

[7] The minimum investment amount in a corporate bond is usually SEK 1 million. The minimum investment amount in a corporate bond fund is often SEK 100.

[8] FI has recently conducted an in-depth supervisory analysis on leverage related risks in alternative investment funds evidencing that only 22 funds of around 800 operating under their jurisdiction use leverage on a substantial basis, that is a commitment leverage of above 300 percent in terms of Net Asset Value (NAV). The analysis did not include UCITS.

**11. Swedish bond markets—sovereign and corporate— are prone to liquidity shortages**. In March 2020, several Swedish asset managers suspended operations or dealings in their funds exposed to Swedish corporate bonds. Around thirty open-end funds were temporarily closed, corresponding to over SEK 120 billion in managed assets.[9] The uncertainty around prices and asset valuation in the Swedish bond market made it nearly impossible to liquidate corporate debt and estimate a reliable fund share value. The impaired price discovery may not have been the only factor determining the funds closing. Compared to funds that continued their activity in March 2020, those that closed temporarily besides suffering larger outflows, had a less diversified portfolio and, on average, held a lower proportion of cash (Table 2).

**Table 2. Sweden: Funds Suspended in March 2020**

| | SEK Corporate bond | | SEK Flexible HY (High Yield) | |
|---|---|---|---|---|
| | **Yes** | **No** | **Yes** | **No** |
| **Share of cash (%)** | 0 | 7 | 7 | 13 |
| **Share of corporate bonds (%)** | 83 | 74 | 82 | 77 |
| **Number of bonds in portfolio** | 89 | 141 | 120 | 128 |
| **Outflows (% of NAV)** | 13 | 3 | 47 | 13 |

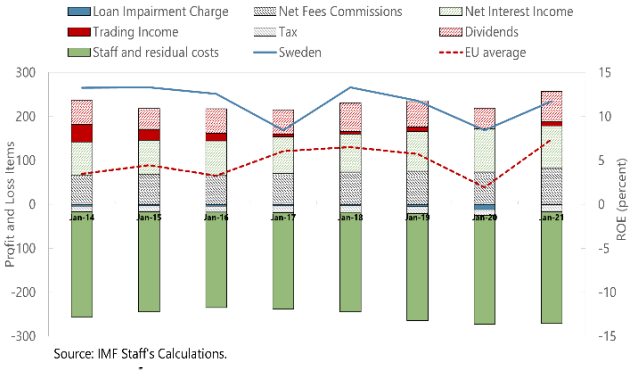
*Note: Comparison at the end of February 2020.*
*Source: Morningstar, Riksbank, IMF staff*

**12. Bond market instability is underpinned by significant market imperfections.** The market is shallow, with just about 10 dealers and few market makers, and it lacks transparency, owing to private placements and over the counter trades. In addition, the terms and creditworthiness differ considerably between individual bonds, making bond valuation more difficult. The Riksbank also owns a large share of Swedish sovereign debt (405 billion SEK), consistent with its Quantitative Easing program objectives. As these underlying vulnerabilities remain post-pandemic, a decline has been observed recently in the composite liquidity indicator, suggesting market tightness (Figure 3).

[9] See Riksbank No. 3 2021, 7 December. According to FI the number of open-end investment funds suspending redemptions in relation to the Covid-19 market events could be higher. Temporary suspensions are considered as liquidity management tool (LMT) that can be used in exceptional circumstances in the interests the fund owners.

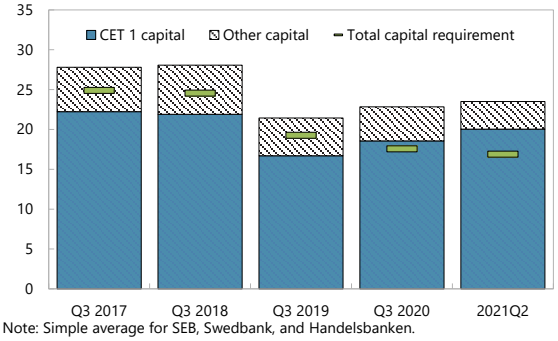
## Figure 2. Selected Banking Indicators

### Bank Profitability
(In SEK billions)



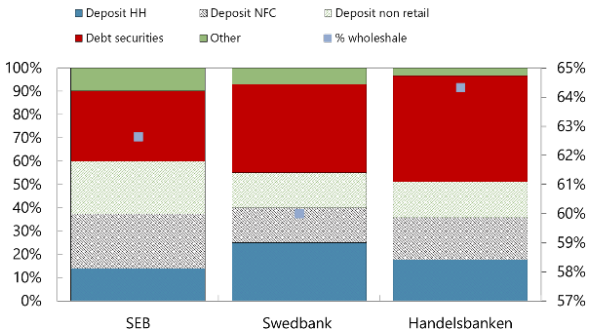

Source: IMF Staff's Calculations.

### Regulatory Capital
(Percent of risk-weighted assets)



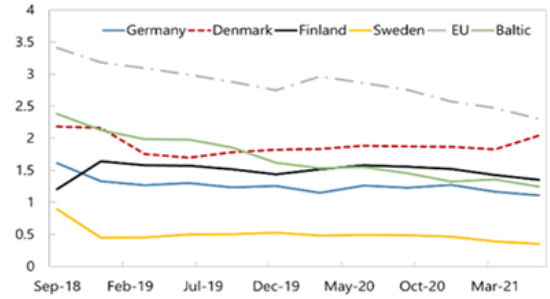

Note: Simple average for SEB, Swedbank, and Handelsbanken.
Sources: Finansinspektionen, and IMF Staff Calculations.

### Major Banks' Liability Composition
(In percent)



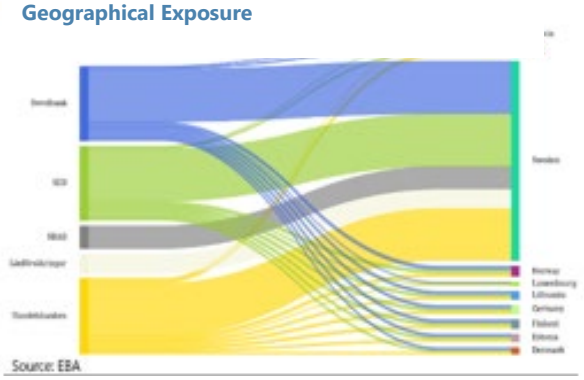

EBA, Riksbank

### Non-Performing Loans
(Percent of total lending)



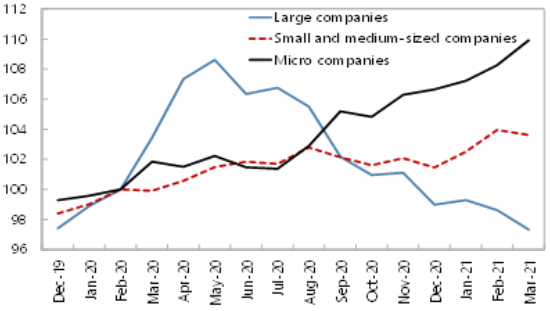

Source: European Banking Authority.

### Geographical Exposure



Source: EBA

### Bank Lending to Swedish Companies
(Outstanding bank loans, Index February 2020= 100)

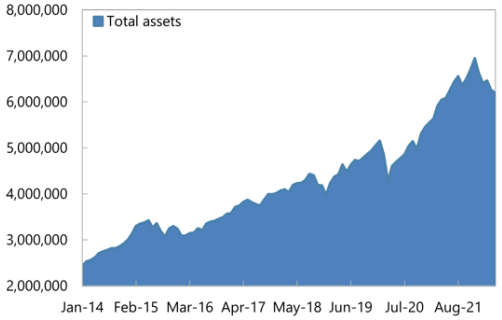



Sources: Statistics Sweden; and Sveriges Riksbank.

## Figure 3. Bond Market Indicators and Investment Funds

### Total Net Assets of Investments Funds

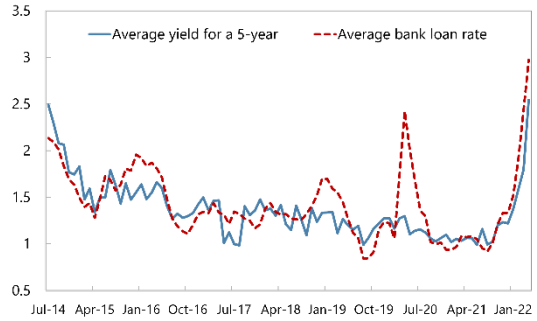
In SEK million




Source: SCB

### Market Financing Cost vs Bank Financing Cost

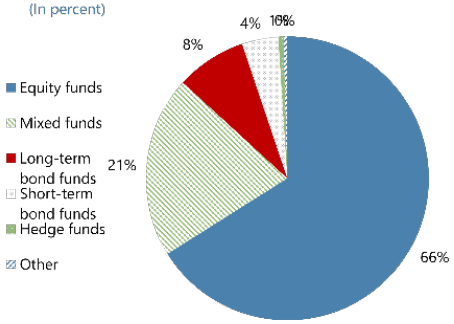
(In percent)




Sources: SCB

### Share of Investment Funds

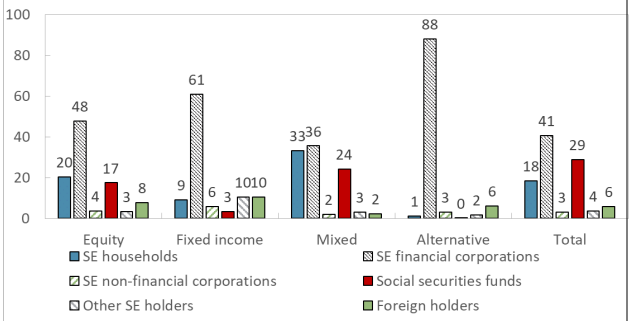
(In percent)




Source: FI

### Fund's Ownership

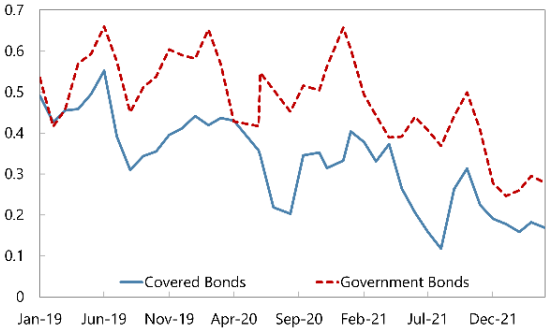
(In percent)




Source: FI.

### Composite Liquidity Indicator

(In percent)




Source: Refinitive Eikon

## B. Macro-Financial Conditions and Risks

**13. Sweden's financial sector enters the current economic juncture with generally solid fundamentals**. Banks have structurally higher profitability than their European peers and high regulatory capital[10] and liquidity positions that exceed regulatory minima (Box 1, Figure 2). These positions have worsened only slightly during the Covid -19 crisis, sustained by timely policy measures by the regulatory authorities. These included: (i) a full release of the counter-cyclical capital buffer,[11] (ii) allowing banks to temporary fall below the minimum liquidity coverage ratios (LCR), (iii) the recommendation that banks postpone dividend payments; and (iv) the temporary exemption from amortization requirements.[12]

**14. Non-Performing Loans (NPLs) remained flat through the Covid-19 period** (Figure 2). Credit losses and non-performing exposures are structurally low in Sweden, driven by the full recourse provisions on mortgages. Also, during the pandemic, fiscal support measures and relatively milder activity containment measures, kept the bankruptcies at low levels. The limited number of household and corporate defaults over the past thirty years, alongside increasing asset valuations, have a material impact in banks estimates of risk paraments for capital requirements calculations. However, historical data on credit losses do not capture the increase in indebtedness of both households and leverage of corporates, which makes them more sensitive to interest rate rise than in the past.

**15. Banks' favorable lending conditions and support measures helped sustain strong borrowing by households, which in turn fueled residential housing prices growth.** Preference shifts in housing also contributed to house price growth. Both house prices and total household debt in relation to income peaked in Q4 2021. However, interest rate payments in relation to disposable income remained at historically low levels, as a combined effect of low interest rates (50 percent of mortgages have interest rate fixing time below one year) and limited amortization requirements.[13] Previous Finansinspektionen (FI) stress tests suggested that most households have

[10] Banks capital requirements are mostly determined by internal rating-based (IRB) models. Most exposures (91 percent) are treated according to IRB approach, which leads to generally low risk weights across whole loan portfolios of banks. Low risk weights are a key driver of high capital ratios.

[11] The buffer will remain at zero until September 29, 2022, when it will be applied at 1 percent. It will be raised to 2 percent in June 2023.

[12] The exemption expired in August 2021.

[13] Amortization requirements were introduced in 2016 and apply to new mortgages. For loans with a loan-to-value ratio over 70 per cent amortization requirement is 2 per cent, when loan-to-value ratio is below 70 per cent the requirement drops to 1 per cent, until the loan-to-value ratio has reached 50 per cent. In 2018, a stricter requirement was introduced. In addition to LTV-based requirements, households with a LTI above 450 per cent have to amortize an extra per cent. For a limited period, the requirement can be waived for individual households if special grounds exist.

sufficient buffers to service their debt in case of income loss or mortgage rate increases,[14] and the loan-to-value ratio is still quite low, albeit rising (at around 70 percent, on average).

**16. Corporate borrowing also kept up throughout the pandemic albeit at a slower pace.** Companies, on average, have had ample access to cheap credit (Figure 3). Average interest rate on loans stood at 1.4 percent. Tighter conditions are expected after the initial policy rate hike in April 2022 and further increases. The credit-to-GDP gap suggested some overheating in 2021, though numbers have been volatile given significant GDP movements induced by the pandemic and recovery, and it was below trend on the later part of the year.

**17. CRE sector borrowing accounts for a large part of corporate borrowing and has become increasingly market financed.**[15] The share of non-bank debt has increased recently surpassing 40 percent of total debt and CRE bonds account for about half of corporate bond market value. Foreign holdings of CRE bonds stand at 53 percent, and about 55 percent of all bonds are euro-denominated, exposing the sector to rapid selloffs, particularly during times of heightened global risk aversion. Among domestic investors, investment funds hold the largest share of CRE bonds, at around 21 percent (Figure 15). While these developments help CREs' risk diversification, refinancing risks are emerging from the bond markets as spreads widen. Finally, ownership concentration and cross-ownership have also recently increased with some CRE firms buying into other CRE firms, elevating the associated risks (see Technical Note on Macroprudential Policy).

**18. At the same time, the sustainability of CREs' revenues is increasingly becoming subject to risks.** Owing to the pandemic-induced hybrid working model, renting —a key source of CRE earnings—is coming under stress as office vacancy rates are rising, for example, from about 3 percent in 2019 to close to 8 percent in 2021 in Stockholm, with similar trends in other major cities such as Gothenburg and Malmö (Figure 6).[16] This, combined with the office yield trend, which has also been declining (Figure 6), is affecting CRE firms' credit rating and ability to roll over their existing debt securities in the local bond market.

[14] About 50 percent of mortgages are at variable rates (1 year horizon), but the rate fixation has been increasing for new borrowers.

[15] Average loan duration is about 3.5 years, and bond maturity is about 5 years. About 55 percent of bonds are in foreign currency against about 6 percent of lending.

[16] This said, some of the properties could be repurposed (into housing, storage, medical, etc.). Strong population growth in Stockholm continues to reinforce the demand for offices and increase the possibility of a future solid space market. There is also a shortage of supply in the office market of Stockholm and especially in the most central areas. There are no indications of large increases in supply. The limited area and current regulations, such as controlling for building height, limit the potential new supply in the most attractive areas (L.Andersson and M. Kallman, 2019).

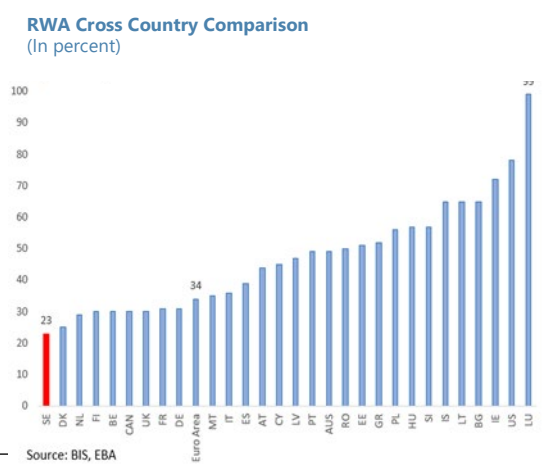
## Box 1. Risk Weighted Assets

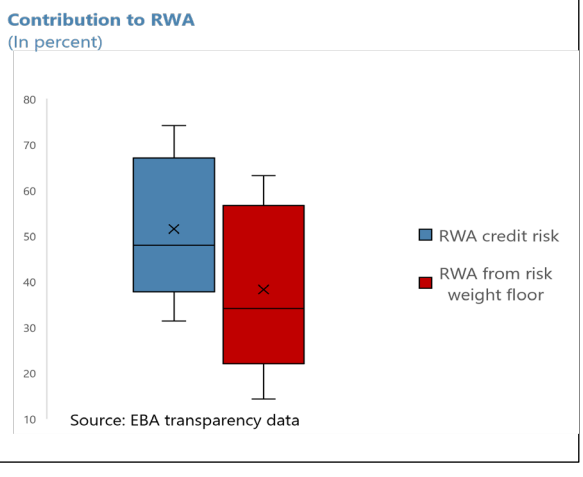
**Swedish banks' Risk Weighted Assets (RWAs) density is the lowest in the EU and among the lowest worldwide, limiting loss absorption capacity** (Figure 4, left panel). As of June 2021, average risk weights (excluding the recently introduced risk weight floor for CRE lending) stood at just 23 percent, ten percentage points lower that the EU average of 34 percent. Overall low risk weights are driven by the large mortgage portfolios, that are kept on the banks' balance sheets, and loans to CRE companies. These segments constitute the bulk of Swedish banks assets (57 percent), and they have not experienced any crises for the last thirty years, while the price of collateral has grown substantially (over 45 percent during the last 5 years). These two facts, alongside the low-interest rate environment have significantly impacted the banks' estimates of PDs and LGDs for internal models. FI has partially addressed this issue by setting risk weight floors at 25 percent for mortgage exposures and residential CRE and 35 percent for commercial CRE.

**The risk weight floors have a significant impact on the largest five bank capital requirements.** The median contribution of the additional requirements is 34 percent, with one bank reaching 63 percent (Figure 4, right panel). Low risk-weights are one of the factors underpinning the high capital adequacy ratios, despite the capital base being low. Hence low risk-weight density can limit banks absorption capacity during systemic crises. It may also underestimate risks and favor excessive risk taking and banks may not have enough capital to absorb higher potential losses on these assets.

**Due to significant changes in the guidance on internal models (IRB repair) Swedish banks have identified the need to make comprehensive changes in all existing PD and LGD models.** FI will have to review and approve the models before implementation to, amongst others, ensure that they meet the regulatory requirements and appropriate captures the risks from the underlying exposures. Going forward, it would also be important for the authorities to enhance implement a robust process for ongoing assessment of the performance of IRB models (PDs and LGDs) including a more comprehensive onsite inspection to assess the quality of deployment of the regulatory approved IRB models.

### Swedish Banks Risk Weights on Mortgages

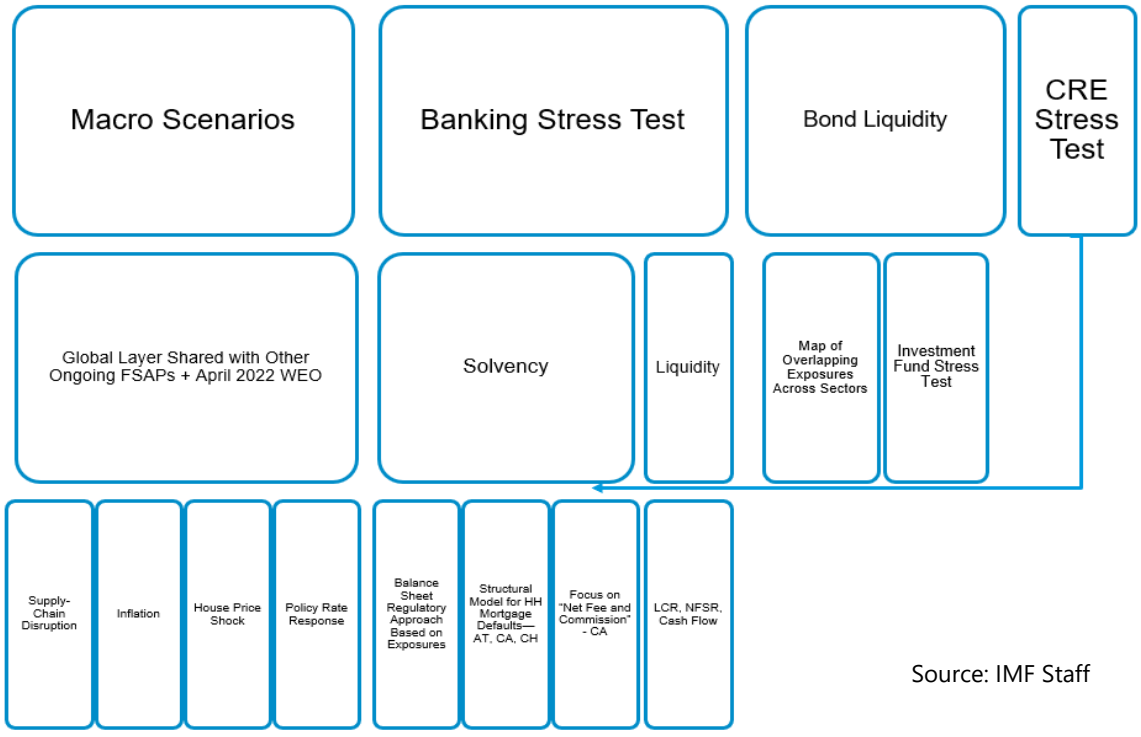


## C. Scope of the Financial Stability Analysis in the FSAP

**19. The Systemic Risk Analysis (SRA) comprised stress testing exercises, covering solvency, and liquidity, for several sectors in the Swedish financial system** (Figure 5). The stress tests were based on a macrofinancial scenario including domestic as well as global risks. For banks, supervisory data were incorporated into the solvency analysis, considering market, credit, and interest rate/funding risks. A sensitivity analysis on CRE exposures was also conducted. The liquidity analysis used cash flow (maturity ladder) data. For funds, supervisory information on detailed portfolios' composition has been complemented with several commercial sources to derive asset characteristics, sectors, credit quality, funds' investment characteristics and flows. Macrofinancial linkages were analyzed linking results of stress tests of banks, households, CRE corporates, investment funds and bond markets. Interconnectedness analysis focused on banks' cross-border and domestic exposures vis-à-vis other banks (or including non-bank financial institutions subject to data availability).

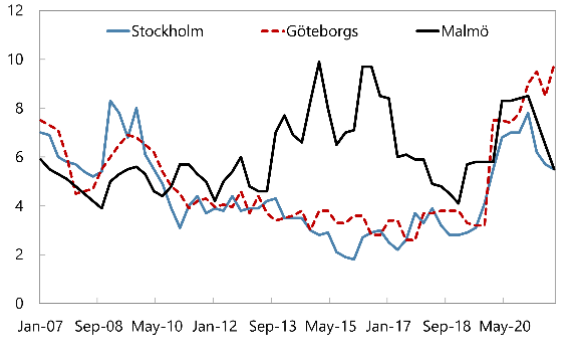
**Figure 4. SRA Approach**




Source: IMF Staff

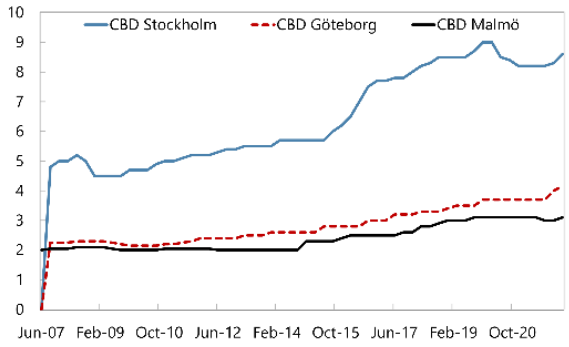
## Figure 5. Selected CRE Indicators

### Vacancy Rate
(In percent)



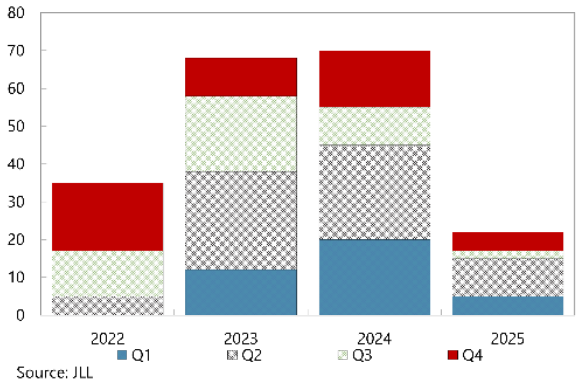

Source: JLL

### CRE—Residential and Commercial Prices
(In SEK thousands)



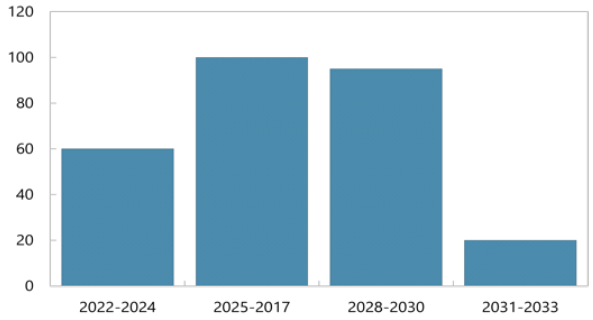

Source: JLL

### Maturity of CRE Bonds Denominated in SEK
(In SEK billions)



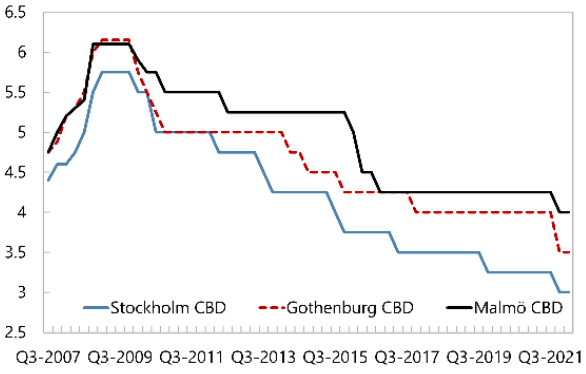

Source: JLL

### Maturity of CRE Bonds Denominated in Euro
(In SEK billions)



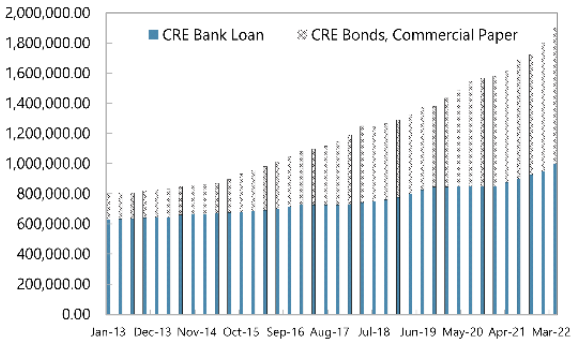

Source: JLL

### CRE-Office Yield
(In percent)




Source: JLL

### CRE Bonds, Commercial Paper, and Bank Loans
(In SEK millions)




Sources: SCB

## D. Macro-Financial Scenarios

**20. The solvency stress tests for banks and CRE considered two macroeconomic scenarios: a baseline and an adverse scenario over a three-year risk horizon (2022-2024).** The baseline scenario is aligned with the April 2022 World Economic Outlook (WEO) projections. For short- and long-term interest rates, not included in the WEO projections, market-implied forward rates were used. For house prices, historical growth before the pandemic was used to determine the path in the baseline. The scenarios were common to all banks and projections were based on the prudential, accounting balance sheet and P&L statements as of end December 2021.

**21. The adverse scenario reflected the main risks in the Risk Assessment Matrix (RAM) and sees the Swedish economy reaching stagflation** (Appendix II: Sweden: Risk Assessment Matrix, Figure 7). It envisages a de-anchoring of inflation expectations in the U.S. and advanced European economies amid persistent geopolitical tensions and continued pandemic-related shortages and other supply chain issues. Sustained demand and widespread cost-push shocks in energy and food with second round effects lead to a late but strong increase in advanced country policy rates (up to 400 basis points for the Swedish repo rate) eventually triggering a sharp recession. As a result, financial conditions tighten, confidence retracts, and risk premia spike. Swedish asset prices contract, especially in the housing market (38 percent lower after two years).[17]

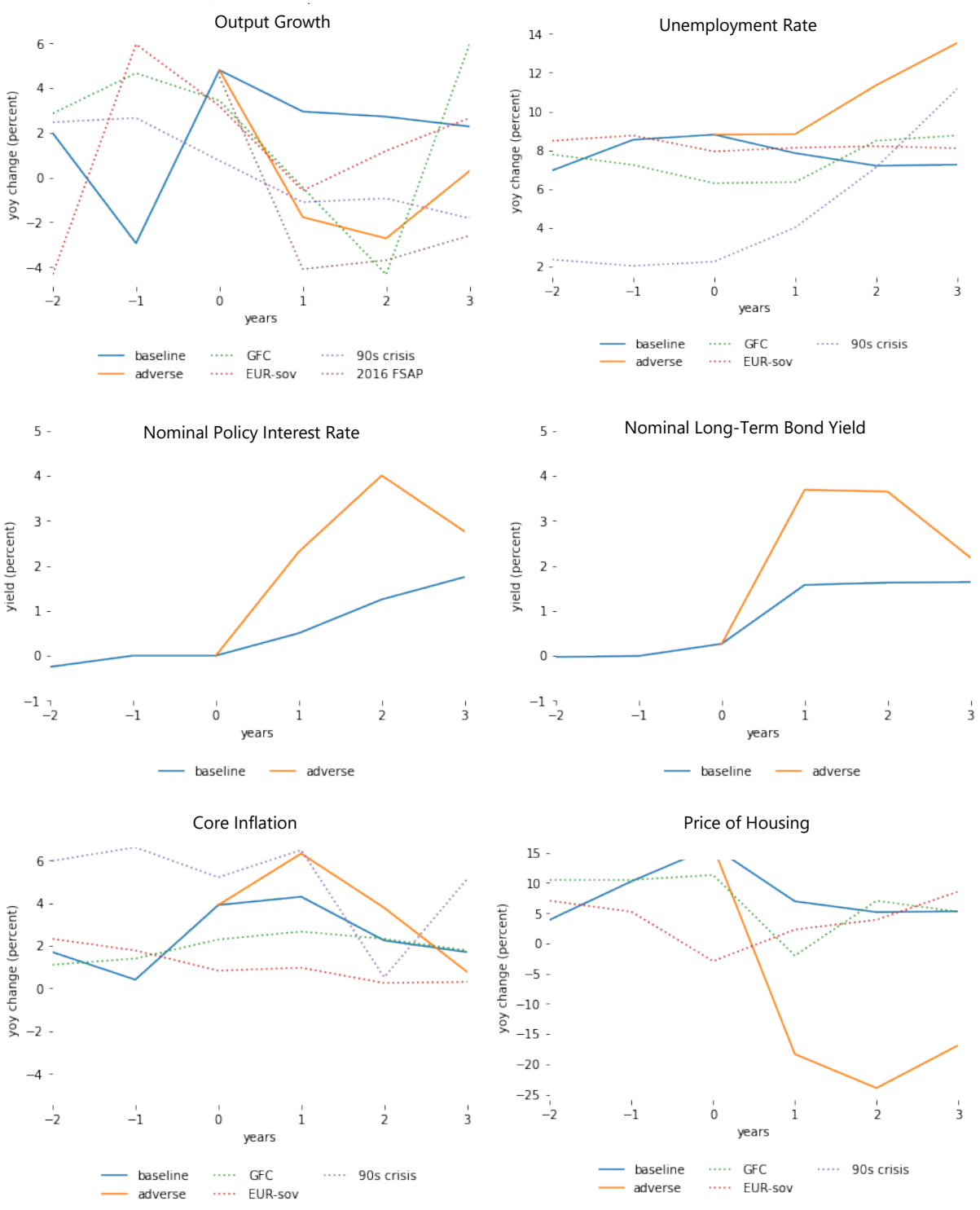
**22. The adverse scenario implies a three standard deviation shock from the baseline for the cumulative two-year growth rate of GDP.** However, the shock remains somewhat less severe than in the last FSAP. The monetary policy shock has been calibrated to reflect the 90th percentile in the last available projection from the Riksbank.[18] The adverse scenario is based on Global Macro-Financial Model (GFM), a structural macro-econometric model of the world economy, disaggregated into forty national economies.[19] Overall, output contracts by 10 percentage points relative to the baseline by 2023, while consumer price inflation grows by 3.7 percentage points.

[17] The sharp decline is due to the combined effect of model's endogenous sensitivity of asset prices to interest rates growth and an exogenous shock on asset price in year one, the latter being calibrated as three times the standard deviation of house price growth in the last ten years.

[18] Monetary Policy Report, April 2022.

[19] Vitek, F. (2015), Macrofinancial analysis in the world economy: A Panel Dynamic Stochastic General Equilibrium Approach, *International Monetary Fund Working Paper*, 227.

## Figure 6. Macroeconomic Scenarios for Stress Tests




Note: The dotted lines provide comparison with historical adverse events, namely the Global financial crisis (GFC), the Europen sovereign debt crisis (EUR-sov), and the 90s Swedish crisis.

# COMMERCIAL REAL ESTATE

**23. The CRE sector's debt level is an important vulnerability for the economy given the interlinkages between companies, banks, and markets.** Banks' exposure to the sector is sizable, and according to FI's analysis (2021), the vulnerability of CRE increased under certain stress test scenarios of firms with bank loans.[20] Riksbank's analysis (2017) of 100 largest Swedish-owned CRE companies valued at around 40 percent of GDP at the time, suggests that challenges in the sector might have tangible effects on banks. Moreover, FI's stress tests (2020) show that refinancing risks are elevated when spreads increase, which together with fixed interest rate, could have an impact on macro-financial stability, and put pressure on banks to cover the shortfall in financing.[21]

**Solvency Stress Test**

**24. Staff's assessment of financial health and vulnerabilities of CRE firms is based on publicly available company financial data**. Orbis database compiles balance sheet and income statements for over 20 thousand Swedish CRE firms.[22] However, not all the necessary data series was available for this group of firms, therefore stress tests were conducted on a sample of firms with the largest 100 companies in the sample holding aggregate assets of around 70 percent of GDP. The analysis focused on a set of customary financial ratios under current and stressed conditions. These ratios measure firms' liquidity, profitability, leverage, and solvency: return on assets (ROA), return on equity (ROE), interest coverage ratio (ICR), debt to earnings before interest and taxes (EBIT), and debt to equity (DE).

**25. A firm's capacity to service debt hinges on its ICR.** It is computed as EBIT/Interest Expense. The lower the ratio, the more the company is burdened by debt expense relative to earnings. An ICR of less than 1 implies that the firm is not generating sufficient revenues to service its debt without making adjustments, such as reducing operating costs, drawing down its cash reserves, or borrowing more. In this analysis, an ICR threshold of 1.5 times is applied to account for potential vulnerabilities to funding risks, in addition to earnings risks (Figure 8). This is a widely used benchmark to gauge an early warning signal as firms with ICR below 1 may have already been in distress. Debt is then categorized into different risk buckets based on the level of ICRs. Debt in the bucket with lower ICR has higher probability of becoming non-performing. Firm profile is calculated as the proportion of firms with median ICR categorized within each bucket.

[20] A study based on 2019-20, loan data included such scenarios as a drop in earnings of 25 percent because of structural changes; an interest rate increase of 3 percentage points; and a combination of scenarios. None of the scenarios consider any measures that the firms or banks may make to mitigate the effects once they have occurred.

[21] CRE bonds comprise about half of the total local bond market issuance.

[22] No. 68 Real estate activities is the NACE Rev. 2 main section L: Real estate activities.

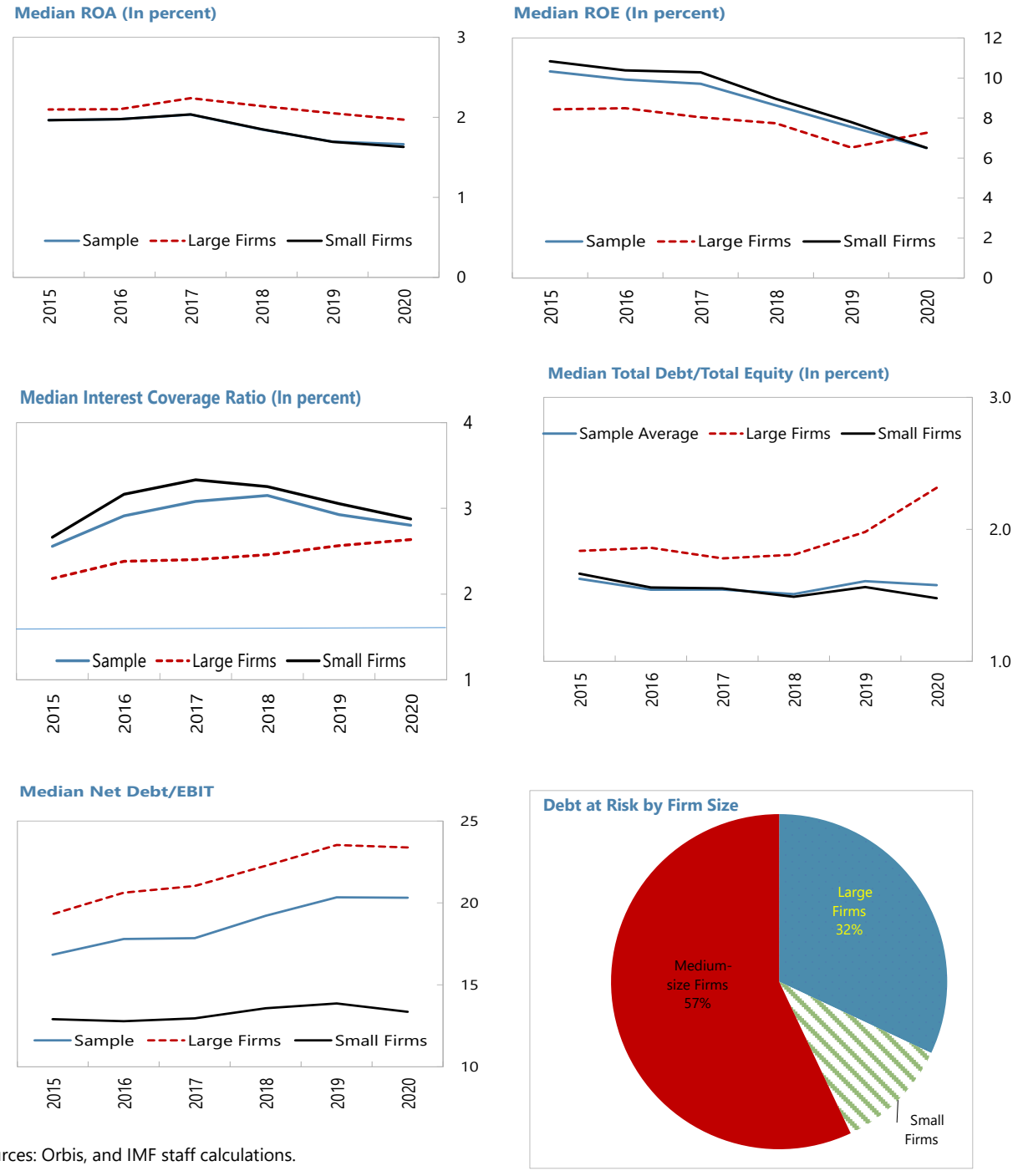
**26. Stress tests indicate that under the adverse scenario the CRE sector displays less resilience in servicing its debt.** While the estimates of debt-at-risk give an indication of corporate vulnerability at a given point in time, they do not show how sensitive firms may be to macroeconomic and financial shocks. Therefore, stress test scenarios incorporating GDP and income shocks, as well as interest shocks as a slowdown in economic growth (along with a fall in rents and/or valuations) could reduce earnings, while interest rates increase costs.[23] Shocks reflecting banks' stress scenario were applied to firms' balance sheets. [24] Under the adverse shock, IRC falls below the threshold 1.5 and debt-at-risk fluctuates between 20–35 percent of total, depending on the calibration (Figure 9). Medium and large-size firms are affected in the same proportion by the shocks.

**27. Strengthening monitoring of corporate liabilities and ownership structure in CRE sector is imperative.** While the results, as in any stress test, should be viewed as indicative and not overarching conclusions given data limitations, given previous real estate crises, the challenges to the CREs' business model, the significant size of the sector and its connection to banks and capital markets, it is imperative to enhance the sector's monitoring. In particular, the authorities could request better disclosure of firms' liabilities, especially those in foreign currency, and improve the collection and analysis of financial data. Concentrated ownership is one of the amplification mechanisms, particularly in the case of the CRE market downturn (see Technical Note on Macroprudential Policy). It is therefore advisable to further enhance the comprehensiveness and periodicity of CRE data (e.g., on rents, vacancies, and transaction prices) and to integrate multisource data into a single database. Knowing the ownership structure will help identify interlinkages across firms as well as the associated vulnerabilities.

[23] Large CRE companies have reduced their reliance on domestic bank financing in recent years, with some issuing commercial paper in euros at negative interest rates. As there is no data available for the share of CRE foreign debt (FX) in total debt, it was proxied after the share of FX debt in total corporate debt with an adjustment for lower exposure to external markets. We estimate about a quarter of issued debt is in FX. Banks' off balance-sheet exposures, such as credit and liquidity facilities, are not included in this study.

[24] In the Riksbank study, shocks of 50 and 100 percent, and 25 percent were applied to the interest rate and revenue, respectively. The results of the stress test show that the baseline ICR of 3.3 percent falls towards a value of one, depending on the calibration of shocks.

## Figure 7. Selected CRE Financial Ratios




Sources: Orbis, and IMF staff calculations.

## Figure 8. CRE Stress Test Results


**Firm size is derived from the country's sample firms by asset size: Large=Top 25th percentile; Small=Last 25th percentile; Medium=In between.

# BANKS

## A. Solvency Stress Test

**28. This section explains the top-down solvency stress tests to assess the resilience of the largest five Swedish banks to system-wide shocks.** It covers: (i) scope of the test; (ii) the stress test methodology (iii) results. The methodology is in line with other FSAPs, namely Euro Area (2018), Canada (2019), Austria (2019).

### Scope of the Tests

**29. Granular supervisory data reported by individual banks to the authorities are used in the analysis.** Supervisory data and reporting on Interest Rate Risk in the Banking Book (IRRBB), at the highest level of consolidation, are complemented by survey data on mortgages and securities holdings collected by the FI and the Riksbank, respectively. The cut-off date of the data is December 31, 2021. Despite best efforts to build a consistent database, the matching and reconciliation of risk data extracted from multiple data sources is a complex exercise subject to caveats.[25] The stress tests covered the SIB[26] and the 2 largest mortgage banks[27] which account for about 75 percent of the banking sector's assets. The stress test followed the balance sheet-based approach, which assesses solvency of individual banks under various scenarios through changes in net income and risk-weighted assets.

### Stress Test Methodology

**30. The projections of revenues, expenses, and loan losses are based on modelled output of the balance sheet for each bank over the scenario horizon.** Most components of pre-provision net revenue, which contains consolidated income statement and balance sheet information for each bank (including components of interest income, non-interest income, and non-interest expenses), are projected using data on historical revenues and operating and other non-credit-related expenses based on a mix of regression and structural models. In particular:

a. Provisions for loan losses. Provisions are calculated as expected losses for all asset classes/economic sectors with exposure at default, including triggered credit lines, revolving facilities and guarantees. The key risk parameters used include probability of default (PD), Loss

[25] The main challenge was to isolate the exposure to CRE companies as FI utilizes a unique definition of CRE firms, which only partially overlaps with the NACE code "L" and CRE exposures as reported in standard COREP templates. Further, the duration of the fixed income portfolio was proxied by remaining maturity even though periodic coupon payments would reduce duration. Probability of default (PD) projections for selected portfolios was based on econometric analysis conducted using Moody's expected default frequency (EDFs) series which tend to display greater volatility than regulatory PDs, as the latter are through-the-cycle measures and are based on a corporate representative portfolio.

[26] Swedbank, SEB, Handelsbanken.

[27] SBAB Bank and Länsförsäkringar Bank.

Given Default (LGD), Exposures at Default (EaD), RWA broken down by exposure class (nine portfolios).[28] Risk parameters assigned to the obligor pool by portfolio and geography in COREP 09.02 are complemented by worldwide parameters reported in COREP 08.02 according to banks' modeling approach (i.e., Internal Risk Based (IRB)-Foundation, -Advanced), asset class, and obligor grade (internal rating scale). Obligor grades with an implied PD =1 are excluded. Similarly, for credit exposures reported with geographic breakdown only, i.e without breakdown by portfolio, implied non-defaulted PDs and LGDs are estimated by subtracting the defaulted exposure from the original exposure. This process requires adjusting as not all exposures are assigned to obligor grades or pools by obligor. Stressed conditions are applied to non-defaulted exposures, and an additional capital charge for defaulted assets to cover systematic uncertainty in realized recovery rates for these exposures are not computed.

b. Default rates. The method to project default rates over the scenarios differs depending on the type of the exposures. PD projections are made at banking sector level and anchored to bank specific starting points in the distance-to-default space. For one bank, whose exposures are insured, losses are capped at 20 percent.

   i. Mortgages. A structural model is used as a satellite to project forward loss rates on mortgages exposures, due limits in historical data. The model uses information on Debt Serving Ratio (DSR) and Loan to Value (LTV) distributions for mortgages initiated or renegotiated in the last six years. The model considers the evolution of household affordability in accordance with the scenario path. House price shocks and household behavioral assumptions are also used to estimate scenario-dependent default rates and loss rates. The approach is described in the model first introduced by the Reserve Bank of New Zealand[29] and has been used, with some additional adaptations for each specific case, in several FSAPs.[30]

   ii. Consumption loans. The relative change in PD from the mortgage structural model is also applied to consumption loans. This choice is motivated by limited data availability on consumption loans and the fact that half of the mortgage borrowers had existing unsecured loans in excess of SEK 132,000, and about 10 percent had unsecured loans of more than SEK 400,000. Some of these loans are taken out in conjunction with house purchase, to cover for the down payment (see Macroprudential policy Technical Note). LGD are kept constant.

   iii. Exposures to CREs. The results from the test described in the previous Section are used to derive PD paths. The macroscenario is adapted to the CRE input using the sensitty found

[28] These were Central Banks and Governments, Financial Institutions, Retail mortgages, Retail consumption, Swedish CRE, Swedish SME, Swedish large corporates, Nordic-Baltic corporates, Rest-of-the-World corporates.

[29] See Harrison and Mathew (2008). "Project TUI: A Structural Approach to the Understanding and Measurement of Residential Mortgage Lending Risk." Reserve Bank of New Zealand.

[30] These are: New Zealand (2017), Switzerland (2019), Canada (2019), Austria (2019).

by the granular FI CRE stress test. The PD is obtained as the change in the fraction of firms with ICR < 1. Stressed LGD in the adverse scenario is obtained based on average LTV on CRE exposures and house price decline. LGD projections for loans collateralized by real estate are assumed not to decline under the baseline scenario despite the slight improvement in the outlook of real estate.

iv. Exposures to Corporates. PDs for corporates are sourced from Moody's using the one-year Expected Default Frequency (EDF) average estimate. A Bayesian Model Averaging (BMA) approach[31] is used to address modeling uncertainty and the plausibility of different drivers of credit risk dynamics. LGD are kept constant.

c. Interest income/interest expense. To assess interest rate risk in the banking and trading book, the effective interest rates of various interest-bearing assets[32] and liabilities are projected considering the scenarios as well as bank-specific repricing and maturity profile of banks computed from IRRBB reporting, maturity ladder and securities holding reporting (see Appendix IV).

d. Net fee and commissions income. Net fee and commissions income represents a significant part of Swedish SIB's income and have been stable in recent years.[33] It is stressed using a relatively simplified approach based on the historical variance of the non-interest income components by income activity. A conservative estimate of projected bank-specific income was produced by adjusting yearly profit by activity: under the adverse scenario, profits from each business activity is projected to be equal to the latest income minus one standard deviation of the historical variability of the income. For some specific items, namely asset management and payment net income, a flat increase by 25 percent of related cost and a decrease by 25 percent of related income are applied to emphasize the negative impact on consumption from the scenario. For one bank, whose loan exposures are insured, the fees related to insurance costs are assumed to increase by 50 percent to capture the increase in the insurance premium due to increase in default events.

e. Trading income and realized losses on securities booked at Fair Value Through Profit and Loss (FVPTL) and Through Other Comprehensive Income (FVTOCI). To assess the market risk, losses in the value of FVTPL/ FVTOCI fixed income securities due to interest rate and credit spread risks are assessed through a modified duration approach. Granular data on securities holdings are used to determine banks' positions and duration in three classes of fixed-income

[31] Gross, M., and Población, J. 2019. "Implications of Model Uncertainty for Bank Stress Testing," Journal of Financial Services Research, 55(1):31-58.

[32] Assets were broken down into mortgages, consumption loans, loans to NFC, covered bonds held, other securities. Liabilities were broken down into retail deposits, covered bonds issued, other securities issued,

[33] This feature is less evident for the two mortgages banks hence a more simplified approach could be used for those.

securities,[34] and two maturity buckets.[35] The scope excludes amortized cost positions held in a hedge-accounting relationship, hedge accounting derivatives, and floating rate bonds.

f. Tax rate is set at the effective tax rate in 2021 at 20.6 percent for the whole stress testing horizon in case of positive net income and zero otherwise.

g. Extraordinary items and minority interest are assumed to be equal to zero.

h. Accumulated other comprehensive income is updated considering unrealized losses on FVTOCI securities.

**31. Some assumptions underpin the determination of balance sheet growth, RWA, dividends, and capital in the scenarios**

a. A semi-static balance-sheet growth was assumed, with growth equal to the nominal GDP growth of the scenario, when positive, and null otherwise. In this way one avoids negative growth rates of banks' balance sheet (deleveraging) in recession and allow for growth in expansionary times.

b. Three components of RWAs were estimated: IRB credit RWAs, market RWAs and operational RWAs.

   i. Basel IRB formulas are used to calculate credit RWAs for each asset call in the segmentation, using projection of point-in-time default rates to obtain through-the-cycle PDs. The 25 percent risk weight floor on mortgage loans and loans to residential CRE, and 35 percent risk floor on commercial CRE was also considered to estimate changes in "additional RWA".

   ii. Market and operational RWAs were kept constant.

c. It is assumed that banks do not issue new shares or make repurchases during the stress test horizon.

d. Dividend payouts are payable out of the current year's profit using the Basel III capital conservation rule. Dividends are assumed to be paid out of current period net income after taxes by banks in compliance with supervisory capital requirements. A maximum allowed dividend payout is assumed to be equal to the dividend payout ratio (dividends over net income after taxes) in 2021, with a cap at 40 percent. If net income is negative, it is assumed that there is no dividend payout.

[34] These are sovereign domestic, non-sovereign domestic, and foreign. The non-sovereign domestic mostly comprises covered bonds, which are used by Swedish banks to manage their liquidity needs, hence the curve for covered bonds included in the scenarios was used to determine the change in interest rate to apply. Foreign securities were in large part EU sovereign bonds, hence the German Bond term structure from the scenario was used to determine the change in interest rates, as no county specific change in spread was part of the scenario.

[35] Maturity below three years, and above three years.

e. Minimum capital requirements used as hurdle rates were consistent with the Swedish capital regulatory standards that reflect Basel III capital requirements. The assessment criteria ("hurdle rate") includes the capital standards implemented via the Capital Requirements Regulation (CRR) and the phased-in buffers. The hurdle rates applied in the stress test are set at the Common Equity Tier (CET1) regulatory minimum of a 4.5 percent Pillar 1 requirement, a fully phased Capital Conservation Buffer (CCB) of 2.5 percent, and a phased-in buffer of 3 percent for SIBs. This led to a CET1 hurdle rate ranging from 7.0 to 10 percent. In the baseline scenario, the phase-in of the countercyclical capital buffer starting from 2023 is also considered.

**Results**

**32. The scenario-based solvency stress test confirmed the Swedish banking sector's resilience to severe macroeconomic shocks, while revealing pockets of vulnerabilities as the economy faces higher interest rates** (Figure 10). The baseline scenario confirms banks' strong capital positions, banks would see their capital ratios trend slightly upwards from 18.7 percent to 19.5 percent. RWAs increase in the first year, causing a mild decline in the CET1 ratio due to higher probabilities of default of borrowers. These are going up due to an increase in interest rates.

**33. Under the adverse scenario banks experience significant capital depletion, yet no bank's capital ratio falls below the hurdle rate.** This is largely due to the high initial capital ratio, as well as the high pre-provision income. On aggregate, the CET1 ratio declines by about 6.2 percentage points by the 3rd year. Credit risk provisioning is the largest contributor to the decline in capital ratios at the system level, amounting to about 8.2 percentage points cumulative over three years in terms of decline of capital ratio. This is followed by risk weighted assets (2.5 percentage points), losses from trading portfolio have only limited impact (0.2 percentage points). Capital deterioration is also due the decline in Net Interest Income (NII) brought about by the abrupt rise in the interest rates and risk premia, with the banks not fully able to pass-through the increased cost of funding to their customers also experiencing overall tighten financial conditions. The decline in Net Fee and Commission Income (NFCI), in line with stress test assumptions in ¶31.d, also weights on the capital ratio. The provision charges stem from the high loss rates on the CRE exposures, while changes in risk parameters also impact the RWA, which reach levels higher than the risk weight floors for CRE. Finally, some banks experience material losses from their consumer loans portfolios.

**34. The impact on bank capital would be larger if banks' exposure to CREs were to increase (flowback risk) — this might happen if market funding dried up and CREs turned to banks.** To measure the impact, a sensitivity analysis (considering both the baseline and the adverse scenarios) was performed to assess banks' resilience to absorb a portion of outstanding market funding, specifically debt maturing over the next three years. As any amount of market financing to be absorbed by banks needs to be backed by collateral, the available collateral is first determined using two steps.

- **First the determination of the total pledgeable collateral**. The amount of the total pledgeable collateral is determined by: (i) considering CREs' property value of 2020 (SEK 2.11 trillion ), (ii) estimating 2021 the property value by applying a 10 percent property growth rate

in 2021 in line with the Swedish historical real estate price growth and yielding SEK 2.32 trillion, and (iii) applying a decline of 20 percent—the average housing decline rate derived from the adverse scenario of the stress test exercise[36]—to obtain the stressed property value (SEK 1.85 trillion). Considering a haircut of 30 percent yields a total pledgeable collateral of SEK 1.3 trillion.

- **Second, deducting the available collateral from the total one**, based on the amount of collateral already used. Specifically, considering the CREs' existing bank funding (768 billion SEK), which is backed by collateral, the existing credit facilities with banks (SEK 200 billion) also backed by collateral, and deducting them from the total pledgeable collateral (SEK 1.3 trillion), the remaining available collateral stands at 337 billion SEK. Thus, banks, if they choose to, can finance up to 337 billion SEK of the outstanding CREs' bonds of 660 billion SEK.

**35. Sensitivity analysis showed that banks would be able to further finance the CRE sector in the baseline and adverse scenarios** (Figure 10)**.** This analysis is motivated by the CRE heavy reliance on market funding: would financial condition tighten CRE firms would turn to bank for credit; banks in turn would have incentive to extend further credit to the sector given their already large exposure, to avoid defaults. The maturity profile of outstanding market funding is used to determine the amount of funding to be absorbed by banks, considering the bonds maturing over the next three years, amounting to SEK 230 billion (Figure 6).The market financing maturing over the next three years is fully covered by the remaining available pledgeable collateral (SEK 337 billion), and could thus be financed if banks choose to. The market financing maturing over the next three years—is fully covered by the remaining available pledgeable collateral (SEK 337 billion) and could thus be also re-financed if banks choose to. Specifically, if banks choose to absorb the SEK 230 billion:[37]

- **Baseline scenario**—Under the baseline scenario, CET1 capital will deplete by 1 percentage point.
- **Adverse scenario**—Under the adverse scenario CET1 capital will be depleted between 2.8 and 3.9 percentage points,[38] primarily for the change in RWA but also due to increase in provisions.

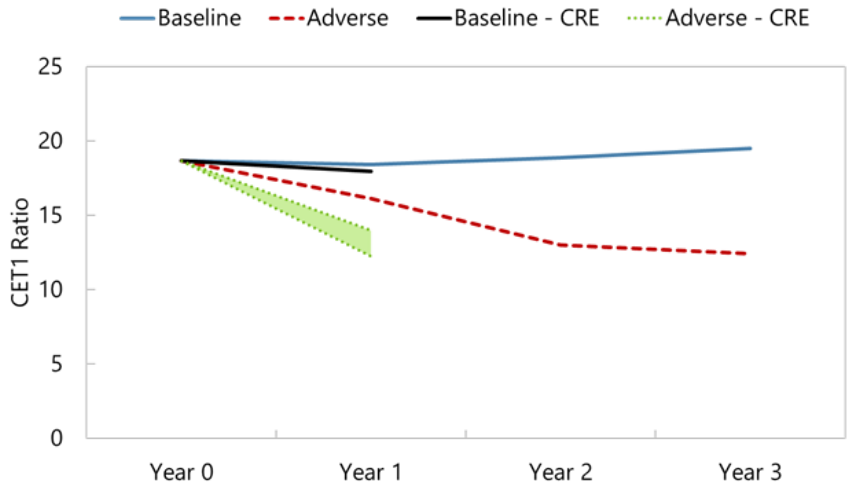
[36] In the adverse scenario real estate price declines respectively by 18.3 percent, 24 percent, and 16.9 percent during the first, second, and third year of the scenario, yielding an average decline of 20 percent.

[37] Banks may choose not to extend further fundings to CREs, if these are deemed risky, or may do so at very high rates and with very high haircuts.

[38] The range is obtained by changing the pass-through between $PD_{PiT}$ and $PD_{TTC}$ to recognize the uncertainty underlining this scenario.

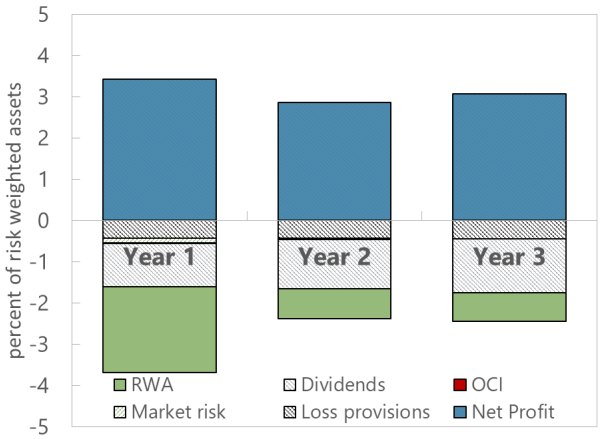
## Figure 9. Results of Scenario-Based Solvency Stress and Sensitivity Tests

**CET1 Ratio: Baseline vs Adverse Scenario**
(In percent)



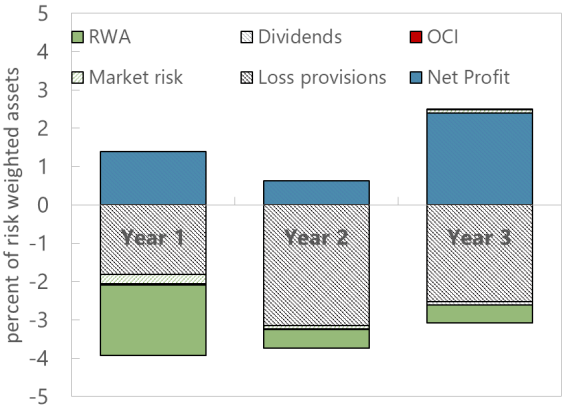

IMF Staff Calculations

**Contributions to Changes in Capital Ratio - Baseline**
(In percent)




Source: IMF Staff's Calculations.

**Contributions to Changes in Capital Ratio - Adverse**
(In percent)




Source: IMF Staff's Calculations.

## B. Liquidity Stress Tests

**36. To assess current banking system liquidity risks, an analysis of banks' structural liquidity ratios is complemented with a cashflow liquidity stress test.** The structural analysis considers the Basel III LCR and the Net Stable Finding Ratio (NSFR). While the former measures short-term liquidity risks, the latter ratio gauges more structural longer-term refinancing and funding risks. The FSAP team did not stress structural LCR/NSFR but focused on cash flow-based stress tests instead. Cash flow-based liquidity stress tests were conducted using supervisory data on contractual cash flows for different maturity buckets. This approach employs multiple scenarios of increasing severity covering several horizons (5 days, 4 weeks, 3 months) with varying assumptions regarding liquidity buffers and shocks to cash inflows and outflows.

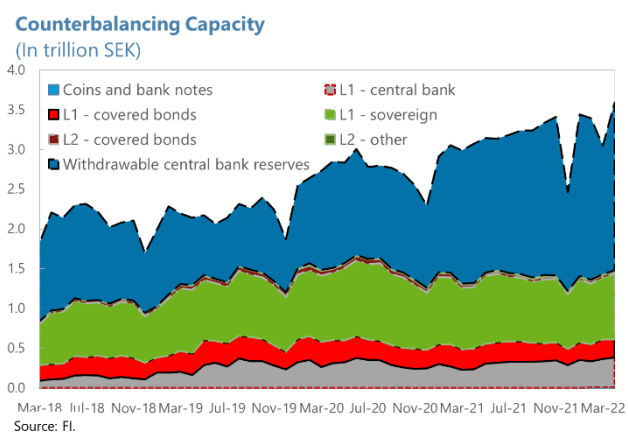
**37. To deal with parameter uncertainty, the cash flow tests were conducted over a wide range of scenarios featuring different degrees of severity** The calibration of the liquidity stress test drew on the assumptions built into the solvency stress test to ensure consistency among both tests. For example, stressed market values of securities or markets' reaction towards banks' ability to raise funding after drop in their capital ratios.

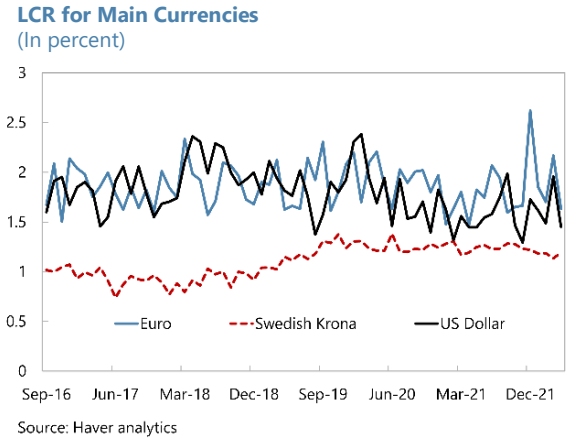
**38. Liquidity analysis reveals that all banks in the sample meet the 100 percent minimum LCR requirement.** The weighted average LCR stand at about 119 percent for SEK, and 163 and 145 respectively for EUR and USD, and all banks have liquidity above the regulatory minimum of 100 percent. The extraordinary monetary support contributed to buttressing banks' liquidity buffers, together with increased retail deposits. Yet, the share of wholesale funding in three major banks remains high at 63 percent. LCR ratios are comfortably above minimum requirements, highlighting large liquidity buffers banks accumulated since the GFC (Global Financial Crisis), including long-term funding from the Riksbank (Figure 11).

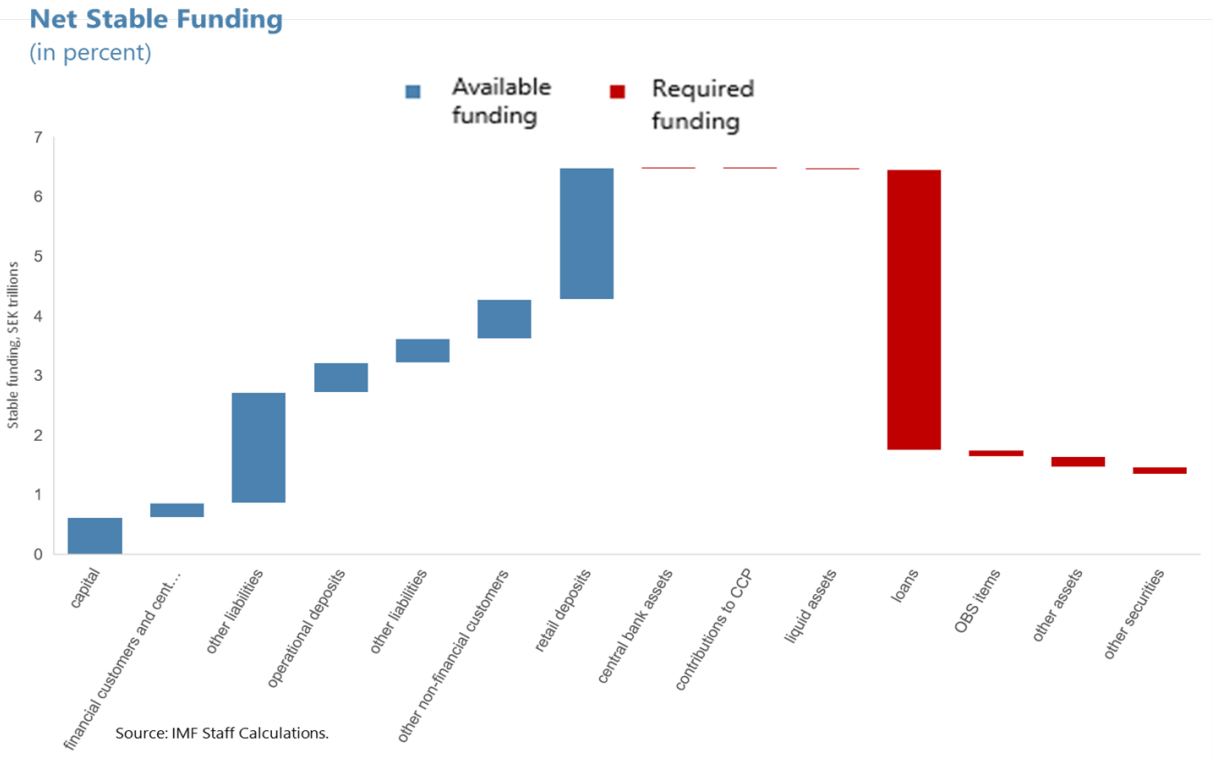
**39. Retail funding, treated as more stable from the LCRs perspective, in the sample of banks is 34 percent.** While retail deposits are a stable base of funding for banks, they are typically of short term, especially as customers do not want to lock-in to low or zero interest rates. From a funding risk perspective, deposit insurance provides additional stability by lengthening behavioral terms of these deposits but is an implied contingent liability for the sovereigns or the banking system, which, in our sample of banks, amounts to SEK 2.6 trillion.

**40. All banks are compliant with the 100 percent NSFR requirement.** Aggregate stable funding needs are around SEK 5 trillion, mainly driven by the loan portfolio. Retail deposits are the first contributor to stable funding (SEK 2.2 trillion) followed by wholesale funding (SEK 1.85 trillion).

**Figure 10. Bank Liquidity Indicators**




**41. Despite the reliance on covered bonds to fund the mortgage portfolios, banks' asset encumbrance ratios (AE) are low on average, with some heterogeneity.** The average AE ratio for the 5 banks in the sample is 23 percent, down from 25 in 2016, yet it reaches 58 percent for one bank. A decline in collateral value by 30 percent would lead to an additional encumbrance of 4 percent of assets, yet all banks would have enough additional liquidity to cover such need. Encumbrance ratio is particularly relevant for banks which issue covered bonds to finance their mortgage portfolio. Banks which have a high share of low risk-weighted assets, such as mortgages, and issued asset backed securities or covered bonds, may be subject to heightened liquidity risks if

losses in mortgage segment would lead to a sharp drop in capital ratio at the time of significant refinancing needs, for example, when banks must redeem own debt securities.

### Cash-Flow Stress Test

**42. Cash-flow based liquidity stress tests transform reported cash-flow data into stressed cash-flows and security flow data based on a matrix of scenario dependent stress factors.**[39] They focus on two key indicators, namely, liquidity risk exposure and liquidity risk bearing capacity of banks. The first indicator is defined as the difference between cash-inflows and cash-outflows in each time bucket (the net-funding gap) and the sum of these differences across buckets (i.e., the cumulated net-funding gap). The second indicator is the CBC, defined as the sum of cash inflows banks can generate under stress at reasonable prices in the respective bucket after considering securities flows. The analysis builds on data collected within the Additional Maturity Mismatch Template (Additional Maturity Ladder, Corep C66.00).

**43. Five scenarios were considered to test the resilience of banks to liquidity outflows** (Figure 12). The stress scenarios were formulated in terms of roll-on/roll-off rates and haircuts to CBC and were designed to capture risks from net outflows of retail deposits, increase in the use of committed credit lines by corporates, significant increase in risk aversion, with higher haircuts on counterbalancing capacity assets due to financial market stress, in line with the macro scenario. Baseline scenario assumes business as usual outflows; contractual – contractual flows; macroeconomic – linked to the macro scenario, assuming haircuts on liquid assets, closure of wholesale unsecured funding markets; idiosyncratic – institution specific shocks; idiosyncratic (no inflow) – assumes institution specific shocks and full provision of credit to the customers (i.e., no inflows from maturing loan portfolio).

**44. Scenario calibration builds on event studies of system-wide and idiosyncratic liquidity stress events and is broadly consistent with the literature.** For example:

a. *Retail deposit outflows* within one week reached 11 percent in the banking system of for Banes to (ES, 1994) 8 percent, and for IndyMac (USA, June 2008) 7.5 percent. For Washington Mutual (USA, September 2008) retail deposit outflows amounted to 8.5 percent in 10 days and for DSB Bank (NL, 2009) they reached 30 percent in 12 days (Schmieder et al. 2012, Table 3). In their severe scenario (comparable to the Lehman crisis), the outflow rates for retail term deposits amount to 10 percent over the 30-day horizon and 20 percent for demand deposits;

b. *Unsecured short-term wholesale funding run-off rates* amounted to 100 percent;

c. For secured wholesale funding the outflow rate is 20 percent.

[39] For details see Schmieder, C., H. Hesse, B. Neudorfer, C. Puhr, S. W. Schmitz (2012), "Next Generation System-Wide Liquidity Stress Testing" IMF Working Paper No. 12/3 and Schmitz, S. W. (2015), "Macroprudential liquidity stress tests", in: C. Bonner, P. Hilbers, I. van Lelyveldt, (eds.), Liquidity Risk Management and Supervision, Risk Books, London 2015, 237–264.

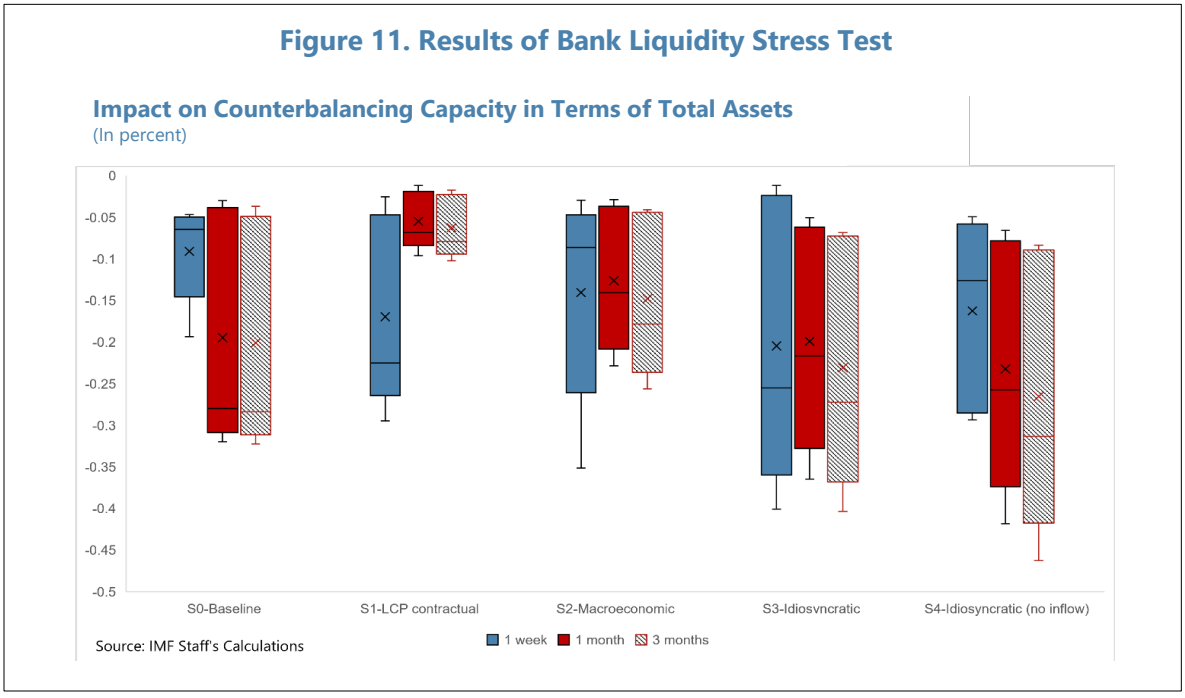
d. *The EBA exercise (Severe Market Scenario)* applied run-off rates of 5 percent (retail deposits), 10 percent (NFC deposits), 20 percent (nonbank financial institutions), 100 percent (financial institutions), and 0 percent (government/public entities);

e. In Halal, Laliotis (2017, Severely adverse scenario) the run-off rates amount to 10 percent for stable deposits, 20 percent non-stable deposits, 100 percent (net unsecured interbank funding), 50 percent (net secured interbank funding), and 100 percent (other wholesale funding, except ABS 50 percent).

**45. The cashflow-based stress test suggests potential liquidity gaps when extending the horizon beyond 30-days.** In general banks can withstand mild and medium liquidity outflows with their existing counterbalancing capacities, however their liquidity position becomes weaker beyond one month. Some banks are prone to liquidity shortfalls even in the short-term, i.e., below 30 days, due to derivatives positions or large off-balance sheet exposures. Shock impact is high: even in the baseline scenario CBC declines by 10 p.p. of total assets (Figure 12), yet banks can withstand significant outflows also when considering high haircuts.

**46. Liquidity stress tests can be enhanced by using more granular data from derivatives reporting and corporate loans.** FI already receives granular data on derivatives trading by Swedish banks in the context of the European Market Infrastructure Regulation. FI can use those data to develop an infrastructure to monitor liquidity needs stemming from margin calls on derivatives portfolios, at least for the banks having sizeable positions, as banks supervisory data give only limited information on such outflows, which can be material in case of market volatility, such as the current economic juncture. Similarly, FI has been collecting ad-hoc microdata on loans to CRE and corporates which can provide a deeper knowledge of committed credit lines to corporates, especially CRE.

**Figure 11. Results of Bank Liquidity Stress Test**



## C. Conclusions and Recommendations

**47. The bank solvency and liquidity analyses suggest that authorities need to use structural models in combination with their existing stress testing frameworks.** Namely, (i) use CRE stress tests to inform banks solvency assessment; (ii) consider alternative modelling approaches to capture the spillover to consumption and corporates profitability while more granular data on households become available; (iii) develop infrastructure to assess contingent liquidity risk from derivatives exposures for the largest banks.

# INVESTMENT FUNDS

## A. Objective and Scope of the Liquidity Stress Test

**48. The liquidity stress testing exercise assesses liquidity transformation risk for open-end investment funds.** The objective is threefold: (i) assess the ability of investment funds to withstand severe but plausible shocks, (ii) identify the types of funds that are potentially more vulnerable to liquidity risk (iii) and estimate the sector's capacity to transmit shocks to the rest of the financial system.

**49. The emphasis is on fixed income and mixed funds investing into assets with different degrees of liquidity and maturity**.[40] Open-ended investment vehicles investing in fixed income instruments, like corporate and other bonds, pool capital while typically granting investors the right to redeem their shares daily. Through this liquidity transformation, these investment funds can collectively give rise to financial stability risks. Based on end of 2021 supervisory data, the sample consists of 171 funds divided in 6 categories reflecting the funds' characteristics and investment policies for a total Net Asset Value (NAV) of SEK 1.223 bn (EUR 120 bn). The categories are the following: alternative funds, mixed funds, government, corporate, HY and short-term bond funds.[41]

**50. Stress test results show that Swedish investment funds, for the most part, appear able to accommodate adverse redemption shocks.** However, vulnerabilities are identified, given that under the severe but plausible assumptions of our simulations, up to 25% of the funds considered in the analysis could experience a liquidity shortfall. These are portfolios either not benefitting from high diversification or heavily exposed to unrated or poorly rated debt securities. These instruments, especially under stressed market conditions, would not benefit from deep liquidity. The results are consistent across the different scenarios. This finding is more sensitive to assumptions over trading volumes in fixed income markets, around which there is considerable uncertainty linked to the evolving market conditions. If liquid assets are not sufficient to cover redemptions, considering the

[40] Funds-of-fund, ETFs and Equity funds are not considered in the stress test exercise.

[41]The alternative fund category considered here includes generic open-end funds investing in hedge-fund like strategies, such as market-neutral, macro trading, systematic trend.

liquidation method adopted by asset managers, the fund could trigger fire sales, especially if its portfolio is invested in securities with limited depth.

## B. Methodology

### Calibration of Redemption Shocks

**51. The set of redemption shocks tested is calibrated based on weekly data at the fund and category level.** Funds within the same category face the same redemption shock ('homogeneity assumption'), which is calibrated based on the average of the worst 3 percent net flows observed by funds in each category. In terms of the NAV, the resulting levels of redemptions shock range from around 8 percent for mixed funds to 12 percent for short-term bond funds. A second set of historical redemption shocks is then calibrated at fund-level ('heterogeneity assumption') to account for idiosyncratic shocks based on a fund net outflow. The levels of shocks are in line with previous FSAPs[42] (see Annex IV for details).

**52. Investment funds' holdings of High-Quality Liquid Assets (HQLA) are compared with the amount of redemption requests.** This choice allows a comparison of liquidity levels between and within fund styles, which gives an indication of which types of funds are more likely to be exposed to liquidity risk.

**53. The Redemption Coverage Ratio (RCR) is used to estimate the ability of funds to withstand shocks and meet redemptions with minimal disruption.** Highly liquid assets are estimated at fund-level using the composition of the portfolio and applying liquidity weights derived from Basel III framework for the calculation of HQLAs.[43]

$$RCR = \frac{HQLA}{Redemption\ shock}$$

**54. The level of HQLA and the redemption highly liquid assets to redemption demands are expressed both in percent of NAV.** The liquidity shortfall is computed as the difference between the redemption shock and the available highly liquid assets when a fund presents an RCR below one.

**55. Following the shock, asset managers need to sell portfolio assets according to a pre-defined liquidation strategy.** Under the stress scenario, fund managers will sell part of the assets held to meet redemption requests. Across different asset classes, these sales may have an impact on underlying markets. The price impact of sales is estimated by comparing the market depth to the volumes of sales. Market depth measures available market liquidity and relates to the ability of a market to absorb orders without the price moving significantly.

[42] See IMF (Luxembourg 2017, US 2020).

[43] A similar approach was used for the 2017 Luxembourg FSAP (IMF, 2017) and the 2020 US FSAP (IMF 2020).

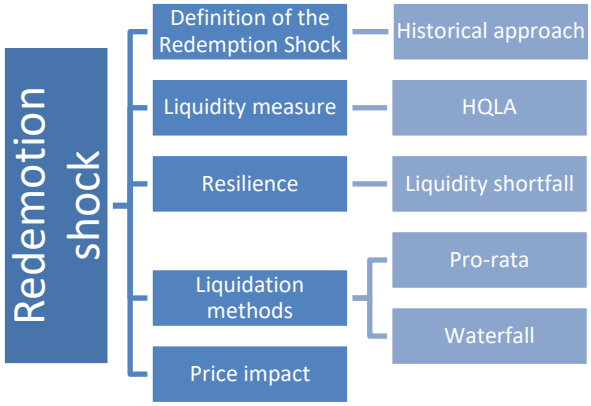
**56. Sales of securities are conservatively assumed to occur in pro-rata fashion (vertical slicing) or alternatively according to the waterfall approach (horizontal slicing).** When liquidating pro-rata manager sells assets proportionally to their weight in portfolio without distorting its composition. This may be preferable for managers pursuing liquidity management practices that preserve fundamental allocation decisions than divesting most liquid securities first, as would be instead the case under the waterfall liquidation strategy (see Annex IV for details).

## C. Results

**57. Overall, funds have a similar structure when looking at their portfolio composition (asset type and credit quality) both within and across categories.** Most funds have a comparable portfolio structure and hold a mix of covered and corporate bonds, with shares of sovereign and Money Market Instruments (MMIs) used to reduce liquidity and counterparty credit risks. The share invested in other collective investment undertaking (CIUs) is overall minor. Mixed funds present more diversification through their investments in equities and foreign assets (Figure 13).

**Table 3. Sweden: Investment Funds Stress Test—Sample and Approach**

**Components of the Stress Test Framework**




**Sample of Investment Funds Invested in Debt Securities**

| Fund category | Composition | |
|---|---|---|
| | Net asset value (SEK bn) | Number of funds |
| Alternative | 41.0 | 15 |
| Corporate bond | 423.3 | 54 |
| Government bond | 11.1 | 5 |
| HY | 74.7 | 27 |
| Short-term bond | 245.4 | 21 |
| Mixed | 427.7 | 49 |
| Total | 1223.3 | 171 |

*Sources: FI, IMF staff calculation*

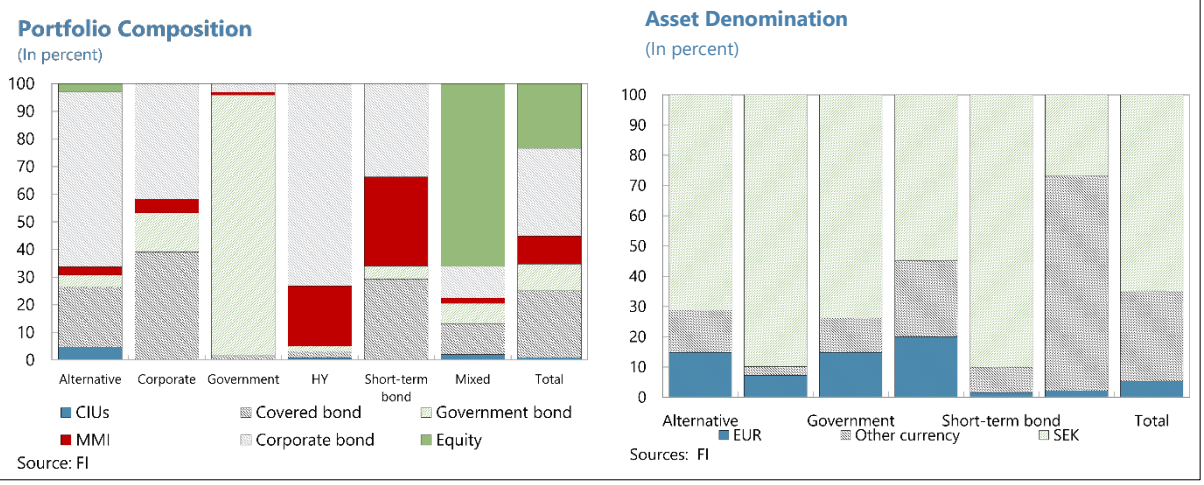
**Redemption Shocks by Fund Category**

| Fund category | Historical approach | |
|---|---|---|
| | Homogeneity | Heterogeneity |
| Alternative | -8.7 | -11.3 |
| Corporate bond | -9.8 | -9.9 |
| Government bond | -11.9 | -11.0 |
| HY | -14.1 | -5.8 |
| Short-term bond | -12.0 | -4.6 |
| Mixed | -7.8 | -0.9 |

Weekly redemption shocks in % of NAV. Median outflow indicated under the heterogeneity approach.

*Sources: Morningstar, IMF staff calculation*

**Figure 12. Assets Held by Swedish Fixed Income and Mixed Funds**




## Funds' Ability to Withstand Severe Redemption Shocks

**58. Only around 75 percent of the funds would have enough highly liquid assets to meet investors' redemptions** (Table 2). Under the historical approach most funds would be able to withstand severe but plausible redemptions. Most investment funds with a low degree of portfolio diversification or exposed to poorly rated and unrated debt securities would need to liquidate assets that do not benefit from deep markets, if these funds do not use any Liquidity Management Tools (LMTs). While results relate to a specific set of exposures that have either a zero or a low liquidity weight for HQLA calculations, the findings are in line with previous studies (IMF, 2019; ESMA, 2019), where it is shown that funds with low portfolio liquidity are more vulnerable than other funds.

**59. The estimated liquidity shortfall for some funds would be above the borrowing limit foreseen for UCITS funds.**[44] In some cases, the liquidity shortfall, defined as the difference between the redemption shock and liquid assets (in percent of NAV) would be above 10 percent (Figure 14), the maximum temporary borrowing limit foreseen by the European UCITS Directive. Funds holding domestic corporate bonds and pursuing long term buy-and-hold strategies appear more likely to have a shortfall, reflecting both the limited depth of the underlying market and structural limitations in assessing credit risk and repricing it as risks change.[45]

[44]UCITS are investment funds, regulated at a European Union level.

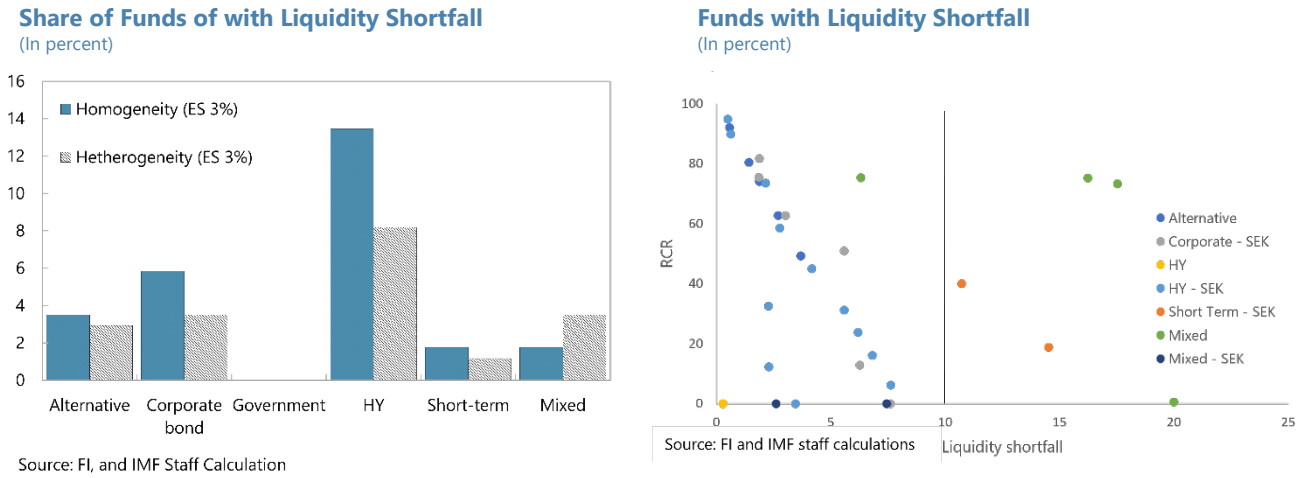
[45] Short-term corporate bond funds are normally used like SEK cash-management vehicles by institutional clients. They have an aggregated maturity of around 3 years, but differently from common money market funds bear a higher credit and interest-rate risk.

### Table 4. Sweden: Results of the Liquidity Stress Test for the Historical Approach

| Category | Homogeneity (ES 3%) | | | Heterogeneity (ES 3%) | | |
|---|---|---|---|---|---|---|
| | Funds with RCR < 1 | % Funds with RCR < 1 | % NAV with RCR < 1 | Funds with RCR < 1 | % Funds with RCR < 1 | % NAV with RCR < 1 |
| Alternative | 6 | 4% | 5% | 5 | 3% | 5% |
| Corporate bond | 10 | 6% | 7% | 6 | 4% | 5% |
| Government | 0 | 0% | 0% | 0 | 0% | 0% |
| HY | 23 | 13% | 85% | 14 | 8% | 59% |
| Short-term | 3 | 2% | 1% | 2 | 1% | 1% |
| Mixed | 3 | 2% | 0% | 6 | 4% | 7% |
| Total | 45 | 26% | 8% | 33 | 19% | 8% |

*Note: RCR is the Redemption Coverage Ratio (Highly Liquid Assets/Redemption shock).*
*Source: FI, IMF staff calculation.*

### Figure 13. Liquidity Shortfall




## Recent Analysis by FI

**60. Following the Spring 2020 market events, the authorities engaged in supervisory activities to review how fund managers manage liquidity risk.** Following the market events, to

complement the analyses done in cooperation with European authorities,[46] FI conducted an in-depth analysis on several fund managers concluding that some may not perform a thorough assessment of liquidity risk and may work on the assumption that assets may be liquidated in a short time-horizon, including large volumes of unrated corporate bonds. These supervisory activities have also highlighted that most fund managers, when assessing their liquidity profiles, do not take sufficiently into consideration redemption requirements arising in periods of market stress and their impact on portfolio composition. In June 2021 FI published a supervisory report including recommendations to fund managers on how to improve their liquidity risk management. FI is currently following up on how fund managers have adapted their management to FI's recommendation. FI is working to operationalize a stress test framework to monitor liquidity risks in the Swedish fund sector.

## D. Conclusions and Recommendations

**61. FI and MoF should ensure that funds exposed to potential liquidity mismatches have adequate LMTs in place and assess their effectiveness.** Only a very limited number of funds have so far adopted these tools following the COVID-19 market stress. Funds investing in less liquid assets that, based on their risk profiles, are at risk of presenting liquidity shortfalls under market stress should move to redemption terms that are more closely aligned with the liquidity profile of their portfolio and have access to a broad and adequate set of LMTs. This could include the introduction of notice periods, which would address externalities associated with individual and collective large sales by funds and under stress scenarios. A second line of defense could also include price tools (e.g., swing pricing), as well as quantity tools (e.g., redemption gates). LMTs should be targeted at reducing the first-mover advantage and ensuring fair treatment of investors. The authorities should follow discussions and developments in international fora and within the European Union (ESMA, FSB (Financial Stability Board), IOSCO) on the effectiveness of LMTs and provide guidance to asset managers on their implementation and application.

**62. FI should provide industry guidance on liquidity stress tests for funds with relevant exposure to asset classes with limited market depth.** The authorities should require asset managers to perform regular liquidity stress tests for different market scenarios, and review and challenge such liquidity stress tests, given the risk associated with abrupt changes in market conditions. In this respect FI should aim at comparability of results and assessment of the liquidity management practices. This is important especially for funds exposed to less liquid asset classes and short-dated bonds carrying credit and interest rate risk that are used like cash-management vehicles.

**63. FI should further develop and adapt their stress test framework and monitoring tools for conducting market wide liquidity risk analysis.** Given the prominent role acquired by the investment fund industry in the Swedish financial system, in line with the recommendations made

[46] The European Systemic Risk Board (ESRB), in the context of the COVID-19 market turmoil, issued a recommendation on 6 May 2020 to enhance preparedness to respond to potential future adverse shocks that could lead to a deterioration in financial market liquidity. FI contributed to the following data collection and analysis coordinated by the European Securities and Market Authority (ESMA).

during the FSAP in 2017, the authorities should complete their analytical framework to assess market impact of collective funds' reaction to episodes of stress and analyse possible risks arising from interlinkages between investment funds and other financial institutions.

# SYSTEMIC RISK, INTERCONNECTEDNESS AND CONTAGION ANALYSIS

## A. Overview

**64. The systemic risk and interconnectedness analysis complements balance sheet stress tests and assesses the transmission of risks across the financial system.** Previous sections focused on stress testing individual institutions and provided an overview of the resilience of the different sectors separately—namely, CRE, banks, and investment funds.

**65. This section aims to bridge those analyses.** Firstly, by looking at the potential contagion among banks due to direct exposures. Secondly, by considering overlaps in bond holdings across various financial sectors. Finally, by considering the impact of funds' liquidation strategies on the market. The spillover from the CRE sector onto the banking sector was already quantified by utilizing the CRE stress test as input to determine risk parameters in the bank solvency test and the related sensitivity analysis.

## B. Analysis

### Interbank Contagion

**66. An interbank contagion analysis did not identify a material risk, partially due to data limitations.** The analysis utilized information on direct exposures reported in common reporting templates (COREP) on large exposures, where banks report equity, debt and derivatives exposures to clients or groups of connected clients when their value is equal or exceeds ten percent of the eligible capital of the institution. The framework defined in Espinosa-Sole[47] was employed. The lack of material contagion is due to several reasons. Firstly, the reporting requirements for the large exposures induce a sample bias, as exposures below the reporting threshold are not included. This underestimates the overall direct impact and prevents to capture potential second-round effects. Secondly, Swedish banks cross-exposures are typically due to covered bonds, which are secured exposures senior to most liabilities and collateralized, hence are bound not to be a major source of distress transmission in case of a solvency shock, which is the assumption behind Espinosa-Sole-type framework.

[47] https://www.imf.org/external/pubs/ft/wp/2010/wp10105.pdf

## Overlapping Securities Portfolios Across Sectors

**67. Bond and capital markets constitute an additional layer of interconnectedness among financial institutions (Figure 15)**. Most Swedish financial institutions participate in various segments of the domestic bond market. To compare their portfolio allocations, a granular dataset of bond holdings of around 900 Swedish financial institutions, covering banks, insurance and pension funds, and investment funds, was compiled.[48] The data included government, covered, banks' senior unsecured instruments, and corporate bonds. After having reconstructed institutions' portfolios, a hierarchical clustering was performed to identify groups of firms with similar allocation. [49] In Figure 15 each row/column represent an institution – the color on the left bar identifies the sector. [50] The main area of the figure displays dark cells when bond portfolios of institutions in the rows and columns are highly similar.[51] The diagonal naturally exhibits darker squares.[52] A concentrated market is represented by larger and darker areas. The analysis was performed on the whole bond market (center left chart), then was separated by segment, with particular emphasis on covered bonds (center right chart) and corporate bonds (bottom charts, with different aggregation strategies).

**68. In all segments, cross-sector portfolio similarity is lower than within each sector, and the covered bond market is the segment where investors have more similar portfolios.** Investment funds is the sector with highest similarity, in line with the findings in the previous section on fund stress tests. The covered bond segment is the one with highest overlap among investors' portfolios, confirming the fact that these instruments are one of the main liquidity tools across sectors, as well as the largest segment.[53]

**69. Investment funds hold most corporate bonds, and the market is fragmented.** When applying the clustering to the segment of corporate bonds at instrument level, two stylized facts emerge: firstly, investors are almost exclusively in the investment fund sector, secondly their portfolios are generally quite different (this is evident from the chart by the light-colored cells). In this sense the market is fragmented because only a limited number of investors trade each

[48] The information was collected from several data sources, including the Banks VINN data. Insurance Solvency II data, and investment fund supervisory reporting. Information on the type of instrument and issuer was enriched from commercial data sources based on the instrument's ISIN.

[49] Jain, A. K., & Dubes, R. C. (1988). Algorithms for clustering data. Prentice-Hall, Inc.

[50] These are: yellow for Investment funds, purple for banks, green for insurance companies

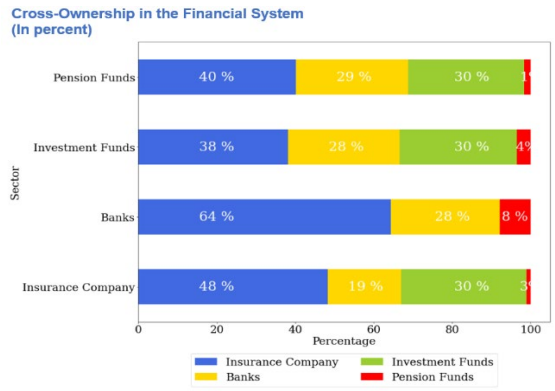
[51] The (dis)similarity between portfolio is measured using 2 distances, Jaccard and cosine similarity, which provided similar results in terms of clustering. The heatmap shows the "distance" between portfolios, so low values (= dark colors) indicate that two portfolios are similar.

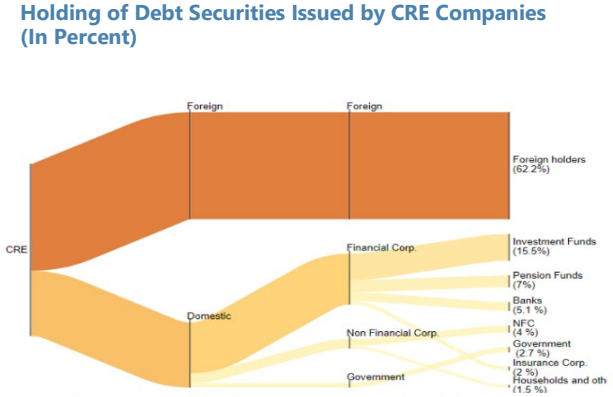
[52] Being the matrix of similarity symmetric by construction

[53] See The Riksbank's purchases of securities | Sveriges Riksbank. As of June 2022, outstanding covered bonds in SEK amount to over SEK 2000 billion, exceeding the segments of government bonds (SEK 800 billion) and SEK corporate bonds (SEK 700 billion) combined. While the analysis did not exclude a priori non-SEK instruments issued by Swedish firms, these were not largely significant.

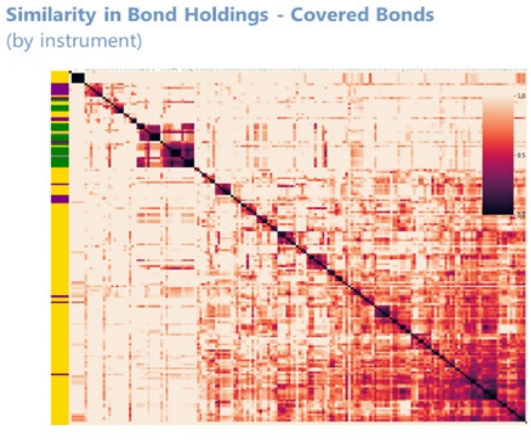
instrument. The picture changes slightly when considering similarity by issuer,[54] as more similarity emerges across investors portfolio (darker area in the chart), confirming market intelligence regarding the practice of targeted (small) issuances.

**Figure 14. Interconnectedness via Securities Holdings**

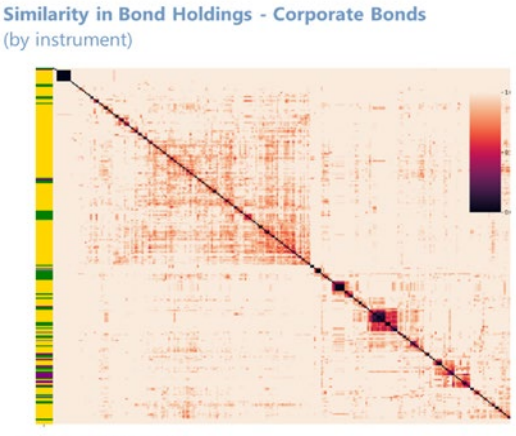







Source: IMF Staff's calculation




Source: IMF Staff's calculation


Source: IMF Staff's calculation

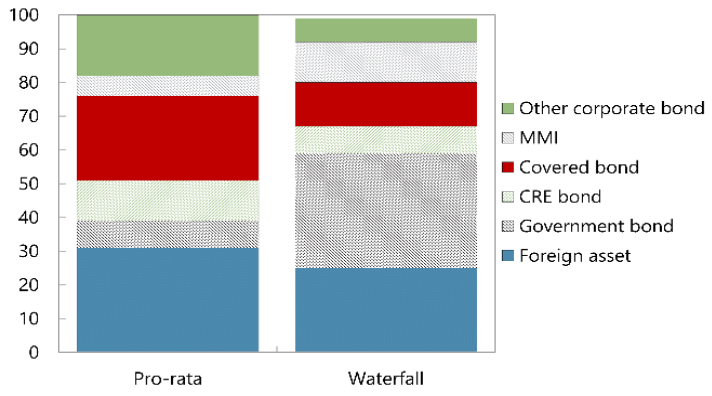
[54] I.e., when portfolio allocation is determined pooling together instruments from the same issuer. This was done because market intelligence suggested that corporates tend to issue several instruments at the same time to meet the demand of different investors.

## Impact of Funds' Forced Sales on Markets

**70. Asset sales by mutual funds to meet redemptions could have a sizeable impact on markets.** This depends on the size of the shock, the related asset sales, and the underlying market depth. When liquidating securities, asset managers face a trade-off between reducing the price impact of sales and maintaining the portfolio allocation in line with investment objectives and the mandates with investors. For a given redemption shock, the impact on underlying markets is expected to be larger when funds use a pro-rata liquidation strategy (vertical slicing) than when using a waterfall approach (horizontal slicing) where they sell their most liquid assets first. On the other hand, under the waterfall approach, all remaining investors would end up with a less liquid portfolio, which could amplify the first-mover advantage.

**71. Under normal market conditions, prices of domestic bonds would not experience large declines following investment funds' liquidation to meet redemptions** (Figure 16). The price impact of sales from funds on their underlying market ranges across domestic bonds between 32 to 100 basis point when considering the pro-rata strategy, and from 18 to 40 under the waterfall approach. The ability to liquidate foreign assets and the propensity of investment funds to pursue a buy-and-hold strategy on domestic segments appear as the major factors contributing to lowering price pression on corporate bonds. On the other hand, the large predominance of funds in the corporate bond sector limits the possibility of direct cross-sectoral contagion through revaluation of portfolios, e.g., to insurers or banks.

**Figure 15. Market Impact and Asset Liquidation (In Percent)**




Sources: FI and IMF Staff's calculation

**72. This analysis, nevertheless, warrants several important caveats.** Contagion dynamics are highly nonlinear, and thus inherently difficult to quantify. For instance, the estimation of price impacts relies on assumptions of market absorption capacity and are based on observed historical patterns. However, data limitation and the structural feature of the Swedish market makes it hard to attain forward-looking measures of market liquidity and depth. Hence, the impaired price-discovery and the difficulties to track liquidity limit the assessment of price impacts following large redemption shocks.

**73. Historical measures for market impact do not allow to gauge the tipping point for corporates to lose access to the primary market.** On the one hand the contagion from funds to other Swedish financial institutions via valuation effect could be limited due to weak cross-sector overlaps in their portfolios. On the other hand, a prolonged secondary market illiquidity, or a structural shift in investor preferences, could impair the ability of corporates, especially CRE firms, to roll-over their funding on the market, thus triggering a more wide-spread effect on the financial

system and the economy. Primarily this would affect banks, which would face the decision on whether to extend more credit to CRE, as described in the solvency sensitivity analysis, potentially beyond existing committed credit lines.

## C. Conclusions and Recommendations

**74. These analyses underpin the necessity to overcome data and modelling limitations**. While the data available helps providing a first understanding of the financial system interconnectedness, many gaps remain to fully capture the potential systemic risk stemming from financial and non-financial firms' interdependencies. Beside data availability, models tailored to the specificity of the Swedish market would be necessary to overcome pitfalls of existing literature, which does not adequately capture some features of the financial system, such as the large use of covered bonds as a low-risk liquid security.

**75. While FI has made progress in data collection and usage, a broader effort is needed to strengthen monitoring and analytical capacity**. This would require improving quality, frequency, and granularity of existing supervisory data especially for funds (e.g., monthly flows, and returns), monitor the duration-times-spread of funds invested in non-liquid asset classes, improve information and liquidity tracking of specific asset types (e.g., debt instruments issued by CRE companies), and maintain adequate information on assets in institutions' portfolios.

# Appendix I. Stress Testing Matrix

| Domain | Top-Down Stress Test Approach by the FSAP Team |
|---|---|
| **Banking Sector: Solvency Stress Test** | |
| Institutional perimeter | • The 5 largest Swedish banks (Swedbank, SEB, Handelsbanken, SBAB Bank and Länsförsäkringar Bank), to cover about 75 percent of banking system assets |
| Cut-off date | December 2021 |
| Data | • Quarterly supervisory data (COREP, FINREP) and reporting on Interest Rate Risk in the Banking Book (IRRBB), at the highest level of consolidation, are complemented by survey data on mortgages and securities holdings collected by the FI and the Riksbank, respectively |
| Methodology and risk drivers | • Semi-static balance sheet approach: annual GDP growth for year when positive, no change in recession time<br>• Scenario-conditional forecasts of various drivers underlying headline capitalization metrics will be combined, including:<br>◦ credit risk (through loan loss provisions): structural model based on copula for HH mortgages, granular CRE stress test, BMA for corporate exposures<br>◦ interest rate risk: projection of effective interest rate for 7 types of interest-bearing assets and liabilities.<br>◦ Net fee and commission income: granular projection based on past variation (1 std deviation shock)<br>◦ Market risk: repricing of securities based on a modified duration - granular data on bond holdings aggregated by issuer type, country, and maturity. Change in yields were derived from the scenario<br>• Tax rate 20.6 – effective rate in 2021<br>• Dividend payout: Dividends are assumed to be paid out of current period net income after taxes by banks in compliance with supervisory capital requirements. A maximum allowed dividend payout is assumed to be equal to the dividend payout ratio (dividends over net income after taxes) in 2021, with a cap at 40 percent |
| Scenarios | • Baseline scenario aligned with latest IMF WEO<br>• Bespoke adverse scenarios addressing the most relevant risks and vulnerabilities confronting the financial system, including aspects of the geopolitical tensions, war in Ukraine and COVID-19 pandemic, sharp rise in global risk premia, exchange rate depreciation, financial institutions' funding cost pressure, etc.<br>• 3-year horizon |
| Policy and sensitivity analysis | • Sensitivity analyses on CRE exposures |
| Hurdle rates | • The assessment criteria ("hurdle rate") includes the capital standards implemented via the Capital Requirements Regulation (CRR) and the phased-in buffers. The hurdle rates applied in the stress test are set at the Common Equity Tier (CET1) regulatory minimum of a 4.5 percent Pillar 1 requirement, a fully phased Capital Conservation Buffer (CCB) of 2.5 percent, and a phased-in buffer of 3 percent for SIBs. This led to a CET1 hurdle rate ranging from 7.0 to 10 percent. In the baseline scenario, the phase-in of the countercyclical capital buffer starting from 2023 is also considered |

| Domain | Top-Down Stress Test Approach by the FSAP Team | |
|---|---|---|
| **Banking Sector: Liquidity Stress Test** | | |
| Institutional perimeter | • The largest 5 Swedish banks (Swedbank, SEB, Handelsbanken, SBAB Bank and Länsförsäkringar Bank) | |
| Methodology and scenarios | • A cash flow-based liquidity stress test (LST) and a standardized Basel III-Liquidity Coverage Ratio (LCR) test will be conducted to assess banks' ability to cover net cash outflows using their counterbalancing capacity.<br>• Scenario's analysis to cover risks from: (i) asset price falls, (ii)run on retail deposits, (iii) run on wholesale funding, (iv) foreign and domestic investors different behavior, (v) run on FX deposits, (vi) scarce access to FX funding, for example via swaps.<br>• Liquidity support from the Central Bank through emergency liquidity facilities will not be factored in, to assess banks' liquidity coverage profiles in the assumed absence of liquidity support from the central bank.<br>• Account for different currencies: Swedish Krona and FX. | |
| **Commercial Real Estate Stress Test** | | |
| 1. Institutional Parameters | Institutions included | • About 3800 firms (total assets amounting to 90 percent of GDP). |
| | Data | • Data on firms will be sourced from Orbis<br>• Data availability as of 2020. |
| 2. Methodology and risk drivers | Methodology (TD) | • Scenario-based forecasts of various income statement and balance sheet line items<br>• Calibration of interest rate shocks, FX shocks, revenue shocks |
| 3. Scenarios | Number of scenarios | • Baseline, and Combined Adverse scenarios in line with the bank solvency stress testing, namely GDP and income shocks, as well as interest shocks as a slowdown in economic growth (along with a fall in rents and/or valuations). |
| 4. Reporting Format for Results | Output presentation | • Impact on solvency (ICR) ratios<br>• Debt-at-Risk measure |
| **Contagion Analysis** | | |
| 1. Institutional Parameters | Institutions included | • Exposure based bilateral domestic interconnectedness will include bilateral exposures between Swedish banks (same sample as in bank stress test) |
| | Data | • Domestic bank interconnectedness analysis as of end-2021 |
| 2. Channels of Risk Propagation | Methodology | • Network contagion based on Espinosa-Vega and Sole (2010), which allows default cascade simulations at different loss given default (LDG) rates will be used for the exposure based bilateral domestic and cross-border interconnectedness analyses. |
| 3. Reporting Format for Results | | • System-wide capital shortfalls (with min, max, and the median in the case of bilateral domestic bank contagion, without identifying individual names) |
| **Investment Funds Liqudity Stress Testing** | | |
| 1. Institutional perimeter | Institutions included | • 171 Fixed-income, alternative and mixed funds |
| | Market share | • Varies by type of fund |

| Domain | Top-Down Stress Test Approach by the FSAP Team | |
|---|---|---|
| | Data and baseline date | • Portfolio reporting date: Dec 31, 2021, or later<br>• Data: Confidential supervisory data<br>• Flows: Sourced from Morningstar, time interval 2008-2021<br>• Assets' characteristics: Sourced from EIKON |
| 2. Channels of risk propagation | Methodology | • Various levels of redemptions shock compared level of highly liquid assets at the fund level<br>• Redemption shocks based on historical fund flow data using VaR and Expected Shortfall methodologies with multiple thresholds |
| | Stress test horizon | • Weekly data frequency, instantaneous shocks |
| 3. Tail shocks | Scenario analysis | • Pure redemption shock: severe outflows based on historical distribution of fund flows |
| 4. Risks and buffers | Positions/risk factors assessed | Risks<br>• Liquidity risk: severe redemption shock<br>Buffers<br>• Level of highly liquid assets |
| 5. Reporting format for results | Output presentation | • Number of funds with a redemption coverage ratio (ratio of highly liquid assets to redemptions) below one<br>• Liquidity shortfall amount for individual funds after redemptions |

# Appendix II. Risk Assessment Matrix

| Risks | Likelihood of Risk | Impact of Risk |
|---|---|---|
| **Russia's invasion of Ukraine leads to escalation of sanctions and other disruptions.** Sanctions on Russia are broadened to include oil, gas, and food sectors. Russia is disconnected almost completely from the global financial system and large parts of the trading system. This, combined with Russian countersanctions and secondary sanctions on countries and companies that continue business with Russia, leads to even higher commodity prices, refugee migration, tighter financial conditions, and other adverse spillovers, which particularly affect LICs (Low Income Countries) and commodity-importing EMs (emerging markets). | H | **Medium:**<br>- A negative shock would hit exports. If demand from Europe declines–particularly those on Sweden's vehicles and machinery exports–would dampen exports and investment and weaken growth.<br>- Higher funding costs impact corporate borrowers, reducing credit availability, including from non-bank financial intermediaries. |
| **De-anchoring of inflation expectations in the U.S. and/or advanced European economies.** Worsening supply-demand imbalances, higher commodity prices (in part due to war in Ukraine), and higher nominal wage growth lead to persistently higher inflation and/or inflation expectations, prompting central banks to tighten policies faster than anticipated. The resulting sharp tightening of global financial conditions and spiking risk premia lead to lower global demand, currency depreciations, asset market selloffs, bankruptcies, sovereign defaults, and contagion across EMDEs (Emerging Market and Developing Economies). | M/L | **High**<br>- Market losses in banks' unhedged fair value portfolios as asset prices fall.<br>- Potential significant liquidity impact on banking sector, given high reliance on wholesale funding, including in FX.<br>- Higher funding costs impact corporate borrowers, reducing credit availability, including from non-bank financial intermediaries.<br>- Higher retail interest rates worsen household financial situation. Further pressure on banks' capital adequacy. Adverse spillover to other (viable) sectors through lower incomes and intermediate input demand. Higher unemployment due to bankruptcies. |
| **Significant property price decline in Sweden due structural changes.** Price declines could possibly affect commercial property markets and/or residential property. | L | **Medium:**<br>- Investment and collateral values for lending could be undermined by sizable falls in commercial property prices.<br>- Loan quality impacted, primarily of firms serving domestic market. Lending could be curtailed if doubts about the quality of covered bonds rise elevating bank funding costs. |
| **Geopolitical tensions and deglobalization.** Intensified geopolitical tensions, security risks, conflicts, and wars cause economic and political disruptions, fragmentation of the international monetary system, production reshoring, a decline in global trade, and lower investor confidence. | H | **Medium**<br>Higher disruptions and barriers to trade would dampen exports and investment and weaken growth. |

| Risks | Likelihood of Risk | Impact of Risk |
|---|---|---|
| **Cyberthreats.** Cyberattacks on critical physical or digital infrastructure (including digital currency platforms) trigger financial instability or widespread disruptions in socio-economic activities. | **M** | **Medium**<br>Disruption is widespread including to supply of essential goods, payments systems, and financial market infrastructure |

# Appendix III. Projections of Probability of Default by Segment

## Corporates

The mission utilized the Bayesian Model Averaging (BMA) tool by Gross and Población, J. 2019[1] to project PDs of corporates for the two largest geographies, Sweden, and the Nordic-Baltic region.

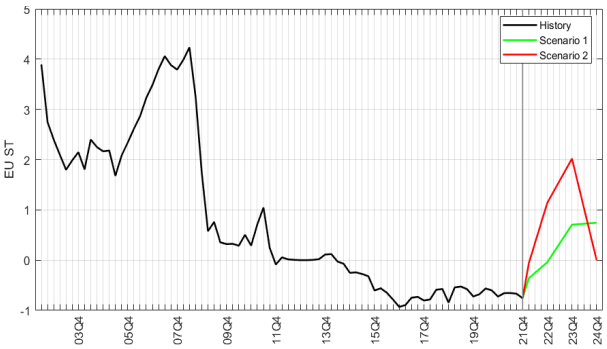
The independent variables were chosen from the pool in the Table 3 below, for the relevant geography. The tool was run with a maximum four and up to three lags of right-hand- variables per model. For Swedish corporates also an autoregressive term was added. A logit transformation was applied to the dependent variable, and sign constraints were imposed on all variables.

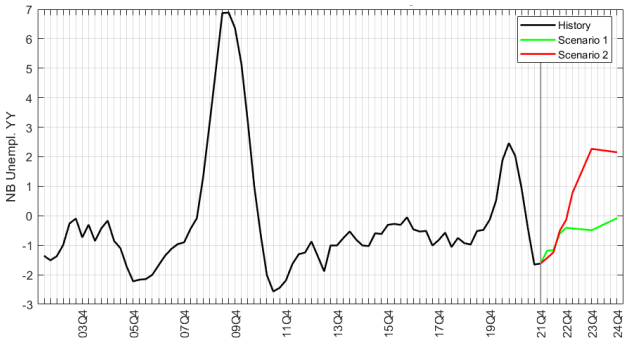
**Table 1. Sweden: Variables for BMA**

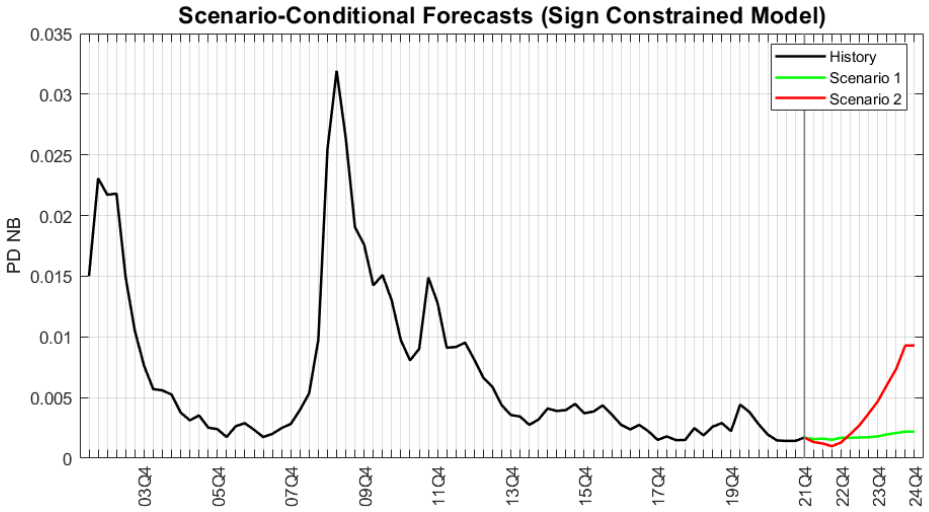
| | | | | |
|---|---|---|---|---|
| Variables | Unemployment - levels | GDP growth QoQ | Term spread | CPI (Consumer Price Index) YoY |
| | Unemployment - QoQ | GDP growth YoY | Short-Term risk-free rate | CPI QoQ |
| | Unemployment - YoY | | | First difference CPI YoY |
| Sign constraint | + | - | + | + |

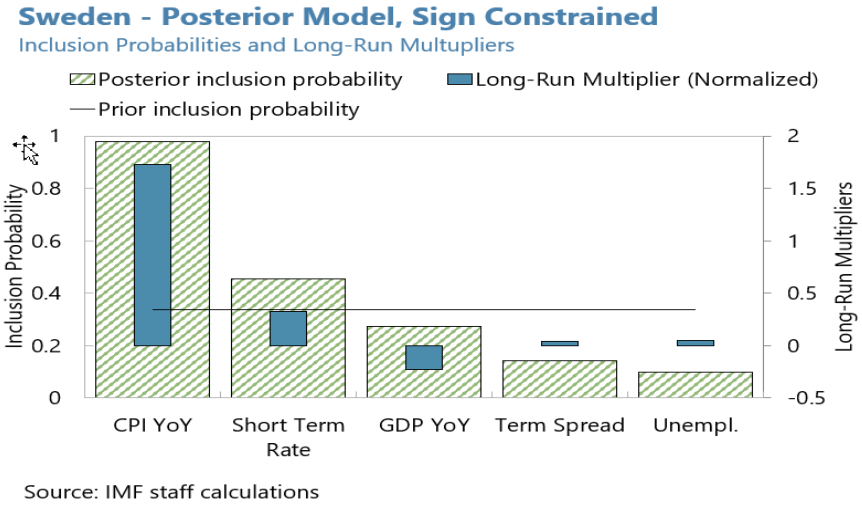
[1] Gross, M., and Población, J. 2019. "Implications of Model Uncertainty for Bank Stress Testing," Journal of Financial Services Research, 55(1):31-58.

## Figure 1. Probability of Default Projections Corporates and Long-Run Multipliers for Nordic-Baltic[1]




Source: IMF staff calculations

[1] Top panels show the baseline and adverse paths for the two macro variables which have largest long-run multipliers. The paths are obtained as weighted average of the paths for the countries in the region, when available from the GFM model employed for the scenario design.

## Households

1. To deploy the structural model for estimating scenario projections for mortgage default rate, the following assumptions could be made:

   a. A DSR/LTV joint distribution for the stock of existing mortgage exposures can be constructed assuming an average maturity of individual loans of 70 years at origination and an unchanged distribution for the years prior to 2015.

   b. DSR and LTV ratios across all vintage distributions were adjusted using household income and house price historical time series as proxies for the impact on DSR and LTV, respectively.

2. The structural component of the model defines the probability of a household being under stress. This probability is a function of the change in the Debt Service Ratio (DSR) due to an interest rate change and the change in the unemployment rate in the scenario. Under the general form, this distress probability is given by the structural function:

$$PSS_t = a_0 \cdot D + a_1 \cdot DSR_t^{\beta 1} + \alpha_1 \cdot \Delta DSR_t^{\beta 2} + \alpha_3 \cdot \left(\alpha_4 \cdot u_t + \alpha_5 \cdot (\Delta u_t)^{\beta 3}\right) \quad \text{(Eq.1)}$$

   with $D$ denoting a demographic distress contribution component, $DSR_t$ denoting the borrower's DSR post stress, $\Delta DSR_t$ the delta in DSR vs the cut-off date, $u_t$ the unemployment rate, and $\Delta u_t$ the change in unemployment rate from the cut-off date. The equation (above) captures the borrower affordability component and how this is affected by the macro-scenario shock.[2]

3. Additional conditions need to be met to assume that a mortgage exposure reaches default. At a second stage, default occurs only when the household is in distress (post-first stage), the household's liquid wealth is not enough to cover servicing needs, and the value of the loan is higher than the value of the collateral (negative equity condition is a prerequisite for default).[3] Therefore, default occurs only if the post-stress LTV is higher than 1 and if any wealth buffers are not enough to cover the servicing needs after a distress event. Hence, under a positive house price assumption the model captures any potential masking of defaults due to price appreciation. In this positive house price scenario, an outright sale would be triggered by a borrower's distress as opposed to a default event.

4. Default probability is given by formula

[2] The original TUI model (Harrison and Mathew, 2008) was slightly adapted with the introduction of a DSR ending-level term (second term of Eq 1) to also account for potential defaults of high-risk borrowers (households with high DSRs should go through the default test).

[3] The fact that this only comes at a second stage and after the control for a household being distress explains why negative equity would not drive default rates; none of the non-distressed households (which are substantially more as a percentage of the overall population of borrowers) would ever default, even in the event of negative equity. Therefore, negative equity is just a trigger of default event vs outright sale. The type of recourse (full recourse vs nonrecourse) also does not play a major role in the structural approach since borrowers' default under distress and when available wealth either in the form of property value or liquid wealth alternatives might be used to avoid default.

$$PD_t = PSS_t \cdot \frac{\{\#|\tilde{V}_t - C < L \text{ and } B^t(LW_0)=0\}}{(\#iterations)}, \qquad \text{(Eq.2)}$$

where the first term within the brackets denotes the probability that the property value after stress $\tilde{P}_T$ minus some liquidation discount $C$ is lower than the outstanding loan notional $L$, and the second term denotes that the stochastic behavioral rule $B^t(x)$—which accounts for the use of Liquid Wealth $LW_0$ at the cut-off—has failed to save the loan from default.[4] The $\#iterations$ suggest that this outcome is the result of a significant number of Monte Carlo simulations in which any type of behavioral rules can be incorporated and any type of house price shock distributions can be modelled.

5. The conditional LGD is driven by the discounted sale price of the house. The sale occurs at time t+s (where s denotes the average time to realize the collateral); the sale proceeds are net of transaction costs (discounted at a rate reflecting the scenario interest rate premium) and assume an additional foreclosure liquidation discount $\delta$:

$$LGD_t = 1 - \frac{(1-\delta)P_{t+s}}{L*(1+r_t+cs_t)^s} \qquad \text{(Eq.3)}$$

6. The joint distribution is partitioned along the DSR and LTV dimensions. Using LTV partitioning values of 1.2, 1.1, 1. 0.9, 08, 0.7, 0.6, and 0.5, and DSR partitioning values of 0.2, 0.3, 0.4, 0.5 and 0.6, the first two dimensions of the household data are mapped to a 5 by 8 partitioned space. For each DSR/LTV partition a Monte Carlo simulation (on house price changes anchored to a central house price shock) is used to produce model-based projections on 3-year loss rates. A portfolio average 3-year loss rate would correspond to the weighted average of the projected loss rates per DSR/LTV density partition. This means the portfolio distribution along the two dimensions (DSR and LTV) can be used to produce an overall portfolio estimate.

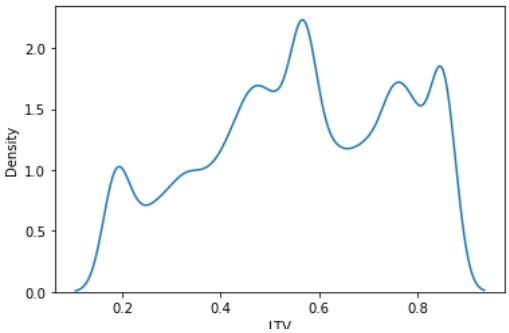
7. The structural model produces 3-year scenario-dependent loss rates. To produce yearly projections, the model is sequentially run using the 1-year, 2-year and 3-year scenario loss rate projection. Each run uses the 1-year loss rate projected by the previous run to infer the annual loss rate that would correspond to a cumulative loss rate as projected by the model for the total number of years and the scenario corresponding to this point in time. In this way, 3-year loss rate projections are translated into yearly projections, with the cumulative impact being anchored to the original 3-year loss rate projection and end-horizon scenario.

8. Model projections for both baseline and adverse are consequently translated into bank-specific projections using the bank mortgage exposure starting points. This translation is

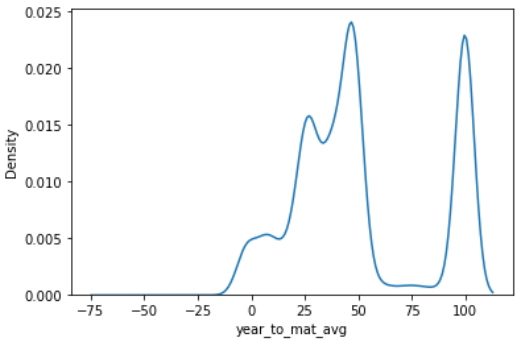
[4] In the actual calibration for the solvency ST a linear survival rule was implemented as the behavioral rule: the survival probability is linear between a wealth buffer of 8 and 36 months. Buffers below 8 months will not be sufficient to weather a default event and borrowers with wealth buffers exceeding 36 months would survive the distress event with probability 1.

performed using an absolute shift in the PD space. As a result, this starting point adjustment brings the baseline scenario projections closer to the idiosyncratic default rates observed in the market under current conditions. Adverse scenario loss rates are projected as an additional delta impact versus the baseline one.

**Figure 2. Retail Mortgages Metrics**




Source: FI. IMF staff calculations




Source: FI, IMF staff calculations

# Appendix IV. Data and Sample of Funds Used in Stress Tests

## Data

**Flows:** For each fund in the sample, daily data on flows and net asset value (NAV) are retrieved over the 2008–2021 period. The sample of fund is based only on funds that were still alive as of end-2021. Daily flows have been aggregated to obtain weekly fund flows. Supervisory information on fund flows is available to the authorities only with a quarterly frequency.

**Computation of net flows:** For each fund, net flows in percent of NAV are computed using the following formula:

$$f_t = \frac{FLOWS_t}{NAV_{t-1}}$$

Net flows whose absolute value is above 50% were excluded as they are likely related to reporting mistakes. When info on daily flows is not available, monthly flows are proportionally distributed over the number of weeks in each month.

**Portfolio composition and info on assets:** For each fund, supervisory information on asset-level portfolio composition at the end of 2021 is used for the analysis. This would include asset categories and ISINs, price and market value of the instruments, portfolio weights, the amount of cash held in portfolio together with remaining liabilities.
Ancillary information on asset characteristics, sectors, credit quality, maturities, yields, and durations are obtained by Refinitiv EIKON.
Metrics on liquidity and trading are derived using information collected under MiFID. Total volumes traded for different asset classes are taken from SELMA, i.e., the Riksbank's reporting of turnover statistics by counterparties for the money and bond markets.

## Calibration of the Redemption Shock

The liquidity risk for open-end investment funds exposed to fixed income instruments is assessed by first calibrating a plausible but severe redemption shock and then comparing it to a measure of highly liquid assets. The shock is intended as instantaneous, i.e., there is no persistence over several periods. The objective is to assess funds' ability to withstand redemptions shocks. The calibration of redemption shocks follows Bouveret and Yu (2021, IMF). Similar approaches have been adopted also in the context of other FSAPs (IMF, 2015b; 2017, and 2018).

Usually, redemption shocks are calibrated based on the distribution of historical net flows by fund categories following a Value-at-Risk (VaR) approach, where different percentiles of net flows are used to calibrate the shock. Formally, the VaR at the $\alpha$ level is given by:

$$Var(\alpha) = F^{-1}(\alpha)$$

where $F^{-1}$ is the inverse of the distribution function of net flows.

This approach has some drawbacks (ESMA, 2019): 1) extreme shocks below the VaR are not considered; 2) when using a parametric approach, the VaR is subject to model risk (Emmer et al., 2015). To address those two issues, a set of redemption shocks is based on the expected shortfall (ES), which is equal to the average net flows below the VaR. The ES is then given by:

$$ES(\alpha) = E(Z \mid Z < Var(\alpha))$$

Where $Z$ represents the net flows.

**Homogeneity assumption**: each fund within the same investment style faces the same redemption shock. In this case the shock is based on the distribution of all individual fund net flows that can be ascribed to the same investment style. The calibration is based on the 3% ES.
As a robustness check, redemption shocks are also calibrated at the 1% and 5% percent levels for the ES, and at the worst 1%, 3%, and 5% net flows observed (VaR).

**Heterogeneity assumption**: the redemption shock is calibrated separately for each fund based only on its own historical data. The shock is based on the 3% ES. As a robustness check, the shock is also estimated at 1% and 5% level as well as using percentiles. This assumption does not allow comparing outcomes across funds for a redemption shock of the same magnitude. Moreover, shocks calibrated will not be meaningful if funds have not experienced large outflows, which would not provide insights on their ability to withstand future shocks (see Bouveret (2017) and ESMA (2019).

Overall, each fund is subject to 12 different redemption shocks (Table 4). The main focus of the stress test is on the homogeneity assumption—which allows funds to be compared within the same category—calibrated at the 3% level, with redemption shocks ranging from 7.8% percent for Mixed funds to ~14% percent for HY bond funds.

**Investment Funds' Resilience: The Liquidity Bucket Approach**

The ability of funds to withstand shocks is estimated by comparing the redemptions to the level of high liquid assets. High liquid assets are measured at fund level using the liquidity weights defined in the context of the Liquidity Coverage Ratio for banks. For each asset class, liquidity weights are defined based on the type of assets and for fixed income instruments the credit quality. Liquidity weights are taken from the Basel Committee rather than domestic implementation of the LCR, to allow for comparability, in line with ESMA (2015, 2019), Bouveret (2017, IMF), and IMF (2019, 2020).

**Table 1. Sweden: Calibration of Redemption Shocks**

| Investment type | Homogeneous shock | | Heterogeneous shock | |
|---|---|---|---|---|
| | ES | VaR | ES | VaR |
| | | **Level: 1%** | | |
| **Alternative** | -11.9 | -5.4 | -12.2 | -10.4 |
| **Corporate bond** | -10.7 | -6.3 | -10.1 | -7.8 |
| **Government** | -13.3 | -10.1 | -13.1 | -8.4 |
| **HY** | -17.2 | -9.0 | -6.2 | -5.0 |
| **Short-term bond** | -12.7 | -8.7 | -4.8 | -3.3 |
| **Mixed** | -11.5 | -4.4 | -1.3 | -0.5 |
| | | **Level: 3%** | | |
| **Alternative** | -8.7 | -3.2 | -11.3 | -4.7 |
| **Corporate bond** | -9.8 | -4.6 | -9.9 | -5.3 |
| **Government** | -11.9 | -6.0 | -11.0 | -5.9 |
| **HY** | -14.1 | -6.4 | -5.8 | -3.1 |
| **Short-term bond** | -12.0 | -7.3 | -4.6 | -3.3 |
| **Mixed** | -7.8 | -2.1 | -0.9 | -0.5 |
| | | **Level: 5%** | | |
| **Alternative** | -6.3 | -2.1 | -8.3 | -1.1 |
| **Corporate bond** | -7.4 | -3.0 | -7.8 | -3.6 |
| **Government** | -9.3 | -4.7 | -8.7 | -4.7 |
| **HY** | -10.5 | -4.1 | -4.6 | -2.4 |
| **Short-term bond** | -9.7 | -5.4 | -4.1 | -3.0 |
| **Mixed** | -5.3 | -1.2 | -0.7 | -0.4 |

Note: Redemption shocks defined as net outflow in % of NAV. Average flow by fund category under the heterogeneity assumption. Weekly flows from January 2008 to December 2021.
Source: Morningstar, IMF staff.

As in the Luxembourg and US FSAPs (IMF, 2017, 2020), the ability of funds to withstand redemption shocks is measured by the Redemption Coverage Ratio (RCR) defined as follows:

$$RCR = \frac{HQLA}{Redemption\ shock}$$

Highly liquid assets for fund $i$ are given by:

$$HQLA^i = \sum_{k=1}^{n} \omega_{i,k} \times s_{i,k}$$

where $\omega_{i,k}$ are liquidity weights assigned to each security $s_{i,k}$ in the fund portfolio as discussed below.
When the RCR is below 1, the fund does not have enough highly liquid assets to cover redemptions with minimal disruption. In that case, the liquidity shortfall is defined as the difference between the redemption shock and the stock of highly liquid assets:

$$Liquidity\ shortfall = Redemption\ shock - HQLA$$

**Table 2. Sweden: Liquidity Weights**

| | AAA-AA | A | BBB | Below BBB |
|---|---|---|---|---|
| **Cash** | | 100% | | |
| **Equities** | | 50% | | |
| **Sovereign bonds** | 100% | 85% | 50% | 0% |
| **Corporate bonds** | 85% | 50% | 50% | 0% |
| **Covered bonds and Securitized** | 80% | 0% | 0% | 0% |

**Liquidation Strategies and Price Impact of Funds Sales**

Given the redemption pressure, fund managers will need to dispose of assets to meet redemptions' requests. Following the redemption shocks, fund managers must sell securities in portfolio to meet investors' redemptions. Different liquidation strategies can be used: vertical slicing (pro rata)—where the manager sells each asset class in proportion of their weight in the fund's portfolio—waterfall (where most liquid assets are sold first). Depending on the liquidation strategy selected, the impact on remaining investors can be sizable.

The pro-rata strategy allows, in line with the investment policy, the manager not to distort the portfolio. This might require selling less liquid assets, which could result in losses due to higher trading costs compared with more liquid assets (Girardi et al., 2017).

Under the waterfall approach, the manager sells the most liquid assets first, which may have a mitigating effect on the price impact of sales. Remaining investors would be then left with an overall less liquid portfolio, creating additional challenges if redemptions were to continue. The order of the liquidation is based on HQLA liquidity weights. When assets with positive liquidity weights have been entirely sold, managers would then resort to liquidating instruments with rating below BBB or without credit rating.

As discussed by ESMA (2020), during the COVID-19 market turmoil, funds have increased their cash positions while decreasing their portfolio share in sovereign, IG and HY and bond holdings. Investment funds in an unfavourable and stressed market situation may retain a higher share of cash to face unforeseen redemption requests or cover for margin calls. Cash is then not considered in the liquidation strategies.

Given a redemption shock and a liquidation strategy, the price impact of the sales is estimated by comparing the volume of assets liquidated is to market depth. Following Count and Schaaning (2017), market depth is equal to:

$$MD(\tau) = c\,\frac{ADV}{\sigma}\sqrt{\tau}$$

where $\tau$ is the time horizon to sell assets, $c$ a scaling factor, $ADV$ the average daily trading volumes and $\sigma$ the asset volatility. The impact is lower when the time horizon is longer. Given the instantaneous nature of the shock, $\tau$ is considered equal to 1 day.

The price impact is calculated at asset class level. Volatility is estimated then for different asset classes by filtering the following market indices through a GARCH (1,1) and taking average values over February and March 2020:

**Table 3. Sweden: Indices for Market Impact Calibration**

| Name | Symbol | Currency | Frequency | Full Name |
|---|---|---|---|---|
| S&P SWEDEN IG CORP BOND INDEX | SPSEICR | Swedish Krona | Daily | S&P Sweden Investment Grade Corporate Bond Index |
| S&P SWEDEN SOV BOND INDEX | SPSFISV | Swedish Krona | Daily | S&P Sweden Sovereign Bond Index |

While market indices would be available for more granular market segments (i.e., maturity, type, and rating) sovereign and corporate bonds are pooled together given the lack of information on daily traded volumes at instrument level.

Total daily traded volumes for asset classes are taken from SELMA and averaged over the period from 1 January and 31 May 2022. Volumes reported in SELMA do not distinguish specifically for debt instruments issued by CRE companies, there it has been assumed that half of the corporate bonds traded are from CRE companies.

Given a liquidation strategy and a redemption shock, we estimate the price impact by comparing the sales by asset classes to market depth:

$$PI(\tau) = \frac{Sales}{MD(\tau)}$$

**Investment Funds Stress Test Results**

Table 7 present the share of investment funds with RCR < 1 for the 12 different redemption shocks calibrated on funds outflows under the assumption described before. For each approach, six shocks are defined using either the ES or the VaR at three distinct levels: 1%, 3%, and 5%.

**Table 4. Sweden: Investment Fund Stress Tests Results: Resilience**

| Investment type | Homogeneous shock | | Heterogeneous shock | |
|---|---|---|---|---|
| | ES | VaR | ES | VaR |
| | | **1%** | | |
| **Alternative** | 21% | 3% | 4% | 5% |
| **Corporate bond** | 7% | 3% | 5% | 5% |
| **Government** | 0% | 0% | 0% | 0% |
| **HY** | 85% | 60% | 59% | 57% |
| **Short-term bond** | 11% | 1% | 11% | 1% |
| **Mixed** | 2% | 0% | 7% | 7% |
| | | **3%** | | |
| **Alternative** | 5% | 0% | 5% | 0% |
| **Corporate bond** | 7% | 1% | 5% | 2% |
| **Government** | 0% | 0% | 0% | 0% |
| **HY** | 85% | 60% | 59% | 57% |
| **Short-term bond** | 1% | 1% | 1% | 1% |
| **Mixed** | 0% | 0% | 7% | 7% |
| | | **5%** | | |
| **Alternative** | 5% | 0% | 2% | 0% |
| **Corporate bond** | 3% | 0% | 2% | 2% |
| **Government** | 0% | 0% | 0% | 0% |
| **HY** | 73% | 40% | 59% | 36% |
| **Short-term bond** | 1% | 0% | 1% | 1% |
| **Mixed** | 0% | 0% | 7% | 7% |

Note: Share of investment funds with RCR < 1.
Source: IMF staff.