INTERNATIONAL MONETARY FUND

IMF Country Report No. 23/276

# ICELAND

## FINANCIAL SECTOR ASSESSMENT PROGRAM

July 2023

## TECHNICAL NOTE ON STRESS TESTING AND SYSTEMIC RISK ANALYSIS

This paper on Iceland 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 June 11, 2023.

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**International Monetary Fund**
**Washington, D.C.**

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July 11, 2023

# TECHNICAL NOTE

## STRESS TESTING AND SYSTEMIC RISK ANALYSIS

Prepared By

**Monetary and Capital Markets Department**

This Technical Note was prepared by IMF staff in the context of the Financial Sector Assessment Program in Iceland, led by Etienne B. Yehoue. 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

| | |
|---|---|
| AC | Amortized Cost |
| AE | Asset Encumbrance |
| ASF | Available Stable Funding |
| BIS | Bank for International Settlements |
| BMA | Bayesian Model Averaging |
| BPS | Basis Points |
| BSCR | Basic Solvency Capital Requirement |
| CAR | Capital Adequacy Ratio |
| CB | Central Bank |
| CBI | Central Bank of Iceland |
| CCB | Capital Conservation Buffer |
| CCyB | Countercyclical Buffer |
| CET1 | Core Equity Tier 1 |
| CFLST | Cash Flow-based Liquidity Stress Test |
| COREP | Common Reporting Framework |
| CRE | Commercial Real Estate |
| CRR | Capital Requirements Regulation (EU) |
| DA | Defined Ambition |
| DSTI | Debt-Service-To-Income |
| EA | Euro Area |
| EBA | European Banking Authority |
| ECB | European Central Bank |
| EDF | Expected Default Frequency |
| EMIR | European Markets and Infrastructure Regulation |
| EU | European Union |
| FINREP | Financial Reporting Framework |
| FSAP | Financial Sector Assessment Program |
| FSB | Financial Stability Board |
| FV | Fair Value |
| FVOCI | Fair Value through Other Comprehensive Income |
| FVTPL | Fair Value through Profit and Loss |
| FX | Foreign Exchange |
| GAAP | Generally Accepted Accounting Principles |
| GDP | Gross Domestic Product |
| GFC | Global Financial Crisis |
| GFM | Global Macro-financial Model |
| GOV | Government |
| HFF | Housing Financing Fund |
| HH | Household |
| HQLA | High-Quality Liquid Assets |
| IF | Investment Funds |
| IFRS | International Financial Reporting Standards |

| | |
|---|---|
| IMF | International Monetary Fund |
| IRB | Internal Ratings-Based (approach) |
| IRRBB | Interest Rate Risk in the Banking Book |
| ISK | Icelandic Krona |
| LC | Local Currency |
| LCR | Liquidity Coverage Ratio |
| LGD | Loss Given Default |
| LTV | Loan-To-Value |
| MFI | Monetary Financial Institutions |
| MMF | Money Market Funds |
| MoFEA | Ministry of Finance and Economic Affairs |
| MREL | Minimum Requirement for Own Funds and Eligible Liabilities |
| NBFI | Non-Bank Financial Institution |
| NFC | Non-Financial Corporate |
| NII | Net Interest Income |
| NIM | Net Interest Margin |
| NPL | Non-Performing Loan |
| NSFR | Net-Stable Funding Ratio |
| OFI | Other Financial Institution |
| O-SII | Other Systemically Important Institution |
| PD | Probability of Default |
| PiT | Point-in-Time |
| RAM | Risk Assessment Matrix |
| RFR | Risk-Free Rate |
| ROW | Rest of the World |
| RSF | Required Stable Funding |
| RWA | Risk-Weighted Assets |
| RWD | Risk Weight Density |
| SMEs | Small- and Medium-Sized Enterprises |
| SRB | Systemic Risk Buffer |
| ST | Stress Test |
| STA | Standardized Approach |
| STeM | Stress Testing Matrix |
| TD | Top-Down (stress test) |
| TN | Technical Note |
| U.S. | United States |
| VA | Volatility Adjustment |
| WEO | World Economic Outlook |

# EXECUTIVE SUMMARY[1]

**The FSAP took place against the background of a strengthened financial sector in Iceland amid heightened uncertainty in the global economy.** The Icelandic financial landscape has undergone significant structural transformation since the global financial crisis with a contracted banking sector. The banking sector has deleveraged swiftly and curtailed cross-border exposure since the GFC with asset reduced from ten times of GDP to 410 percent of GDP from 2007 to 2022Q3, while pension funds have gained systemic importance with assets at 176 percent of GDP[2] as of end-2022 with large holdings of public debt and close ties with the banking system. The financial system has also weathered the global pandemic on the back of strong fundamentals, while leaving uneven sectoral impact across the economy. Nonetheless, the intensified fragmentation of the global economy coupled with continued tightening of financial condition and volatile market sentiment has amplified the downside risks which may prompt knock-on effects on the Icelandic economy and financial sector going forward.

**The banking sector is sound, but FX funding remains a vulnerability.** Banks' capital ratios are generally well above regulatory minima, and profitability remains robust reflecting high interest margin, low provisions, high fees and commissions, and low cost-to-asset ratio (see also a regional comparison in appendix VII). Non-performing loans have been contained to below 2 percent due to the economic recovery, although many tourism loans were placed under forbearance at the expiration of the loan deferral program in September 2020. Banks also have high exposure to commercial real estate sector, at above 20 percent of total corporate loans, which shows signs of increasing risk-taking. Liquidity positions are generally strong with LCR ratio at around 210 percent, however FX funding from abroad still amounts to about 25 percent bank liabilities. Amidst rising FX funding spreads, banks have increasingly shifted to covered bonds issuance to meet upcoming rollover needs of uncovered FX bonds. Going forward, continuing issuing unsecured long-term subordinated debt instruments to fulfill ongoing MREL requirements is vital. A tightening of global financial conditions could cause disruptions to cross-border funding and other funding markets, potentially leading to liquidity strains of the banks, fire-sales of assets and adverse valuation effects.

**The scenario-based bank solvency stress test confirmed the sector's resilience to severe but plausible macro-financial shocks, with GDP impact similar to the GFC.**

- The baseline scenario confirms banks' strong capital positions, with mild capital accumulation. Banks would see their fully loaded CET1 ratios sustaining at a high level while slightly increasing from 20 to 21 percent. The evolution of is driven by strong profitability

[1] This Technical Note has been prepared by Xiaodan Ding (lead), Mariano Eduardo Spector, Lu Zhang, Knarik Ayvazyan, Mahir Binici, Jorge Ivan Canales Kriljenko (all IMF), and Timo Broszeit (IMF external expert) under the guidance of Etienne B. Yehoue (mission chief) and Thierry Tressel (deputy mission chief). The team is grateful to CBI for their excellent collaboration in this exercise.

[2] Pension savings offered by pension funds, e.g., mandatory Pillar II and voluntary Pillar III, excluding pension savings offered by institutions other than pension funds.

which was partially offset by dividend distribution reflective of current bank dividend distribution policy at 50 percent.

- The adverse scenario confirms banks' resilience to severe yet plausible adverse shocks. Although the adverse scenario produced a significant impact on bank capital ratios, no bank saw its capital ratios falling below the hurdle rates[3], owing to the high initial capital positions and adequate pre-provision income. On aggregate, the fully loaded CAR, T1 and CET1 ratios decline respectively by about 4.2, 3.8 and 3.6 percentage points by the 5th year and 5.6, 5.3 and 5.2 percentage points at the trough. Among risk factors considered, credit risk provisioning is by far the largest contributor to the decline in capital ratios with the cumulative effect over 5 years amounting to 5.1 percentage points over five years, followed by risk weighted assets (RWA) and interest rate risk, at 4.1 and 2.1 percentage points, respectively. Non-financial corporates incur higher credit losses than households. The relatively high RWA contribution can be explained by the inflation indexed and FX denominated lending portfolios which expand considerably over the risk horizon, in addition to the large materialization of NPLs under stress which carry higher risk weights.[4] Contribution from market risk is minimal (a reduction of 60 basis points of CET1 capital ratio at trough and almost 0 basis points by the end of the horizon) because banks have small holdings of trading securities[5], and the initial losses are offset by value gains in subsequent years. The aggregated results mask important bank heterogeneity as certain banks underperform the others due to weaker starting points in terms of both initial capital and default rates, and constrained income generating capacity.

**The stress test results were complemented with an analysis of macro-financial feedback loops, which confirms the aggregate resilience of the banking sector in terms of solvency, while pointing to some vulnerabilities.** The analysis assumes that a contraction in bank credit led by a weakening capital position resulting from the initial shocks from the adverse macroeconomic scenario could result in additional output losses, hence leading to a further deterioration of macroeconomic conditions, which in turn translates into an additional decline in bank capital. This leads to an additional 1.7 percentage point CET1 ratio decline on aggregate over a 5-year horizon. In this severely adverse macro-financial scenario with feedback loops, aggregate capitalization remains above the hurdle rate throughout the stress-testing period, but one bank falls below the hurdle rate (with the capital shortfall in CET1 amounting to 0.3 percent of GDP).

[3] Under the adverse scenario, the hurdle rates for the CET1, Tier 1 and total capital ratio are set at minimum CET1, Tier 1 and CAR ratios (4.5, 6 and 8 percent, respectively) plus SRB, O-SII and Pillar II buffer. Banks are allowed to deplete CCyB and CCoB under the adverse scenario. Under the baseline scenario, the hurdle rates include CCyB and CCoB.

[4] In general, NPLs are considered to be higher risk and therefore typically have a higher risk weight under the STA regulatory standard. However, the specific risk weight assigned to NPLs can vary depending on the category of the loan, the level of collateral or guarantees, and other factors.

[5] There are currently no debt securities recorded under the amortized cost category, therefore all securities are marked to market.

**The LCR-based stress test suggests that although the banking system on aggregate is broadly resilient to adverse liquidity conditions, it is not immune to additional liquidity outflows from pension and non-resident FX funding.** On aggregate, the banking sector saw significant decline of its LCR ratio across three main stress scenarios from a starting point of 200 percent as of 2022Q3 to 122 percent in the most severe scenario combining both retail and wholesale shocks, under which one bank saw its LCR ratio marginally below the minimum threshold among the three D-SIBs. Furthermore, when assuming liquidity outflow from pension and foreign funding in addition to the combined shock, one more bank breached the minimum threshold, bringing the aggregated LCR ratio further down to around 76 percent.

**The bank cashflow-based liquidity stress test indicates potential liquidity gaps when extending the analysis beyond 30-days.** On aggregate, banks can withstand liquidity outflows supported by their existing counterbalancing capacities in the short-term. However, their liquidity position becomes much weaker beyond 30 days owing to a maturity mismatch characterized by more backloaded cash inflows and frontloaded cash outflows. In particular, most of the unsecured and covered bonds are becoming due beyond 3 months. Bank specific results reveals notable heterogeneity, as two banks appear to experience liquidity shortfalls even within 30 days under the most severe scenario, due to lower counterbalancing capacity and higher outflows than inflows over the short term. These findings highlight the importance of regular monitoring of bank specific resilience to large liquidity shocks.

**Both the LCR and cashflow-based stress tests focusing on individual currencies reveal similar vulnerabilities to domestic and foreign currency denominated outflows.** The same LCR and cashflow-based exercises were applied to significant currencies of the banks. For the LCR analysis, the exercise follows closely the regulatory thresholds for significant currencies of operation of Icelandic banks while also assuming a homogenous requirement of 100 percent across currencies. For the cashflow analysis, banks are considered failing the stress test if they fully deplete existing counterbalancing capacity. The results for the LCR analysis indicate vulnerabilities for individual currencies, particularly U.S. dollars and Icelandic Krona. The findings can be explained by various factors, such as weaker initial positions, lower liquidity buffers, non-trivial outflows relative to inflows both in the short-term and long-term, as well as high reliance on funding from foreign investors mainly via unsecured bonds. Specifically, under existing regulatory minimum (50 percent for Icelandic Krona, 80 percent for Euro and assuming 100 for US dollars) one bank breaches the threshold in U.S. dollars. All D-SIBs meet minimum threshold in Euro and Icelandic Krona. If a 100 percent were assumed for all three significant currencies, one bank breaches the minimum LCR threshold in Euro and one breaches the threshold in U.S. dollars. None of the D-SIBs would be able to meet minimum thresholds in Icelandic Krona under the most severe scenario. Similarly, the cashflow-based stress test indicates that one bank would experience liquidity shortfall in Euros while two banks experience shortfalls in US dollars and Icelandic Krona separately under the most severe scenario, over both short (less than 3 months) and longer term (beyond 3 months). This confirms the findings of the LCR analysis that banks' liquidity positions are weaker in Icelandic Krona and US dollar, especially over the short-term.

**The systemic liquidity stress test confirms the adequacy of CBI's international reserves to backstop FX liquidity outflows, while pointing to FX liquidity gap of the banking sector.** By imposing combination of FX liquidity shocks from household, NFCs, nonresident funding, pension and investment fund and international bond funding outflows, the analysis identified meaningful FX liquidity shortfalls of the banking sector, which points to the needs to further buildup of FX liquidity buffers of the banks. Should pension funds or other NBFIs decide to move more domestic assets offshore, banks may face additional FX outflows which enlarge their initial shortfall. Nonetheless, such gaps can be fully met either by swap agreements with other European banks or direct central bank FX liquidity support, given the current high level of international reserves at the CBI.

**In the adverse scenario, assets of pension funds would decline considerably in the first years of the projection horizon, ultimately also reducing future pension values materially**. The FSAP conducted top-down and bottom-up risk analysis for pension funds. Given the characteristics of a mostly defined-ambition regime in Pillar II, where pension members bear the investment risk, the impact of the adverse scenario was calculated on future pension values. For the median pension fund, asset values decline by 13 percent in 2023 and another 3 percent in 2024, before recovering in 2025 (+10 percent). Most of the valuation impact stems from lower stock prices, held both directly and through investment funds. Especially in the first year, the depreciation of the Krona counterbalances the decline through an increase in the value of FX-denominated investments. Future pension values would accordingly decline by between 8 and 15 percent for a member with 10 years prior to retirement. Pension funds are furthermore sensitive to changes in the valuation regime for liabilities, including the discount rate and mortality assumptions.

**Liquidity risks are contained under normal circumstances but allowing pension members to withdraw funds from Pillar III in exceptional circumstances can have a significant impact**. The mandatory Pillar II scheme does not allow for any withdrawals, and the sector as a whole is still accumulating funds and growing, with contributions exceeding pension payments. Within Pillar III, cash flows are impacted through transfers of pension rights between funds at the request of members, and mortgage loan repayments which members can request to be deducted from their monthly contributions. Further outflows can occur through extraordinary withdrawals which the Icelandic government has allowed during the Financial Crisis and the Covid-19 pandemic. Net cashflows, though, have remained positive in all quarters for almost every pension fund in the sample.

**Further asset-side vulnerabilities could potentially arise from mortgage lending and concentrated exposures to domestic banks.** As of end-2022, pension funds hold a share of around 22.7 percent in the mortgage lending market. Like banks, pension funds are subject to macroprudential requirements which have been introduced to cap the loan-to-value (LTV) and the debt-service-to-income (DSTI) ratio—for newly issued loans, the mean LTV ratios of the analyzed pension have been fluctuating around 50 percent, and the mean DSTI ratios have increased to slightly above 20 percent. While losses on mortgage loans have been very low in recent years, a small increase in default probabilities could be expected in an environment of rising interest rates. All large pension funds have concentrated exposures towards the three large domestic banks, and

the exposure to the whole domestic banking sector amounts to slightly more than 10 percent. mostly through (covered) bonds, shares and deposits. While the single-name concentrations remain below regulatory limits, the sectoral concentration warrants close monitoring.

**The corporate stress test using firm-level data confirmed heightened vulnerability of the corporate sector under stress conditions.** The exercise complemented the banking stress tests and conducted both a scenario-based stress test and a sensitivity analysis on highly granular firm-level data. It identified notable increases in the debt-at-risk amid further rise in interest rate, as well as a significant pickup in probability of defaults under a stress scenario in line with the banking sector stress test.

**Table 1. Iceland: 2023 FSAP: Key Recommendations**

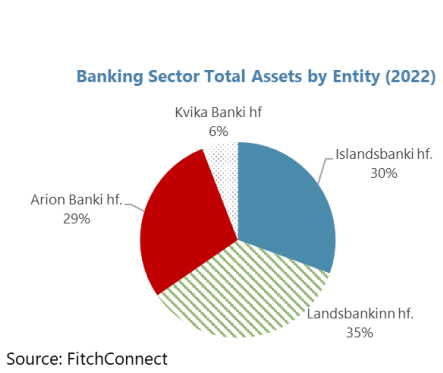
| Recommendations | Authorities | Timeline[1] |
|---|---|---|
| **Systemic Risk Analysis** | | |
| Develop stress testing approaches to monitor funding risks from nonbank financial institutions (including pension funds) and foreign investors. | MoFEA/CBI | MT |
| Differentiate inflation indexed and non-indexed lending and funding instruments in the analysis of inflation impact on banks' credit, interest rate, and market risks. | MoFEA/CBI | MT |
| Continue conducting liquidity stress tests with various runoff and haircut rates, enhance monitoring of LCR by currencies, and address outlier banks through Pillar 2 and supervisory actions. | CBI | NT |
| Perform data quality checks for banks and pension funds' supervisory reporting data, require banks and pension funds to submit corrections, if necessary, and expand automated validation rules. | CBI (FSA) | NT |
| Closely monitor the impact of higher inflation and interest rates on banks' solvency condition and pension funds' investment behavior, counterparty default risk, and (particularly for smaller pension funds) Pillar III cash flows. | CBI (FSA) | NT |
| Analyze pension funds' mortgage lending practices, in particular pricing, loss provisioning and risk management. | CBI | MT |

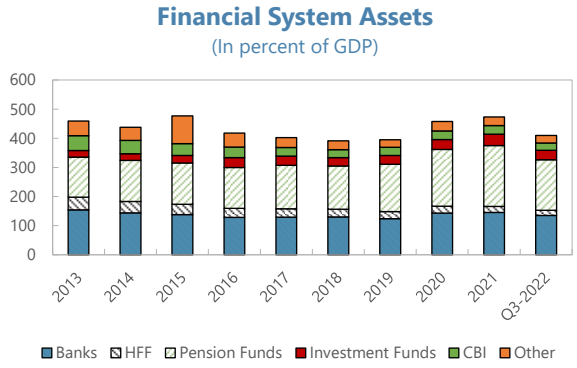
1/ I = Immediate (within one year); NT = Near Term (within 1-3 years); MT = Medium Term (within 3-5 years).

# INTRODUCTION

**1. The Icelandic financial landscape has undergone significant changes since the global financial crisis** (Figure 1). Total financial sector assets reached 410 percent of GDP in September 2022. The banking sector assets have contracted from 10 times of GDP in 2007 to about 135 percent of GDP by 2022Q3. After the GFC, the domestic banking system went through rapid deleveraging and restructuring, with the government rescue resulting in the state becoming a majority shareholder in several banks. As a result, the sector is highly concentrated and dominated by three D-SIBs, all of which are majority or partially owned by the government or pension funds, accounting for 95 percent of the system assets. In the meantime, competition from nonbank financial institutions, particularly from pension funds which account for 42 percent of total financial system assets and hold a notable share of domestic mortgages, could compress banks' market share and profit margin.

**Figure 1. Iceland: The Financial and Banking System**




Source: CBI, FitchConnect and IMF staff.

**2. The Icelandic economy is better prepared to handle the risks in capital mobility than before the global financial crisis.** Fifteen years after the global financial crisis, Iceland has regained a high degree of capital mobility following a period of pervasive capital controls that were gradually lifted over time. Its integration to global financial markets provides it access to a world of investment, funding, and financial risk sharing opportunities but also exposes it to cross border risks. The government, firms, and households are now managing better the corresponding risks through incentives that encourage prudence in risk taking and sound macroeconomic and prudential frameworks that can adapt to changes in the external environment. Macroeconomic policy frameworks have improved significantly and become more consistent with an environment of high degree of capital mobility since the global financial crisis. These frameworks are typically designed to maintain policy space and financial buffers to deal with the materialization of risks when adverse shocks hit the economy and financial system. Solid policy frameworks reduce the uncertainty investors face when shocks materialize, reducing the probability of disruptive capital flows that may emerge if governments and other residents are not perceived to be able to honor their contractual

obligations. Enhanced regulation and supervisory and policy frameworks have improved Iceland's ability to manage the risks associated with capital mobility and cross border exposures. In addition to adopting policies and measures that limit risk appetite and exposures to the risks of high capital mobility, a framework for dealing with disruptive capital flow movements has been developed since the global financial crisis (see Appendix I).

**3. The banking sector overall is sound** (Figure 2). Owing to the significantly strengthened and much more stringent regulatory and supervisory framework post-GFC, Icelandic banks have built up strong capital buffer and weathered well the pandemic shock, with capital ratios at high levels and well above regulatory minima. The CAR, T1 and CET1 ratio comfortably stand at 23, 21 and 20 percent as of 2022Q3. Liquidity ratios also saw an upward trend since mid-2022 with LCR increasing from 151 to 210 percent in 2022Q3, although most of the increase was driven by higher inflows which were used to pay off debt maturing rather than growth in bank liquidity buffers. In fact, the strong lending growth, dividend payments, and share buybacks in the domestic and foreign markets have caused the banking sector liquid assets to shrink in 2022. Profitability remains robust reflecting high interest margin, low provisions, high fees and commissions, and low cost-to-asset ratio. Non-performing loans have been contained to below 2 percent due to the economic recovery, although many tourism loans were placed under forbearance at the expiration of the loan deferral program in September 2020. In the meantime, bank credit increased since the pandemic reflecting household mortgage demand, with credit-to-GDP standing at 157 percent, corresponding to a negative 16 percent credit-to-GDP gap as of end-2022.

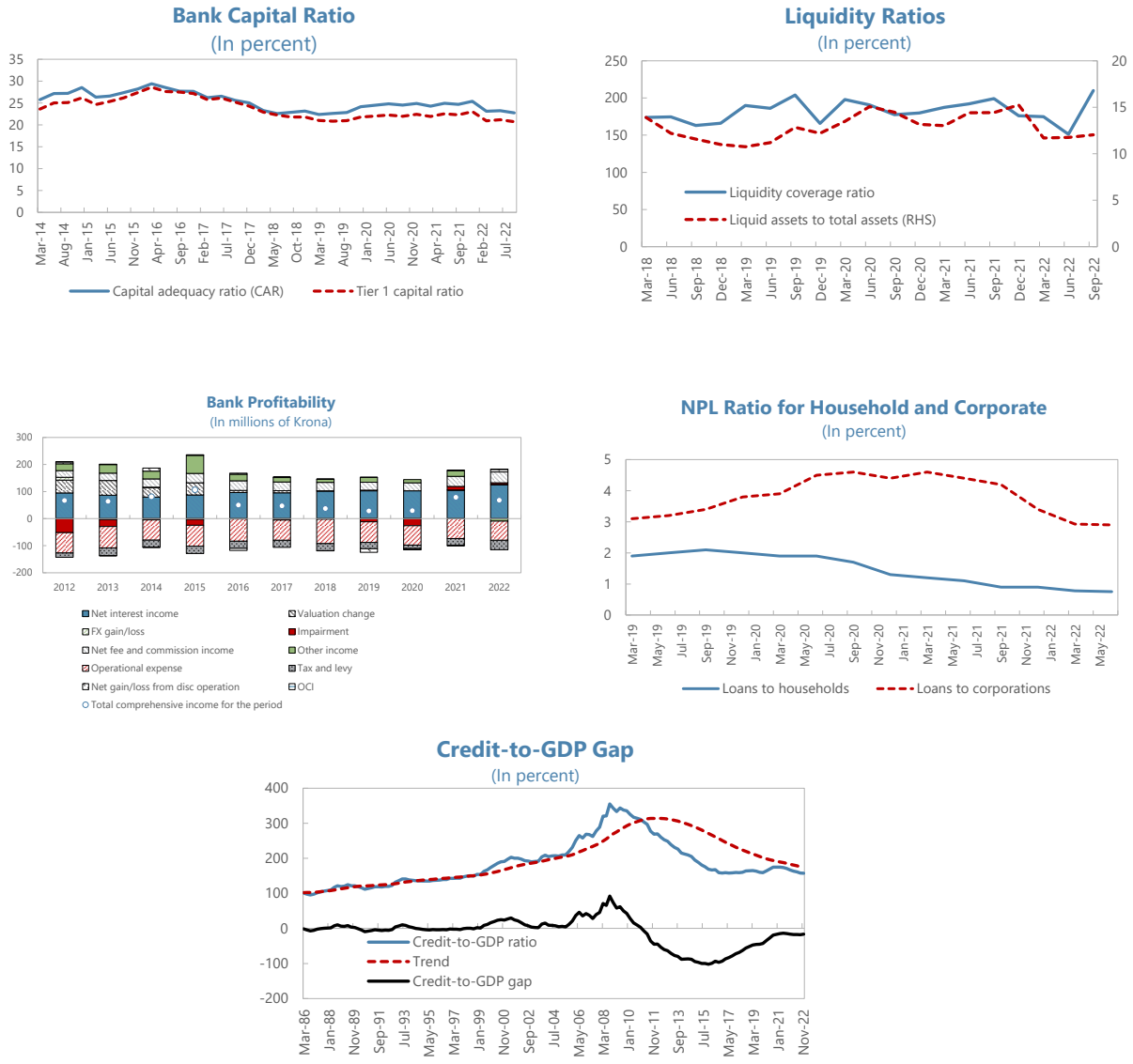
**4. Nonetheless, there are some intrinsic risks associated with bank business models** (Figure 3). The mission identified below some cyclical and structural vulnerabilities which may expose Icelandic banks to both short-term and long-term risks:

- *Reliance on pension and foreign funding*. Although the banking sector has significantly reduced its foreign exposure since the GFC[6], there remains a notable share of foreign funding extended to banks mainly via unsecured debt securities and some nonresident deposits, which accounts for about 25 percent of total funding. In a downside scenario, banks could find it difficult to meet the upcoming FX bond maturities[7] without refinancing at a higher spread given a low risk appetite of foreign clients, further tightening of global financial conditions and increased bank lending to the domestic sector. Consequently, banks have increasingly shifted to covered bonds

[6] Since the global financial crisis, the banking sector has significantly cut back its foreign exposure both from lending and funding channels. As a result, domestic household mortgages and corporate loans account for 75 percent of total assets, whereas residential customer deposits account for 73 percent of the total fundings of the banks.

[7] It is expected that 16 percent (or 130 billion Krona) of FX bond will mature in 2023, and 23 percent (or 185 billion Krona) will mature in 2024. As of March 2023, Banks have been able to issue new covered bond to meet maturity of old bond in 2023. However, banks' existing subordinated debt will need to be refinanced to meet MREL requirement in the next year.

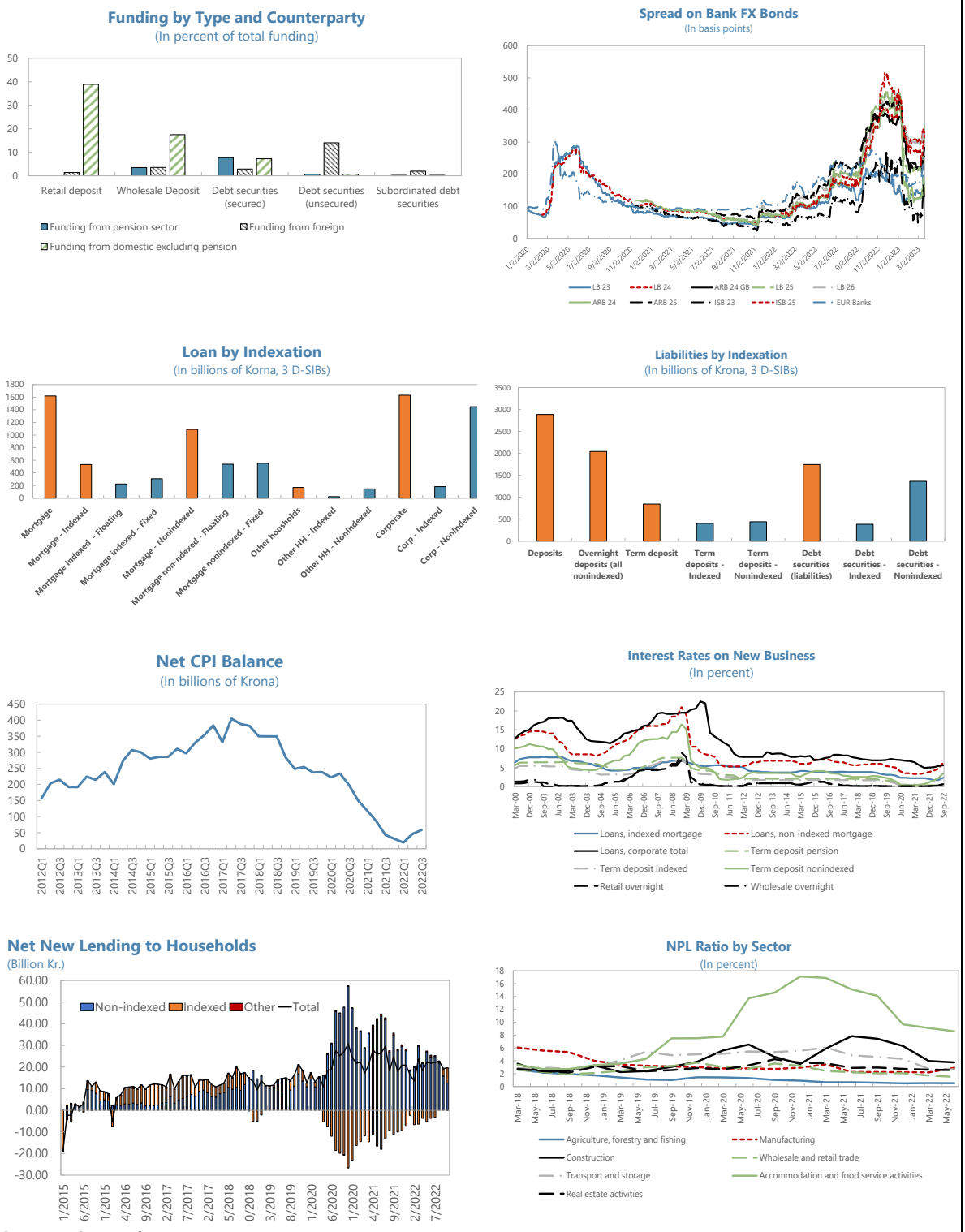
## Figure 2. Iceland: Selected Banking Indicators




Sources: IMF Financial Soundness Indicator and CBI.

Note: The credit-to-gdp gap follows standard BIS definition.

## Figure 3. Iceland: Bank Business Models




Source: CBI and IMF.

issuance to meet upcoming rollover needs of uncovered FX bonds.[8] In the meantime, they could be exposed to volatile non-resident deposits, evidenced by historical stress episodes. Moreover, pension funds provide material funding to banks, mostly through direct deposits or purchase of covered bonds, at 12 percent of total bank funding and are mostly in domestic currency. They are also major shareholders of two of the three D-SIBs. Should their investment behavior change, for instance by re-directing investment from the domestic market to foreign markets if their foreign currency exposure limits permit, banks may face funding pressure.[9] On the other hand, the large foreign assets of pension funds could also help stabilize the banking system if pension funds repatriate funds from overseas during episodes of financial stress. Finally, pension funds' indexed mortgage lending, which continues to compete with banks' lending, could constrain banks' net interest margin.

- *Inflation indexation of assets and liabilities*. Icelandic banks issue indexed loans on the asset side and indexed deposits or debt securities on the liability side. As of 2022Q3, roughly 22 percent of total loans are indexed, and 17 percent of total liabilities (deposit and bond issued) are indexed. Therefore, banks in general keep a positive net inflation indexed position which can lead to value gains during high inflation episodes, as assets would expand more than liabilities. Although borrowers have the option of switching between indexed and non-indexed mortgages during the term of the loan, both products may expose banks to various channels of credit risks, as interest rates of non-indexed loans are known to spike during periods of high inflation, whereas indexed loans, which charges real interest rates but add inflationary effect onto the principal of the loans, could erodes the debtors' equity and leads to negative amortization during times of high inflation. Since the start of the pandemic, many borrowers have chosen non-indexed mortgages to benefit from ultra-low interest environment. However recent evidence suggests a migration from non-indexed to indexed mortgages due to persistently high inflation and further tightening of financial conditions which lead to higher debt burden on non-indexed mortgages.

- *Exposure to tourism and CRE sector.* The financial conditions of the corporate sector have seen sectoral divergence since the onset of the pandemic with tourism and CRE sector, which are considered covid-sensitive, underperforming the rest of the sectors, evidenced by the sharp increases in their NPL ratios since 2020, to a peak of 17 percent and 8 percent respectively, relative to a peak of total corporate NPL ratio to 4.6 percent. Banks also have concentrated

[8] There are also certain risks associated with covered bond, especially when the market faces sharp asset price correction and hence decline in value of the cover pool underlying the bond. If the price of the assets in the pool declines significantly, the value of the collateral backing the bond will also decline, which could lead to a downgrade in the credit rating of the bond, a reduction in its market value and rising risk premium. In some cases, if the decline in the value of the assets in the pool is severe enough, the issuer of the bond may be required to provide additional collateral to maintain the required level of collateralization.

[9] As of March 2023, the limited on foreign investment ratio of the pension funds has been lifted from 50 percent to 65 percent, with incremental implementation till 2036.

exposure to the CRE sector which accounts for over 20 percent of total corporate loans. Other sectors experienced milder cycles due to government intervention and payment moratoria granted by the banks. Although tourism activities have rebounded in recent months, a full recovery will likely take longer and be impeded by the intensified global fragmentation and regional conflicts going forward.

- *Risks associated with collateral quality.* The coverage ratio of the banks is at around 50 percent as of 2022Q3 which has decreased since 2018 supported by asset price increase and tightened lending standards. The recovery rate for household loans is considered high and has likely increased amid rising housing prices. The LTV cap was also further tightened from 85 percent for all borrowers and 90 percent for first time buyers in 2017, respectively to 80 percent for all borrowers and 85 percent for first time buyers in June 2022. Collateral quality for corporate loans however is more difficult to assess but is in general considered riskier than the household segment. Going forward, potential over-valuation of the real estate price above fundamentals could lead to reversal in asset prices and subsequently collateral re-valuation, and the associated adjustment in loan loss provision.

**5. The banking sector's both direct and indirect exposures to Russia appear to be limited.** According to data compiled by the CBI, there are no assets identified as Ukrainian and negligible assets identified as Russian, and the banks own no securities in these countries either. Indirect exposures are also considered minimal, as trade with Russia and Ukraine has been quite limited for the last few years. For instance, imports of goods from Russia amounted to 0.6 percent of total imports from 2018 to 2020 and export of goods amounted to only 1.1 percent over the same period. Also, Iceland does not rely on energy from Russia since renewable energy provided almost 100 percent of its production, with 75 percent coming from hydropower and 24 percent from geothermal power. Nonetheless, the direct and indirect effects on services trade could outweigh the effects on goods trade. If the war persists and disrupts airlines and other transportation, the tourism sector could be negatively affected, and higher fuel and commodity prices could further erode purchasing power of tourists.

**6. Similarly, Icelandic banks have low direct exposure to Credit Suisse and to a revaluation of securities classified under amortized cost as the one that led to the failure of SVB**. Icelandic banks currently do not hold any debt securities classified under the amortized cost category and those that are marked-to-market are also quite limited relative to total assets only at 8 percent, and with short durations at around 3.4 years. In the meantime, Icelandic banks' direct asset exposures to Credit Suisse and UBS amount to only about 0.5 billion Krona, equivalent to 0.01 percent of total assets, as of Feb 2023, which includes both on- and off-balance sheet exposure. Hence, the overall risk of direct spillover is considered low at present.

**7. Icelandic banks are interconnected with foreign banks**. Counterparties for Icelandic banking sector largest cross-border exposures include U.S., Belgium, and Canada. Around two-thirds of the exposures come from the European countries such as Belgium, Norway, and Denmark. There are also significant exposures outside Europe, particularly with the U.S. and Canada, accounting for 30 percent of total exposures.

**8. The pension fund sector in Iceland is large and plays a vital role in the domestic financial sector as investor and lender.** Total assets of the sector—which provides mandatory Pillar II pensions and personal pension savings in Pillar III—amount to 176 percent of GDP[10] at end-2022, making it one of the worldwide largest. Exposures to Icelandic banks account for 10 percent of total pension fund assets and 14 percent of banks' financial liabilities, and holdings of sovereign bonds account for 21 percent of assets.[11] Pension funds are active in the mortgage market with an outstanding volume amounting to 23 percent of the outstanding mortgage volume. The share of foreign-denominated assets has reached 35 percent of assets as of end-2022.

**9. Non-financial corporate sector debt has declined significantly but remains high at around 95 percent of GDP[12] by the end-2022** (Figure 4). The share of external debt in total declined from about 50 percent in 2008 to 17 percent by the end-2022, due, in part, to tighter prudential regulations. The Icelandic NFCs remain highly dependent on loan financing. The large share of non-indexed corporate loans, further increase or prolonged period of high interest rate environment could put pressure on the debt servicing capacity of the NFCs, thus increasing credit risks for banks.

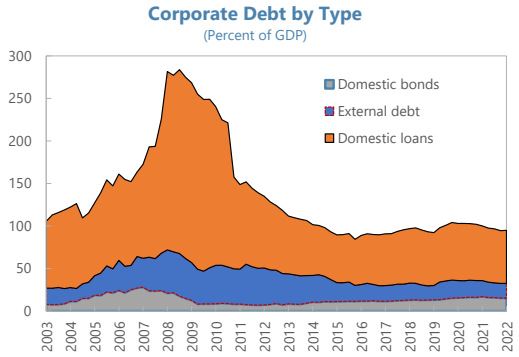
**10. The pandemic caused a significant drop in enterprises' sales and increased corporate debt distress, but timely support measures played an important mitigation role.** Profitability has declined both for publicly listed firms and privately held firms, while leverage has remained contained. A large proportion of (mostly medium-sized) firms had low interest coverage ratios (ICR) in 2020. Firm-at-risk and debt-at-risk—for which ICR is lower than 1.5— increased by 2.4 and 3.1 percentage points, respectively, in 2020, compared to the prior year (Figure 4). Aggregate non-performing loans on D-SIBs lending to NFCs increased marginally during the pandemic.

[10] Other pension saving providers manage a further 7.9 percent of total pension savings not included in this figure.

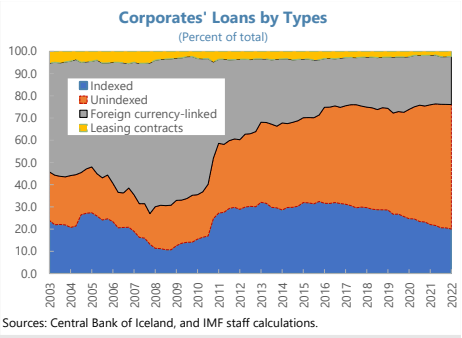
[11] The sovereign bonds also include bonds issued by municipalities.

[12] This includes credit from captive financial institutions.

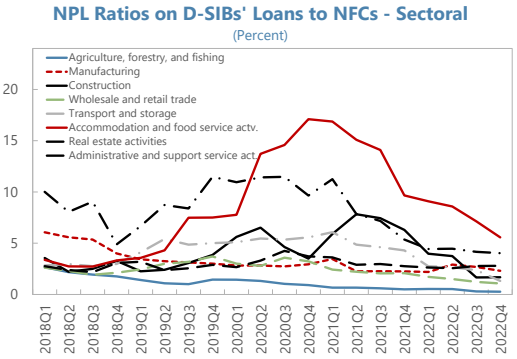
## Figure 4. Iceland: Corporate Sector Development



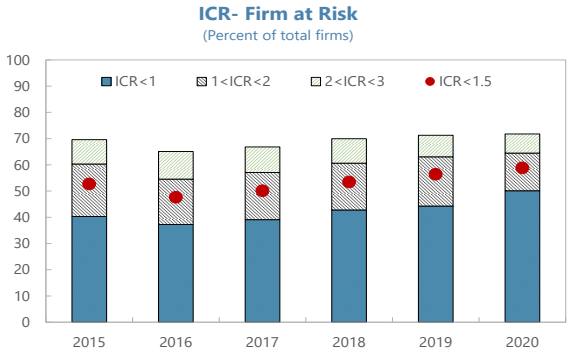

Sources: Central Bank of Iceland, and IMF staff.



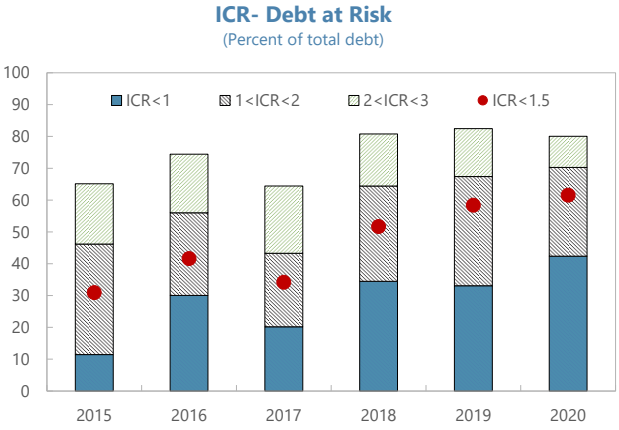

Sources: Central Bank of Iceland, and IMF staff calculations.




Source: Central Bank of Iceland




Sources: ORBIS, and IMF staff calculations.

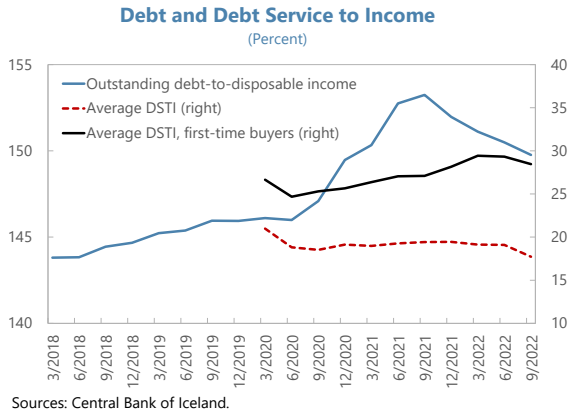



Sources: ORBIS, and IMF staff calculations.

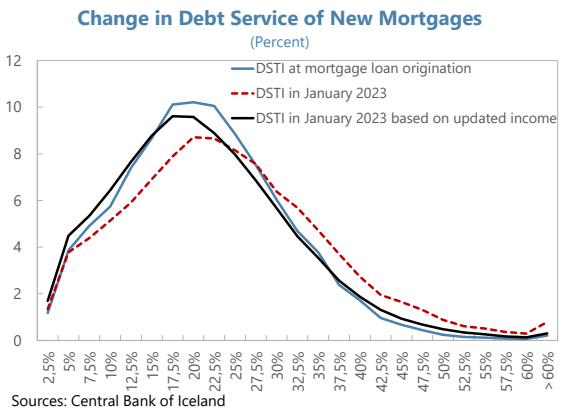
Note: Firm-at-risk and debt-at-risk presents the share of the firms and the share of the debt at different ICR threshold including when ICR is lower than 1.5.

**11. Household debt increased marginally during the pandemic but has been on a downward trajectory since the GFC** (Figure 5). Interest rate hikes weigh on household debt service, but higher income is a mitigant. CBI simulations suggest that, comparing the DSTI at origination versus in January 2023, the share of borrowers with DSTI above 35 percent increases from about 7 to 15 percent. Based on updated income as of January 2023, however, the share increases from about 7 to 9 percent only. Real wage increases, about 7 percent higher than in 2019, have boosted households' debt service capacity.

**Figure 5. Iceland: Risks to Household Debt Service**




Sources: Central Bank of Iceland.

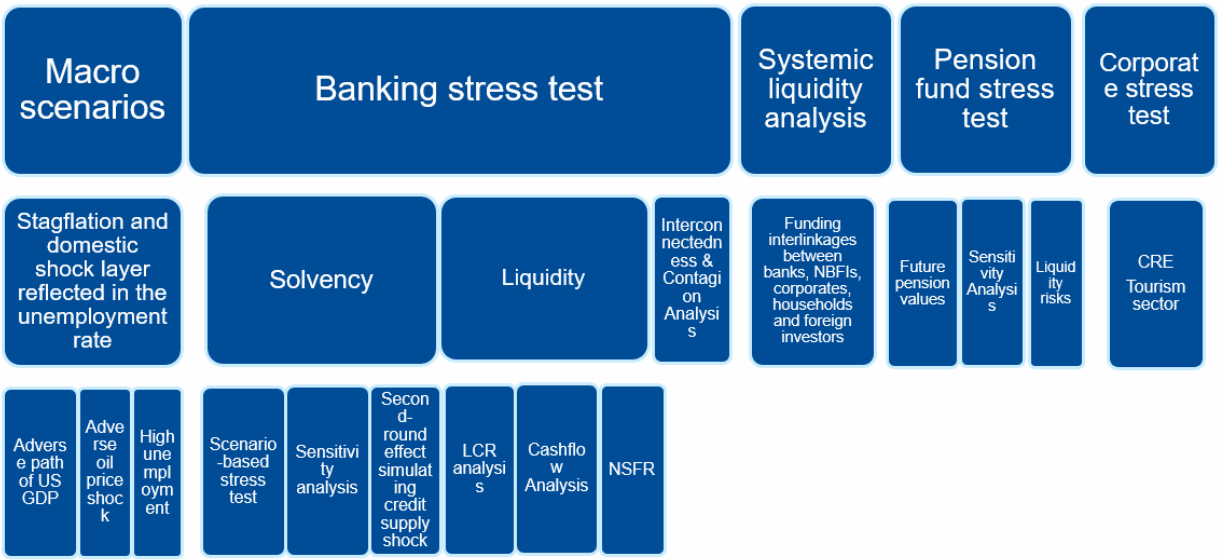



Sources: Central Bank of Iceland

**12. Against this backdrop, the FSAP conducted a comprehensive set of stress tests and risk analyses to assess the resilience and vulnerabilities of the banking, corporate, pension fund and other NBFI sectors in Iceland (Figure 6).** Using confidential supervisory data, the banking analysis implemented a scenario-based stress test to assess the resilience of three D-SIBs, which covers 95 percent of the banking sector assets, to adverse macroeconomic shocks on the highest consolidation level, complemented by a macro-financial feedback layer and a series of sensitivity tests encompassing corporate concentration analysis, sector specific shocks and a further tightening of financial conditions. The banking risk analysis also covered liquidity stress tests and contagion analysis, assessing domestic and cross-border interbank exposures, as well as domestic and cross-border cross-sectoral interlinkages between banks and non-bank financial institutions. The scope of the analysis was further extended by carrying out a systemic liquidity analysis to assess the

adequacy and FX liquidity buffers of the entire financial sector, taking into account simultaneous liquidity shocks affecting different sectors of the economy and their interconnections. Additionally, a separate stress test on the corporate sector leveraging highly granular firm-level balance sheet data complements the banking stress test by assessing corporate resilience and simulating corporate PDs under stress. Finally, the FSAP conducted top-down and bottom-up risk analysis for pension funds. Given the characteristics of a mostly defined-ambition regime in Pillar II, where pension members bear the investment risk, the impact of the adverse scenario was calculated on future pension values. Additional sensitivity tests, an assessment of liquidity risk, and work on pension funds' investment behavior and mortgage lending complemented the risk analysis.

**Figure 6. Iceland: Stress Testing Framework**




Source: IMF staff.

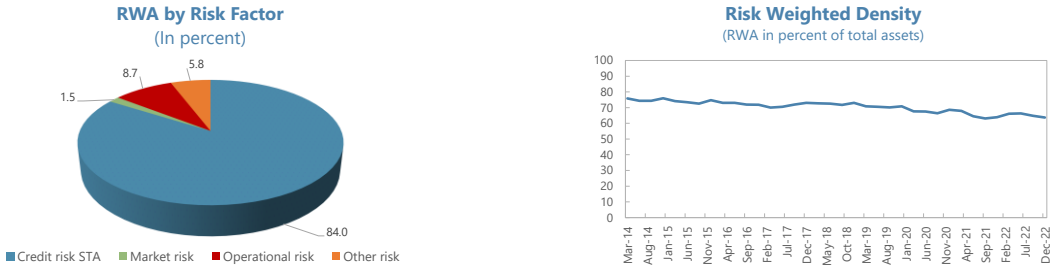
# TOP-DOWN SOLVENCY STRESS TEST OF BANKS

## A. Banking Sector Vulnerabilities by Risk Categories

### Credit Risk

**13. Credit risk constitutes the largest risk factor for the banking system** (Figure 7). As of 2022Q3, RWAs of credit risk account for 84 percent of total RWAs in the sample banks, in line with the banking sector's asset composition. RWA density has been steadily decreasing over the period and is now just below 64 percent. Since the banks use the standardized approach, there is not much room for lowering the density further than that with the current business models of the banks.

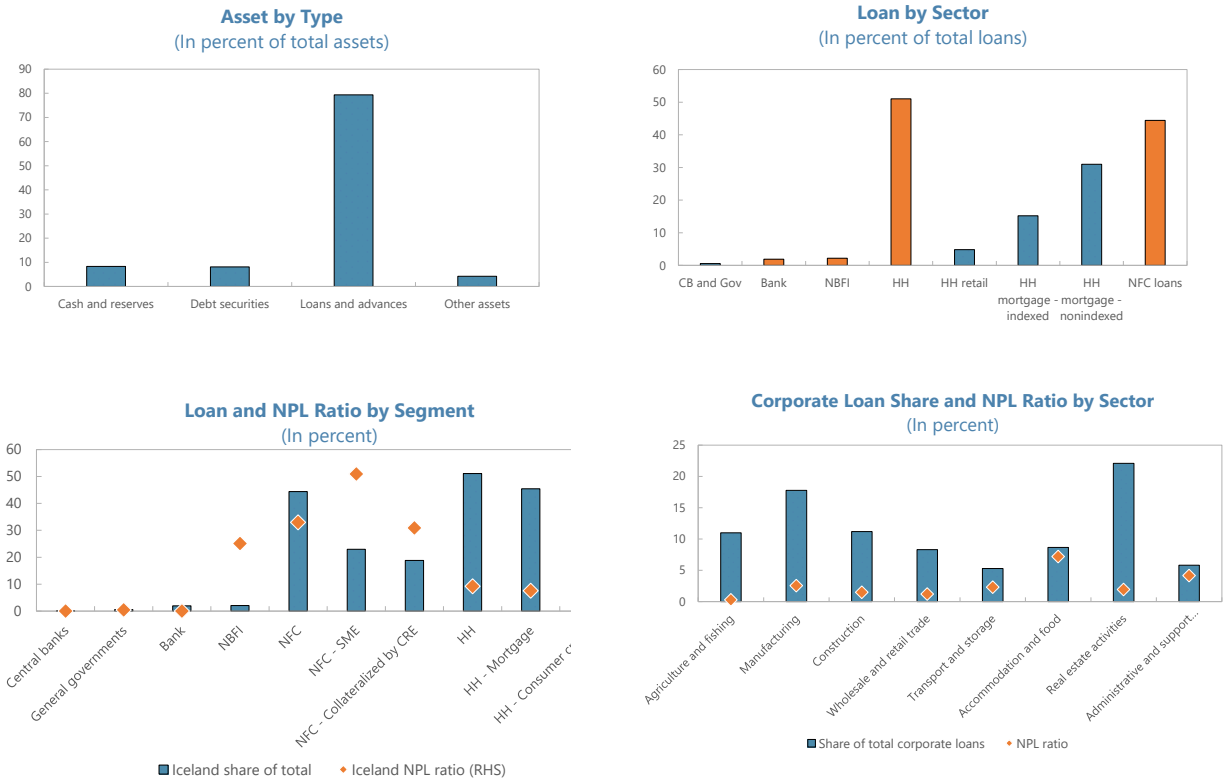
**Figure 7. Iceland: Risk Weighted Assets and Density**

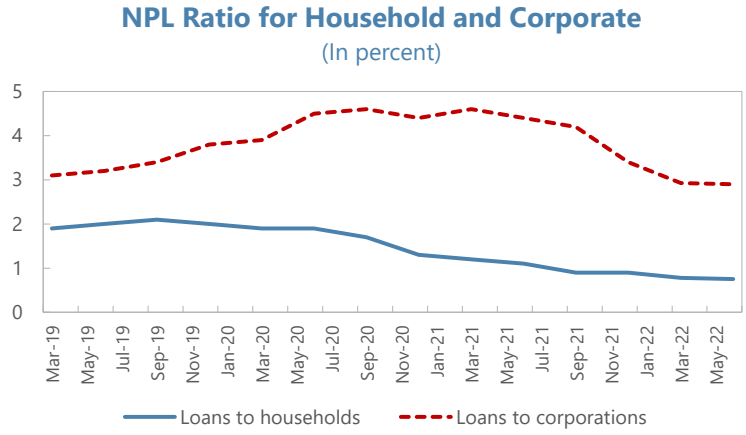



Source: CBI and IMF staff.

**14. Banks' asset composition reflects their business models and market orientation (Figure 8).** As of 2022Q3, the largest portion of assets are loans, representing 80 percent, followed by central banks reserves and non-interest earning assets at 8.3 percent. By sector, loans are mostly concentrated in households and corporates, at 51 and 44 percent respectively, followed by nonbank financial institutions, banks, central banks, and governments which are all small in size. Foreign loans are considered immaterial, at around 1 percent of total loans. Asset quality also varies between households and corporates, and various sectors within corporates, as NPLs for corporates are higher at 2.5 percent than household at 0.7 percent. Within the corporate sector, accommodation, and food services, which broadly represent the tourism sector and experience severe shock during the pandemic, bears the highest NPL ratio at 7.2 percent.

## Figure 8. Iceland: Bank Asset Composition and Credit Quality

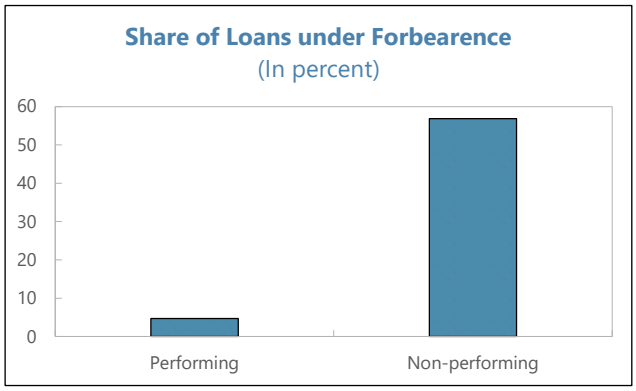



Source: CBI and IMF staff.

Note: HH = Household.

**15. A significant portion of the NPLs has undergone forbearance process.** Although moratoria have expired in Iceland, various types of forbearance measures have been offered to distressed borrowers, mostly at the discretion of banks, to prevent further rise in NPLs and to reduce existing stock of NPLs. As of 2022Q3, 57 percent of the total non-performing loans have been re-negotiated and restructured with borrowers (38 percent for household NPLs and 62 percent for corporate NPLs). These measures, if used properly, can provide sufficient buffers to viable firms and households facing transitory liquidity difficulties, and in the meantime relieve stress on banks by bringing down the probability of default and the resulting level of loan loss provision. However, banks should make reasonable efforts to identify and distinguish viable borrowers from those that are non-viable.

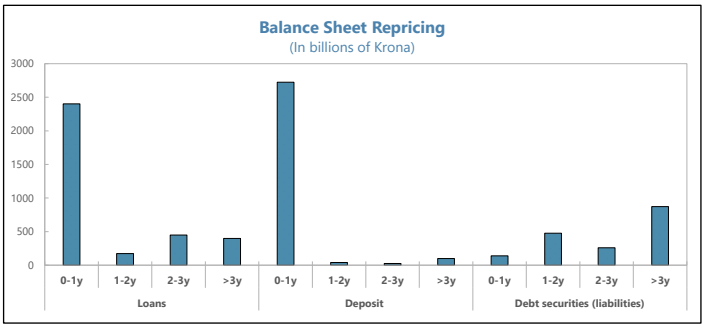



## Interest Rate Risk

**16. Indexed loans in general charge lower interest rates than non-indexed loans.** Lending rates charged by the banks are in general higher than funding rates driven by banks' margin incentives. As of 2022Q3, Icelandic banks net interest margin stands at around 3 percent, higher than Nordic average. Interest rates for indexed mortgages are at 2.3 as of 2022Q3, lower than non-indexed mortgages at 6.3. Similarly, deposits that are indexed typically carry lower interest rates, at around 0.1 percent as of 2022Q3, relative to 3.5 percent for non-indexed deposits. This is because indexed instruments charge real interest rates which are usually lower than nominal interest rates in periods of high inflation, so that the borrowers can benefit from a lower interest payment over the short term. However, since the inflationary effect is added onto the principle of the loans each month, it is possible that there can be negative amortization where the principal of the loans expands even if borrowers meet regular payments. Finally, the higher share of indexed assets than indexed liabilities, market competition for loans from pension funds and rising funding cost of the banks due to tightened global financial conditions, could potentially lead to lower net interest income under an interest rate shock, as the increase in lending revenue could be smaller and slower than that of the funding cost of the banks.

**17. Icelandic banks keep a broadly balanced repricing structure of assets and liabilities.** Household floating rate loans account for about 52 percent of total household loans, and most of the corporate loans are floating rate. The remaining, though classified as fixed rate loans, are generally not fixed for longer than 3 to 5 years. This results in a repricing gap between interest-bearing assets and liabilities that is relatively small as most loans are repriced typically within a year, as shown in IRRBB template provided by the CBI as of 2022Q3.

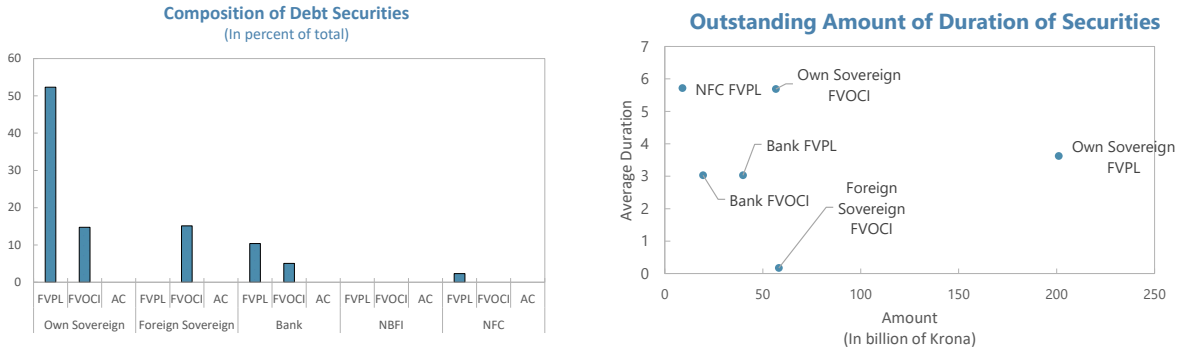
Specifically, roughly 70 percent of loans are subject to repricing within less than a year, compared to 94 percent of deposits. Debt securities issued by banks generally have longer repricing profile. This repricing structure limits the pressure on interest rate margins stemming from interest rate shocks by allowing the banks to pass interest rate shocks to existing and new borrowers, which on the other hand, may amplify credit risks.




## Market Risk

**18. Holdings of debt securities are small and have short duration.** At 384 billion Krona, or 8 percent of total banking assets, banks' holdings of debt securities are not significant at present and have a short duration at around 3.4 years on average (Figure 9). Sovereign securities account for 6.6 percent of total assets and are composed of mostly domestic sovereign securities, at 5.4 percent of total assets. Thus, market losses associated with re-valuation of tradable securities does not constitute a major source of risk for the Icelandic banks.

**Figure 9. Iceland: Debt Securities Decomposition and Residual Duration**




Source: CBI and IMF staff.

**19. The valuation changes driven by banks' exposure towards CPI-linked products in a context of rising inflation dominate other market risks.** Other market risks mainly include FX and inflation risks associated with existing net open positions as well as risks associated with equity positions of the banks. Icelandic banks in general keep a positive inflation indexation balance which can lead to profit during period of inflation as the inflation expansion of assets is greater than that of liabilities. On the other hand, FX and equity risks are limited given banks' almost closed FX net open position and immaterial equity exposure.

## B. Solvency Stress Tests of the Banking Sector

**20. The stress test covered 3 banking institutions, constituting around 95 percent of total banking system assets.**[13] The stress test used supervisory data as of 2022Q3 at the highest consolidation level within Iceland. Banking statistics, including regulatory report such as COREP and FINREP and other risk indicators such as system level and bank specific probability of default and transition matrix were provided by the CBI on a confidential basis. The exercise adopted scenario-based approach to stress test the banking sector, which was complemented by a series of sensitivity analysis aiming to assess the impact of further rise in interest rates, additional credit shocks to specific economic sectors, as well as concentration risks of the banks via default of top corporate credit exposures.[14]

### Macroeconomic Scenarios and Growth at Risk

**21. The scenario-based bank stress test assessed banks resilience towards a joint materialization of several key macro-financial risks.** Specifically, the stress test constructed an adverse scenario which features:

- Intensification of regional conflict(s). Escalation of Russia's war in Ukraine or other regional conflicts and resulting economic sanctions disrupt trade (e.g., energy, food, tourism, and/or critical supply chain components), which push up inflation.
- Abrupt global slowdown or recession. Global and idiosyncratic risk factors combine to cause a synchronized sharp growth slowdown, with outright recessions in some countries.
- Monetary policy miscalibration de-anchoring inflation expectations, which leads to increases in risk premia, long-term bond yields and corporate spreads to historic heights.
- A sudden correction in the domestic real estate market.
- Systemic financial instability. The sharp swings in real interest rates, risk premia, assets repricing and policy shifts prompt insolvencies in countries with weak banks or non-bank financial institutions, causing markets dislocation.

These compounded effects trigger a recession which spills over to the Icelandic economy via a sharp fall in real income and domestic demand, rising unemployment rate, and sharp correction in asset prices (see also the Risk Assessment Matrix in Appendix II). The multivariate consistent downside scenario is derived from a VARX framework, within which the adverse path of US GDP and the oil price from the GFM model are used as exogenous shocks complemented by a domestic shock layer reflected in the unemployment rate. The severity of the adverse scenario is closely aligned with 5

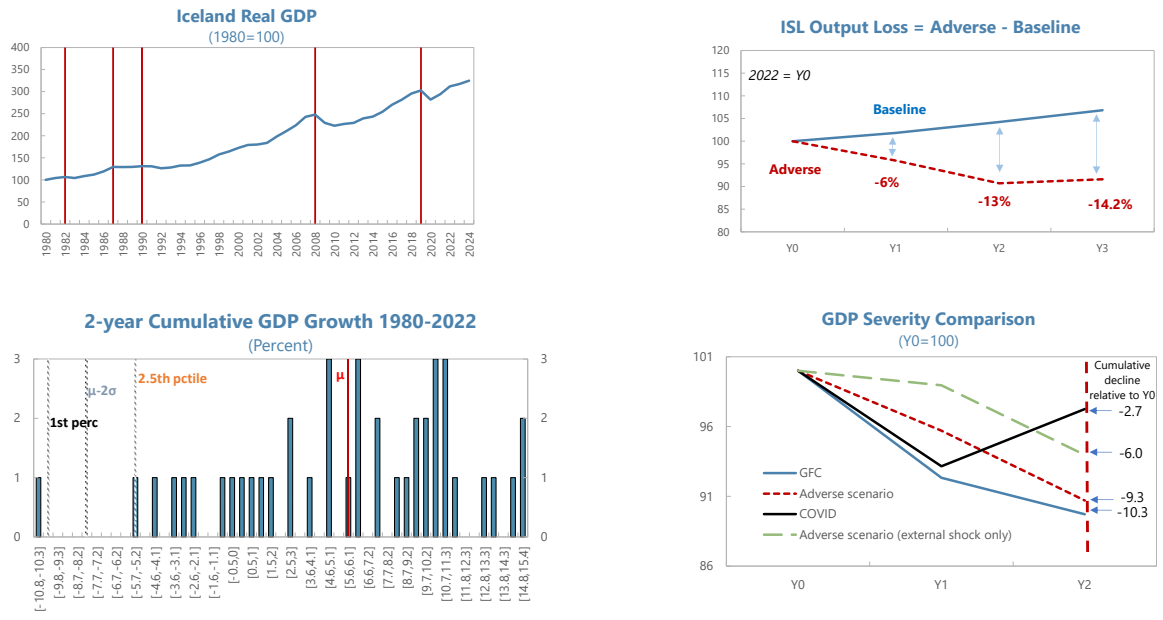
[13] The three D-SIBs are Arion bank, Islandsbanki and Landsbankinn, covering 28, 31 and 36 percent of total banking sector assets, respectively.

[14] The results assume no supportive policy actions taken to counteract negative impact on the banks.

percent Growth-at-Risk estimate[15], implying a 13 percent (or 2.2 standard deviation) shock to real GDP growth relative to the baseline, and a 9.3 percent decline relative to the starting point over a two-year horizon. Out of the total output loss, about 65 percent is accounted for by external drivers.

**22. The severity of the real GDP shock over two years resembles the GFC, which is much more severe than the Covid-shock, reflecting asset market corrections and a different policy trade-off (Figure 10 and 11).** Under the adverse scenario, the output shock is almost as severe as the GFC over a two-year horizon and the unemployment rate is broadly in line with past crises, accompanied by a decline in real estate prices and higher depreciation of the Krona. The short-term interest rate in the adverse scenario continues to tighten till 2024 driven by higher inflation and rising spread and declines thereafter in response to output contraction and lower inflation. Most variables converge to their pre-shock path by the end of the forecast horizon.

**Figure 10. Iceland: Output Contractions and Scenario Design**




Source: IMF staff.
Note: μ and σ denote historical mean and standard deviation of the 2-year cumulative GDP growth, respectively.

[15] See appendix III for further details.

## Figure 11. Iceland: Adverse Scenario

(In percent)


Source: IMF staff.

## Scenario-Based Solvency Stress Test

### *Methodology*

**23. The scenario-based solvency stress test followed a balance sheet approach and was based on IFRS9 accounting framework.** IFRS9 framework introduced in 2018 required banks to move away from incurred loss calculations (under the IAS39) to a forward-looking expected loss calculation. As a result, FSAP stress test methodology was revised to model the concept of asset stage classifications, the use of transition matrices, and the calculation of the life-time expected loss compliant with the new accounting standards.

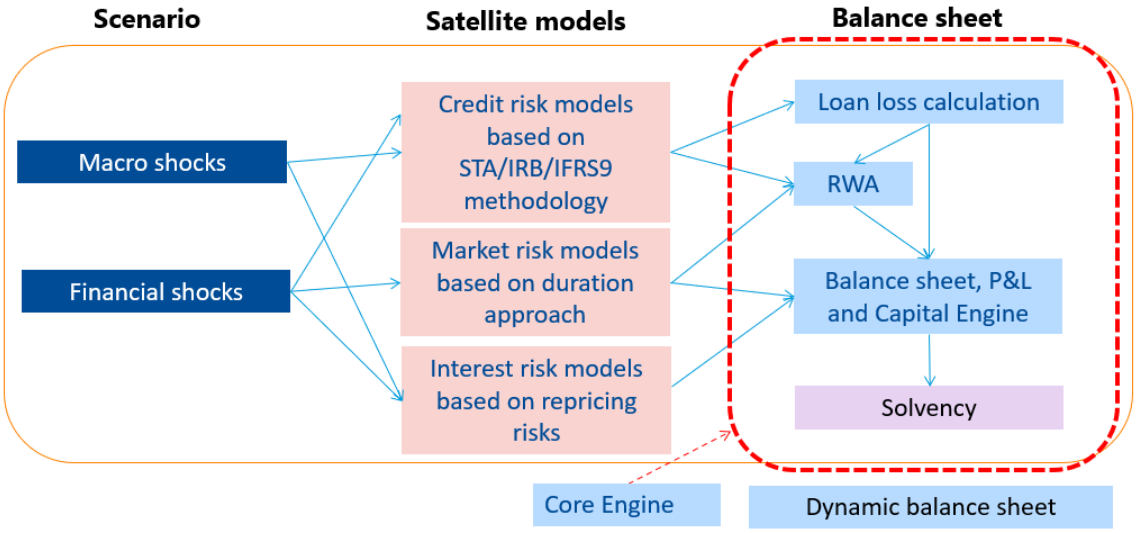
**24. The stress test used regulatory capital requirement calculations.** The performance of the three sampled banks was assessed based on total capital adequacy ratio (CAR), Tier 1 capital (T1), Common Equity Tier 1 (CET1) capital and leverage ratios. Under both scenarios, capital requirements include, in addition to minimum capital ratios, bank specific Systemic Risk Buffer (SRB), O-SII buffer, and Pillar-II requirements where applicable. Banks are allowed to deplete their capital conservation buffers (CCBs) and countercyclical capital buffer under the adverse scenario.[16,17]

**25. The stress test adopted a solvency framework that covers a comprehensive set of risks** (Figure 12). It included credit risk associated with all exposures, market risks, sovereign risk, and interest rate risk in the banking book. By contrast, the derivatives book was not considered, due to lack of access to granular enough information to stress the derivatives portfolio in a meaningful way. Macro scenarios were translated into the evolution of PDs, LGDs and interest rates using a set of satellite models, and in the meantime indirectly affect the growth of balance sheet items, pre-provision net income and other base components. Shocked risk parameters drove Risk-Weighted Assets (RWAs) and provisions (via IFRS9 transition matrices), asset repricing and market valuation losses. The final step combines all P&L items and full balance sheet under evolution to obtain CET1, Tier 1 and total capital and leverage ratios over the stress testing horizon. Figure 10 summarizes key elements of the solvency framework.

[16] As of 2022Q3, the average SRB, O-SII buffer and Pillar II requirements across three sample banks are 2.8, 2 and 3.2 percent, respectively.

[17] In March 2023, CBI announced an increase of the CCyB from 2 percent to 2.5 percent, which is expected to further strengthen the capital position and thus the resilience of the banking system amid intensified global uncertainties and increased downside risks to financial stability.

**Figure 12. Iceland: Structure of Solvency Stress Testing Framework**




Source: IMF.

**26. A quasi-static approach was used for the growth of banks' balance sheet over the stress-test horizon.** Under this approach, balance sheet growth is assumed to follow the Iceland's nominal GDP growth given the limited cross-border lending exposure of banks. However, to prevent banks from deleveraging, a floor on the rate of change of balance sheets was set at zero percent. This constraint is binding in the adverse scenario. In addition, the balance sheet growths can be driven by inflation and foreign exchange movements under both the baseline and adverse scenarios, based on bank exposure to inflation-indexed and FX-denominated assets and liabilities, as well as conversion of a portion of off-balance sheet items (i.e., credit lines and guarantees) to on-balance sheet exposures. Specifically, inflation indexed exposure is assumed to grow in accordance with inflation dynamics, albeit at slower pace to take into account the amortization which can partially offset a full expansion of the loan principal.[18] As a result, balance sheet expansion due to inflation and currency depreciation could in parallel lead to higher RWAs, and subsequently lower capital ratio of the banks.

**27. The evolution of default under stress in Iceland was estimated separately for household and corporate portfolios, using the Bayesian Model Averaging (BMA) methodology** (Figure 11 and Appendix V). Historical default rates (PDs) at the aggregate level, which were provided by the CBI, were estimated for household and corporate loans separately.

[18] The growth assumption on inflation indexed portfolios is based on calculation provided by the CBI on interest payment and amortization schedule of a sample inflation-indexed loan.

Point-in-time PDs were projected using BMA models with macro variables as independent variables. The risk-neutral PDs for sovereign, banks, NBFIs were generated using Merton approach which translates credit spreads under stress to PDs, according to the following formula, using the credit spreads for sovereign, bank and NBFI exposure linked to the scenario $S^i_{t,T}$, time to maturity (T-t), and assuming an LGD of 45 percent.

$$PD^i_{t,T} = \frac{1 - exp^{-S^i_{t,T^*}(T-t)}}{LGD^i_t}$$

The results were then used to shift the transition matrices of each type of loan portfolio held by individual banks.

**28. A logit transformation was applied before conducting BMA/OLS estimates to address the truncated nature of default rate distribution.** This transformation addresses biases and ensures that the projected rate is contained within the 0-1 bound once the logit forward path is applied to the forecast.

**29. Conditional PD forecasts, which indicate larger impact on corporate than household portfolios, were generated based on the estimated model parameters** (Figure 13)**.** Given a stable macroeconomic outlook in the baseline, the PDs in both segments are projected to remain flat in the baseline scenario and to sharply increase in the adverse scenario. The impact under the adverse scenario displays idiosyncrasies across segments, with the impact on corporate more sizable than those on household mortgages. The magnitude of the projected PD shock under the adverse scenario is in general milder than historical stress episodes explained by structural changes in the economy since the GFC.

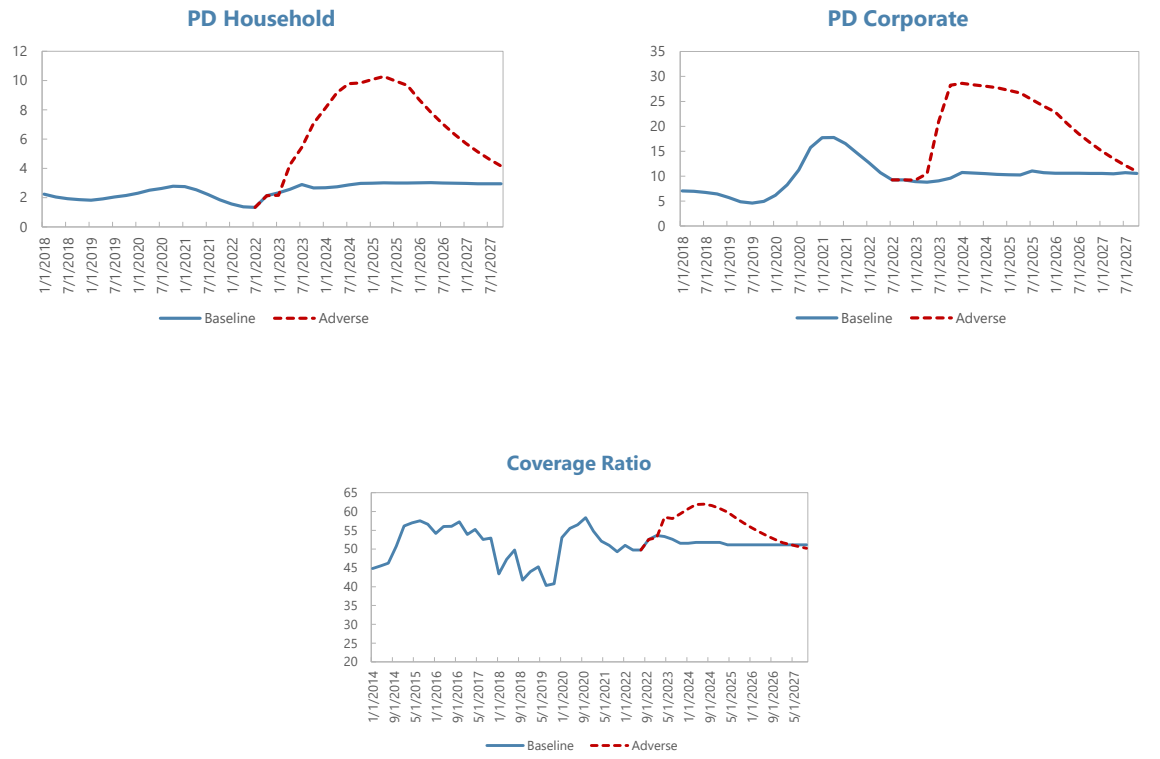
**30. Unemployment rate, interest rates as well as asset prices proved to be relevant for the buildup of credit risk** (Appendix V).[19] This is reflected in the level of significance of included explanatory variables. For instance, unemployment rate and interest rate on indexed mortgages appear to be significant drivers of household PDs, and similarly, unemployment rate, term premium and stock market prices are shown to be significant and jointly explain the evolution of corporate PDs. The type and number of significant variables however varies distinctly across segments, as manifested by the individual characteristics of their historical PDs.

**31. The projections for point-in-time LGDs rely on both econometric approach and structural models.** For mortgage segment, the projection employed a structural approach

[19] Nonetheless, certain model could be subject to sample bias due to data limitation, as the size of the sample appears to be small such as for coverage ratio with low R-squared.

originated from Gross et al. (2020)[20] which was designed to model LGDs for real estate-collateralized portfolios using information on loan to value ratio (LTV) and LGDs at the starting point as well as scenario path for house price growth. In addition, the projection made the distinction between indexed and non-indexed mortgage portfolios by assuming the LTV ratio for indexed mortgages to be determined by both the house price growth (denominator) and inflation (numerator), as high inflation under stress could lead to expansion of indexed-loan principle, thus pushing up the LTV. For portfolios other than mortgages, the LGDs were projected using historical time series on coverage ratio for the total loan portfolio provided by the CBI. The forward paths under the baseline and adverse scenario were then attached to bank starting point to derive bank specific Point-in-Time (PiT) LGDs over the 5-year horizon.

**Figure 13. Iceland: PD Projections**
(In percent)




Source: IMF staff.

[20] Gross, M., Laliotis, D., Leika, M., and Lukyantsau, P. (2020), "Expected Credit Loss Modeling from a Top-Down Stress Testing Perspective", IMF Working Paper No. 20/111.

**32. Credit risk affects banks' capital ratios both through loss provisions (numerator) and risk weights (denominator).** The calculation of loan loss provisions is consistent with the account standard (IFRS9) and depends on the evolution of loan exposures, stage transition matrices (guided by the stressed PiT PDs) and the PiT LGDs under stress. The capital requirement (RWAs) is subject to regulatory approaches used by the bank. For Iceland, since all banks adopt standardized approach, the RWA densities at the starting point of the stress test are assumed to remain the same over the scenario horizon with a differentiation between performing and non-performing loans, as below:

$$\rho_e^{PE\ or\ NPE}[0] = \frac{RWA(STA)_e^{PE\ or\ NPE}[0]}{EAD(STA)_e^{PE\ or\ NPE}[0] - PROV(STA)_e^{PE\ or\ NPE}[0]}$$

$$RWA(STA)_e^{PE\ or\ NPE}[t] = \rho_e^{PE\ or\ NPE}[0] * (EAD(STA)_e^{PE\ or\ NPE}[t] - PROV(STA)_e^{PE\ or\ NPE}[t])$$

**33. The assessment of interest rate risks can be decomposed into two main components: base effect and gains or losses under stress.** The base effect is defined as the changes of interest income or expense due to changes in the outstanding amount of interest earning assets or liabilities, in absence of interest rate shocks. It is computed as the product of the effective interest rate on each relevant balance sheet item and their outstanding amount under the stress horizons. Gains or losses due to interest rate shocks are treated as an add-on component which uses a gap-analysis to assess the cash-flow effects from a general increase in interest rates that affects banks' banking books. The impact is felt on interest income or funding cost through bank's cash-flow structure comprised of interest sensitive assets and liabilities and repricing buckets. Throughout the stress horizon, interest rate shocks were applied to the interest rate-sensitive assets and liabilities as the positions reach their time of repricing, from less-than-1-year to the 5-year buckets, consistent with the stress testing horizon. Funding risks are considered as part of the interest rate risk assessment which prevails in the repricing of the sensitive liabilities subject to rising funding rates, such as deposit rates or interest rate on debt securities. Projection of net interest income is computed as the sum of the base component and the gains and losses due to interest rate shocks.

**34. Interest payments were assumed to accrue only on performing exposures under both the baseline and adverse scenarios.** The interest revenue on performing exposures was calculated on the gross carrying amount. While accounting rules allow banks to accrue interest income on non-performing exposures with provisioning required on the more delinquent and uncollectible assets, the stress test exercise took a more conservative approach which does not allow banks to project income on non-performing exposures.

**35. The assessment of interest rate risks for Iceland used as input the historical time series of aggregated interest rates as well as interest rate sensitive asset and liabilities reported by the CBI.** The evolution of the cost of funding and lending rates were treated as a function of the macroeconomic variables projected in the scenarios. The projection used aggregate bank rates for new business (front-book) and were mapped into three main categories on the asset side (household, corporate and consumer loans) and three main categories on the liability side (overnight deposits, term deposits, and debt securities). Further, similar to the assumption on

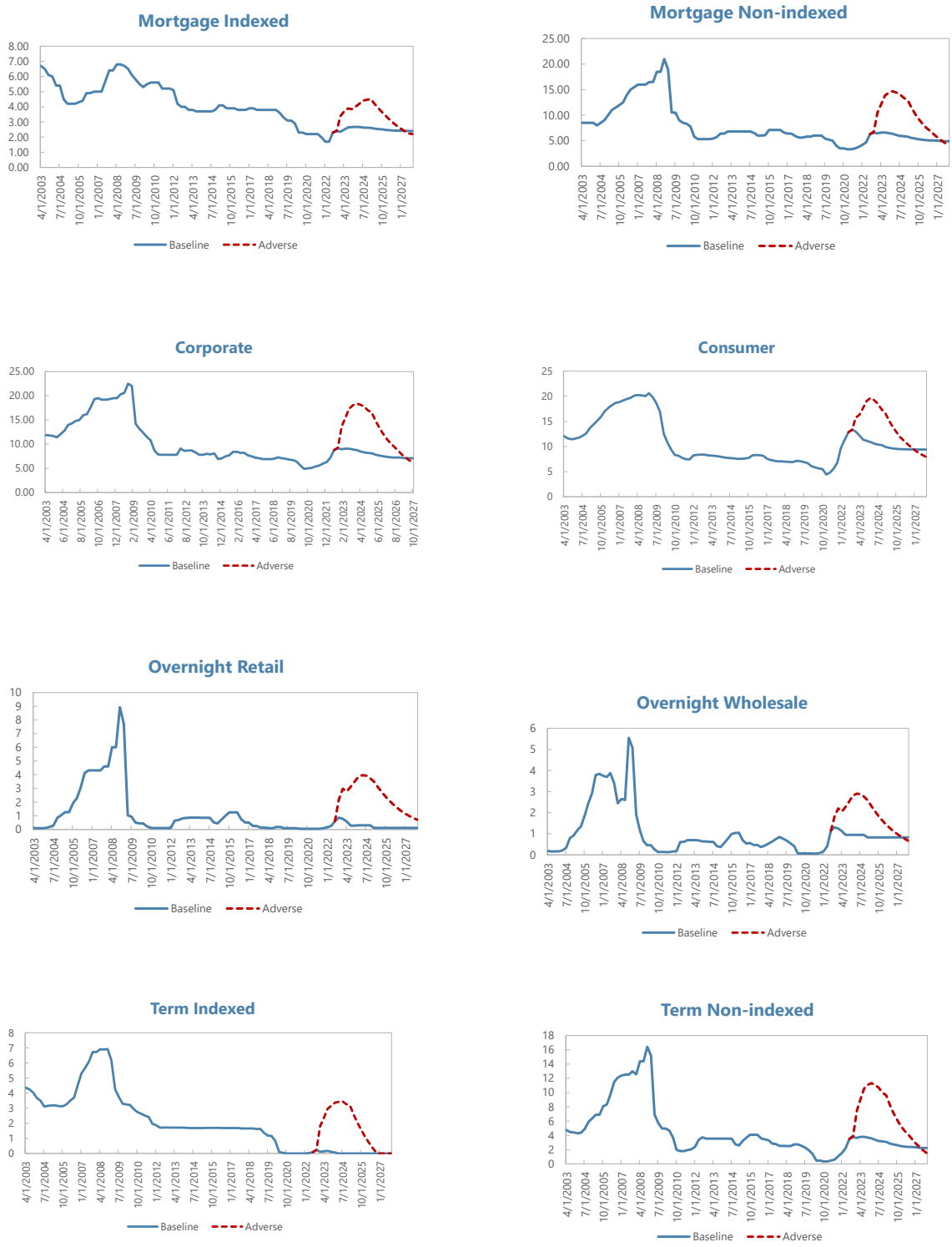
balance sheet growth, the interest rate risk assessment made a distinction between banks' indexed and non-indexed portfolios to reflect the differences in their evolution under each scenario, as indexed portfolios typically grow faster than non-indexed portfolios in periods of inflation. Specifically, on the asset side, household loans were further decomposed into indexed mortgages, non-indexed mortgages, corporate loans and consumer loans, and on the liability side, term deposits were further divided into indexed and non-indexed retail and wholesale term deposits, so were debt securities. The projection of the lending rates allows the inclusion of funding rates, such as indexed and non-indexed term deposits, as explanatory variables, thus allowing banks to partially pass the rising funding cost onto lending rates to preserve net interest income. The projection of interest rate on indexed and non-indexed debt securities follows the dynamics of indexed and non-indexed term deposits, while adding a spread benchmarked to historical average.

**36. Results from satellite models on aggregated interest rates reveal the significant role of short-term rate, long-term rates, and pass-through effect from funding to lending rates** (Appendix VI). On the liability side, the cost of overnight deposits is largely determined by the short-term rate while term deposits appear to be driven mainly by long-term interest rate. The pass-through from short-term rate and long-term sovereign yield on overnight and term deposit rates appears to be large and significant, particularly for indexed and non-indexed term deposits. On the asset side, lending rates are largely explained by long-term interest rate and the passthrough from funding costs such as indexed and non-indexed term deposits, which appear to be statistically significant. Interest rate for non-indexed mortgages, corporates and consumer loans are also positively correlated with inflation rate, which is consistent with the pricing of non-indexed loans as inflationary effect is fully priced in the nominal, non-indexed lending rates.

**37. The projected interest rates paths are broadly in line with banks' portfolio characteristics** (Figure 14). On the liability side, this is reflected by a more severe impact on the long-term funding as opposed to highly liquid short-term funding. Also, shock to inflation-indexed funding is lower than non-indexed funding. On the asset side, the increase on the lending rate appears to be more moderate for mortgages than corporate and consumer loans as mortgages bear relatively lower credit risks. Also, similar to funding rates, the increase in indexed mortgage rates is smaller than that of non-indexed mortgages. This is to reflect, in addition to the fact that indexed mortgages do not consider inflation premium, the constraint faced by the banks under stress due to competition from pension funds, which grant almost exclusively indexed mortgages. As a result, relative to the baseline, net interest margin declines in the adverse scenario by about one percentage point on average for the sample banks, relative to a net interest margin of the total banking sector at the starting point at around 3 percent.

## Figure 14. Iceland: Interest Rate Projections

(In percent)




Source: IMF staff.

**38. A modified duration approach was used to measure gains or losses in the value of fixed income securities, due to changes in bond yield.** Securities holdings by types of securities and the corresponding durations for each bank were provided by the CBI. Gains and losses were calculated using the modified duration approach. The analysis covers the impact on the debt securities portfolio accounted in the fair value through profit and loss (FVTPL) and fair value through other comprehensive income (FVOCI)[21], separated into sovereign and central bank, banks, NBFIs and corporate bonds. Rebalancing of the portfolio was not allowed throughout the horizon.

**39. Valuation changes due to other market risks were assessed for banks' FX and inflation exposures, as well as their equity holdings.** Specifically, information on net positions of FX, inflation and equity holdings with trading intent were provided by the CBI via confidential supervisory reports. Subsequently, the fair value impact of each market risk factor on bank profitability follows the evolution of their respective market prices projected under both the baseline and adverse scenario. For instance, gains or losses associated with banks' FX risk would multiply the FX net open position at the starting point with shocks to nominal exchange rate under each scenario. Similarly, valuation gains or losses associated with banks' inflation and equity exposure would be the product of their net inflation and equity position and shock to inflation and stock price, respectively. It is expected that banks would on average benefit from an inflationary scenario, as they tend to keep a positive net inflation position which can lead to larger expansion of assets than liabilities, thus leading to valuation gains.

**40. Net income (profit and loss) was projected using all the risk factors in the stress test.** Net profits were mainly driven by the gains and losses from credit risks, market risks and interest rate risks.[22] Remaining items on the income statement, such as net fee and commission income and other non-interest income, were projected to grow in line with real GDP growth under both scenarios. Operational and administrative expenses were assumed to be constant over the risk horizon. Extraordinary income and loss were assumed not to recur during the projection period. The corporate income tax is factored in the profit and loss calculations, and it was set at banks' effective tax rate at 20 percent.

**41. The distribution of profit is subject to the following assumed dividend policy.** Dividends are assumed to be paid out at a rate of 50 percent of current period profit after taxes by banks that are making profits (i.e., only if profits are positive) and in compliance with supervisory capital requirements. Banks are not allowed to issue new shares or make repurchases during the stress test horizon.

[21] As of 2022Q3, no debt securities were booked under the amortized cost category.

[22] Since the stress test starts at 2022Q3, the profit and loss items were annualized to avoid underestimation of the overall profit pre-shock.

***Result of the Scenario-Based Stress Test***

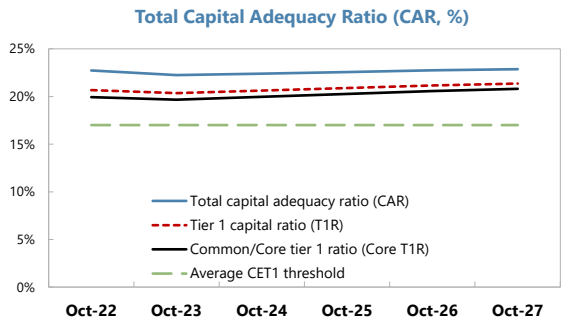
**42. The result of the scenario-based bank solvency stress test confirmed the sector's resilience to severe macroeconomic shocks, while revealing bank specific vulnerabilities** (Figure 15).

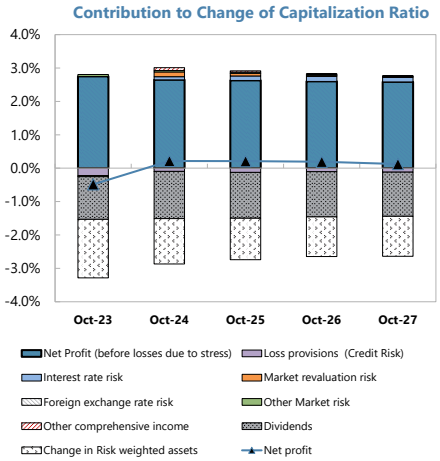
- The baseline scenario confirms banks' strong capital positions, with mild capital accumulation. Both retail and large international banks would see their fully loaded CET1 ratios remaining at a high level while slightly increasing from 20 to 21 percent. The marginal capital accumulation is driven by strong income generation capacity which was simultaneously offset by dividend distribution reflective of current bank dividend distribution policy at 50 percent.

- The adverse scenario confirms banks' resilience to severe yet plausible adverse shocks. Although the adverse scenario produced a significant impact on bank capital ratios, no bank saw its capital ratios fall below the hurdle rates, owing to the high initial capital positions and adequate pre-provision income. On aggregate, the fully loaded CAR, T1 and CET1 ratio decline respectively by about 4.2, 3.8 and 3.6 percentage points by the 5th year and 5.6, 5.3 and 5.2 percentage points at the trough. Among risk factors considered, credit risk provisioning is by far the largest contributor to the decline in capital ratios with the cumulative effect over 5 years amounting to 5.1 percentage points, followed by risk weighted assets (RWA) and interest rate risk, at 4.1 and 2.1 percentage points, respectively. Loss provision for household portfolio is lower than corporate portfolio, at 2.2 relative to 2.5 percent of RWA over the risk horizon. The relatively high RWA contribution can be explained by the inflation indexed and FX denominated lending portfolios which expand considerably over the risk horizon, in addition to the large materialization of NPL under stress which carries higher risk weights. Contribution from market risk is minimal (60 basis points at trough and almost 0 by the end of the horizon) given small holdings of trading securities of the banks, as well as the initial losses being offset by value gains in the subsequent years. The aggregated results mask important bank heterogeneity as certain banks underperform the others due to weaker starting points in terms of both initial capital and default rates, and constrained income generating capacity. Finally, banks' leverage ratios, which start from a very high level at 14 percent, declined to 11.5 percent under the adverse scenario at the trough, well above the minimum threshold at 3 percent.

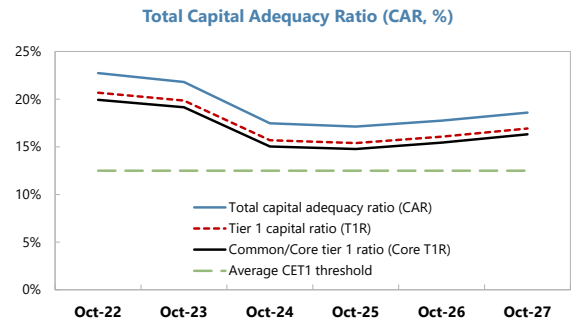
## Figure 15. Iceland: Result for Bank Solvency Stress Test

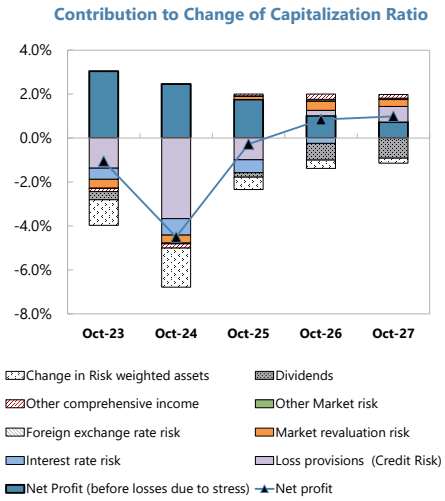
*Baseline Scenario*




*Adverse Scenario*




Source: IMF staff.

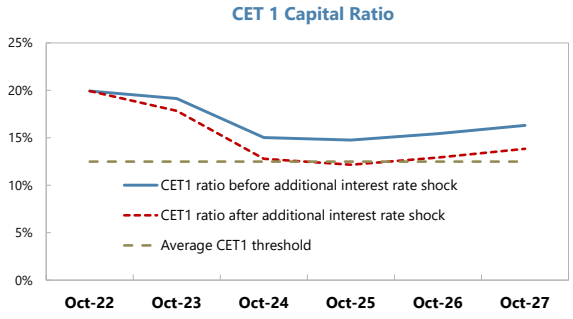
## Sensitivity Analysis

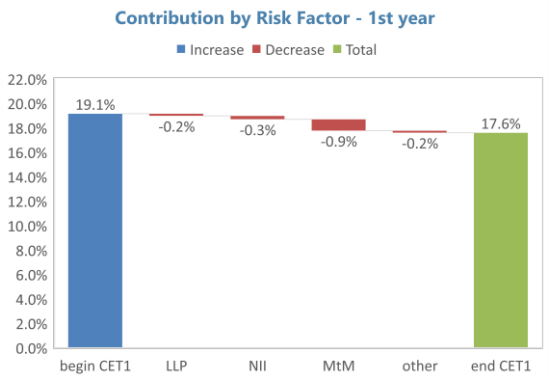
**43. Further interest rate hikes could have an impact on banks' solvency position, mainly through market risk, interest rate risk and credit risk.** The impact of rising interest rates could be immediately felt on bank trading portfolios, such as marketable debt securities due to either realized or unrealized valuation losses through the categories of fair value through profit and losses (FVTPL) and fair value through other comprehensive income (FVOCI). Holdings of securities booked under amortized cost[23] could also lead to market losses, especially when they need to be liquidated at market value to meet rapid liquidity outflows, as book value could overstate their real-time market value in turbulent markets. Such market risks could be hedged using interest rate derivatives. Over time, higher rates may increase or decrease net interest income (NII) depending on the time-to-repricing of assets versus liabilities and increase loan defaults and loan-loss provisioning (LLP) costs.

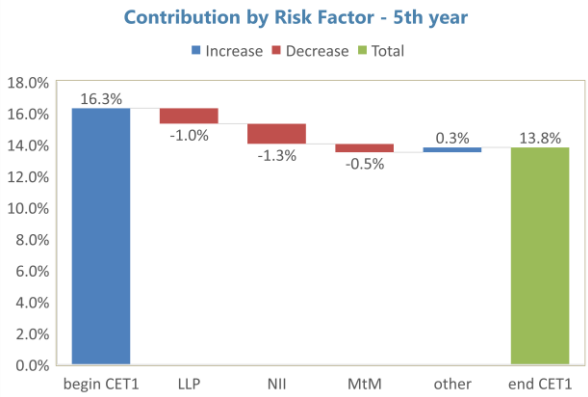
**44. The sensitivity analysis simulating further tightening of financial conditions reveals high sensitivity of banks to interest rate changes** (Figure 16). Specifically, a 2 percentage points parallel increase along the yield curve (e.g., parallel upward shift in both short term and long-term bond rate in addition to the initial adverse scenario) results in material impact on bank capital. As a result, the capital ratios saw an additional 250 basis points decline relative to the initial adverse by the end of the horizon, rendering two banks facing challenges in meeting the hurdle rates. The further depletion of capital is jointly explained by market risk, interest rate risk (NII effect) and credit risks, with higher contribution from market risks in the short term, and interest rate and credit risks over the short and medium term. The higher NII effect is primarily driven by the positive net indexed position of the banks (e.g., banks hold higher share of inflation indexed assets relative to inflation indexed liabilities and thus the interest increase on the asset side overall is smaller relative to liabilities), as well as a partial passthrough of funding cost to lending rates assuming increased lending competition faced by the banks. Banks credit risks are also sensitive to further rise in interest rate due to higher inflation and already quite high lending rates and tightened financial condition (especially on non-indexed loans), albeit usually with a lag given that it takes some time for actual default and provision to materialize.

[23] There are currently no debt securities recorded under the amortized cost category, therefore all securities are marked to market.

**Figure 16. Iceland: Interest Rate Sensitivity Analysis**




Source: IMF Staff.

Note: 1. The contribution charts show each risk factor's contribution to the gap in CET1 ratio between the initial adverse scenario and the additional interest rate sensitivity shock.

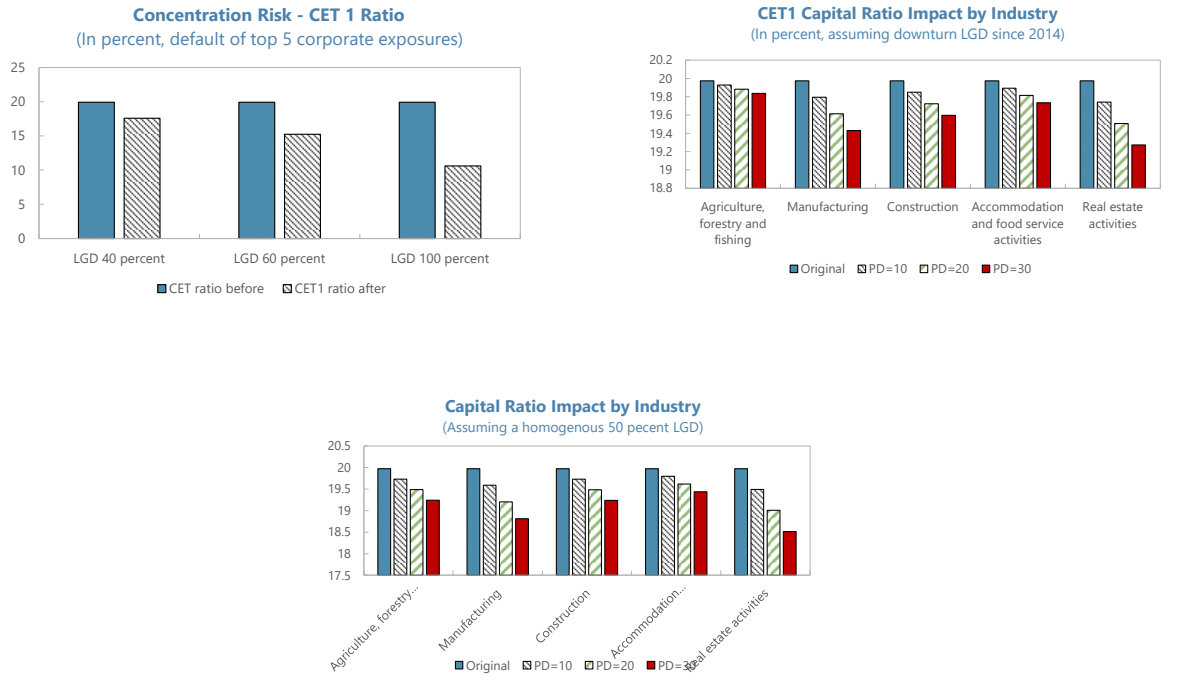
2. LLP=loan loss provision, NII=net interest income, MtM= marked-to-market of tradable securities, other=net impact mainly from RWA (negative impact due to higher credit risk) and reduced dividend distribution (positive impact).

**45. In addition to the analysis of further interest rate hikes, two separate sensitivity analyses were considered to assess bank vulnerabilities to the corporate sector.** The first exercise assessed concentration risks of the banks by allowing impact to bank's capital from the simultaneous default of the top 5 exposures for each bank. It also assumed a range of LGDs from 40 percent up to a maximum of 100 percent (equivalent to zero recovery rate) which is considered the most stringent assumption. The second exercise took a sectoral approach by assessing the provision needs for selected sectors which the banks are most exposed to. It assumed a homogenous PD ranging from 10 percent to 30 percent for each sector, along with sectoral and bank specific downturn LGD since 2014 using data provided by the CBI. Then, provisions were computed for each sector by multiplying the PDs and their corresponding LGDs and were deducted from the CET1 ratio which were then compared across the sectors. Another experiment used homogenous LGDs of 40

percent across industries. In both cases, the estimated provisions were subtracted from the RWA to offset partially the initial negative effect coming from lower capital.

**46. The sensitivity analysis broadly confirms the banking sector's resilience to top corporate exposure and covid-sensitive segments, although the results hinge on the assumptions on collateral quality** (Figure 17). Specifically, under the first exercise which simulates the default of the top 5 exposure for each bank, the two milder scenarios assuming 40 and 60 percent LGDs led to CET1 ratio depletion of 2.4 and 4.7 percentage points, with no banks breaching the hurdle rates. However, when using a zero-recovery rate which is considered as the most stringent assumption, the aggregate CET1 ratio of sample banks would decline by 9.3 percentage points from 19.9 percent to 10.6 percent, under which two out of three D-SIBs may have trouble meeting the regulatory minimum CET1 capital. Under the second exercise which simulates increasing PDs on the key sectors of the credit exposure of the banks suggest higher capital impact from real estate activities, given the high exposure and relatively higher LGDs, although no banks would breach the minimum thresholds.

## Figure 17. Iceland: Corporate Sector Sensitivity Analysis




Source: IMF Staff.

## C. Recommendations

**47. The FSAP recommends further work by the CBI to differentiate inflation indexed and non-indexed lending and funding instruments in the regular risk monitoring and stress testing framework.** The fact that banks are actively engaging in inflation indexation on both side of their balance sheets and the differing risk profiles between indexed and non-indexed product could warrant a separation of these two in the risk monitoring and stress testing framework to better capture and quantify the inflation effect on bank solvency position. Various channels can be considered such as credit, interest rate and market risks. For instance, credit risks can differentiate probability of default between indexed and non-indexed loans, as indexed loans charges lower interest rate in an inflationary environment relative to non-indexed loans, potentially leading to lower default risks thanks to lower interest payment over the short term. Interest rate models could capture different dynamics of interest rates over the stress testing horizon on indexed and non-indexed portfolios and map them to different repricing schedules, to gauge overall impact of indexation on banks' net interest margin. Market risk models could assess banks' exposure to balance sheet revaluation risks due to inflation via net inflation-indexed position. Such differentiation could also benefit from additional data collection of non-performing loan ratio and probability of default separately for indexed and non-indexed loans.

**48. The CBI could closely monitor the impact of higher interest rates on banks' solvency condition.** Given the high sensitivity of banks' solvency position to interest rate shocks, CBI could periodically assess the impact of interest rate shock on banks' profitability and solvency condition, via net interest margin, credit losses and market revaluation gains and losses on both tradable and non-tradable securities. The assessment should consider both short- and long-term horizons, to capture instantaneous impact of market revaluation as well as the slower transmission such as through credit losses.

**49. Finally, the FSAP recommends enhanced data quality and consistency of banks' supervisory reporting,** The risk monitoring and top-down stress tests led by the CBI leverage strongly on banks' supervisory reporting. Hence, it is important to continuously improve the data quality of the supervisory reporting, for instance through the use of automated validation rules which would reject inconsistent banks' reporting.

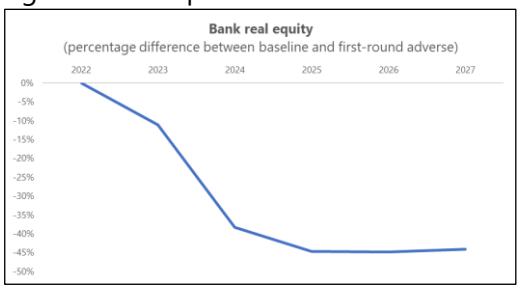
# MACRO-FINANCIAL FEEDBACK LOOPS

**50. The solvency bank stress test was complemented by an analysis of macro-financial second-round effects.** The initial external shocks that generate the adverse scenario considered in the solvency stress test could be amplified through the banking sector's response, especially a contraction in its credit supply to the real economy. This credit supply shock could lead to a further deterioration of the macroeconomic scenario, which would in turn deepen the stress on the banking sector. This section assesses these second-round effects by estimating a VAR model that links the initial shock to bank capitalization with the path for bank lending and other macroeconomic variables.

**51. A structural VAR (SVAR) model was used to identify the macroeconomic effects of a shock to bank capitalization.** The SVAR uses the same domestic and external variables as the ones included in the model used to generate the first-round adverse scenario. The domestic variables include: Iceland's real GDP, CPI, nominal exchange rate (all in logs), unemployment rate, and policy interest rate, while the external variables are: US real GDP, oil price (both in logs) and US policy rate. The external variables enter the VAR as exogenous regressors, since we are considering Iceland to be a small open economy. To capture macro-financial linkages, a banking block was added to the model, with three variables: bank capital, bank outstanding loans to domestic households and non-financial corporates (both in logs and divided by CPI to express them in real terms), and the spread between the lending rate and the policy rate.[24] The SVAR was estimated at quarterly frequency, over the period 1998Q1 and 2022Q2, and uses only aggregate variables.[25]

**52. A credit supply shock to bank capital was identified through sign-restrictions and block exogeneity assumptions.** The block exogeneity assumption establishes that bank capitalization cannot have a direct impact on any of the other variables in the SVAR except bank lending. This means that the only way in which a shock to bank capital is transmitted to the macroeconomy is through a bank lending channel. As for the sign restrictions, a positive credit supply shock was assumed to have a positive impact on bank capital, bank loans and real GDP, and a negative impact on unemployment and the spread between the lending and policy rates. In other words, an increase in credit supply increases the quantity while decreasing the price of credit (where the price of credit is captured by the lending-policy rate spread), which has a positive impact on aggregate economic activity (as captured by real GDP and unemployment). Appendix IV provides further details on the SVAR estimation.

**53. The bank capital variable included in the SVAR creates a bridge between the solvency stress-test and the macroeconomic scenario.** The change in bank capital between the baseline and the adverse scenarios obtained from the solvency stress-test (displayed in the text Figure) was used to generate a credit supply shock in the SVAR. This gap is sizeable, with a maximum magnitude of 45 percent. Using the estimated SVAR, the FSAP team computed the path for all the other endogenous variables conditional on this bank



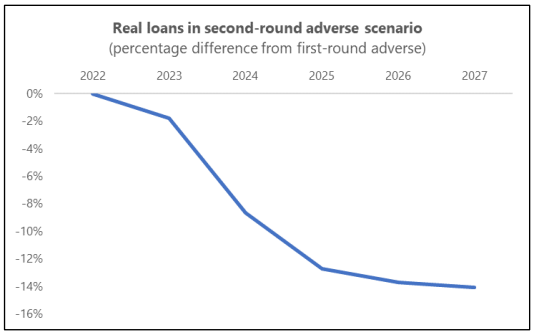

[24] While the literature on credit growth often uses CAR as a supply-side factor, this variable did not show a statistically significant impact when estimating a simple regression of lending growth on changes in CAR. Meanwhile, accounting bank equity did show statistically significant coefficients, with the expected sign, and the magnitude was stable across controls (see Appendix IV). Capitalization ratios such as CAR or CET1 ratio could potentially suffer from endogeneity when used as explanatory variables for bank lending because the denominator of these ratios are the risk-weighted assets, which are closely related to the outstanding stock of bank loans. So, for example, if a bank chooses to increase its lending through higher leverage, then the increase in the stock of loans would increase RWAs as well, thus decreasing CAR. This effect has the opposite sign than what our SVAR model is trying to capture. For this reason, accounting bank equity was used instead as a measure of bank capitalization.

[25] The time-series available at bank level, which start in 2014, were deemed to be too short for the estimation of the SVAR, so a specification with only aggregate variables was preferred, covering the period 1998Q1-2022Q2. Using this longer time-series has the drawback that it includes both the pre- and post-GFC period, so a caveat of the analysis is that the Icelandic banking sector underwent a significant restructuring within the sample.

capital gap.[26] In order to compute these conditional forecasts for the endogenous variables included in the SVAR, two steps are followed: first, uncover the structural credit supply shocks that generate the given gap in bank capital; and second, use the estimated impulse-response functions from the SVAR to compute the path for the other variables.[27]

**54. A second-round scenario for all macro variables was then obtained by adding these conditional paths from the SVAR to the original first-round adverse scenario.** In other words, the difference between the first- and second-round scenarios is given by the feedback effects captured by the SVAR model. This amended scenario was then used for a second-round of the bank-level solvency stress-test. One caveat to this approach is that the initial first-round adverse scenario is assumed not to include any macro-financial feedback, but this is likely not the case. Although the VAR model used to generate the first-round scenario does not include any banking sector variables, macro-financial effects may still be captured indirectly through their correlation with the variables which do enter the VAR. Therefore, in the second-round adverse scenario there could be some "double-counting" of macro-financial feedbacks.

**55. The second-round scenario displays more adverse paths for macroeconomic variables together with bank deleveraging; these two developments have opposing effects on bank capitalization ratios.** The second-round scenario obtained by adding the macro-financial feedback effect displays a sharper contraction in real GDP, higher unemployment and lower housing prices (3.8 percent lower, 1.6 percentage points higher and 9 percent lower, respectively, at the trough, which occurs in 2024. Figure 18). This more adverse scenario negatively affects banks' profitability. However, the second-round stress-test assumes a deleveraging of the lending portfolio that is equal to the aggregate real loan growth obtained from the SVAR[28] (see Figure), which decreases RWAs and thus tends to increase capital ratios. Therefore, since there are two effects at play which move capital ratios in opposite directions, the total effect could generally go either way.



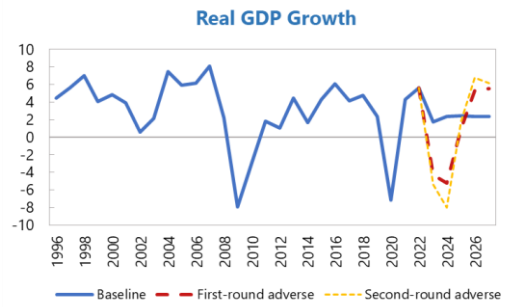

[26] The stress-test results from the three banks were first aggregated in order to obtain a path for aggregate bank capitalization which can be used in the SVAR to compute conditional forecasts.

[27] A few variables which are required as inputs for the solvency stress-test are not included in the SVAR (e.g., housing prices, stock market index). To generate conditional forecasts for these variables, separate bridge equations were estimated.

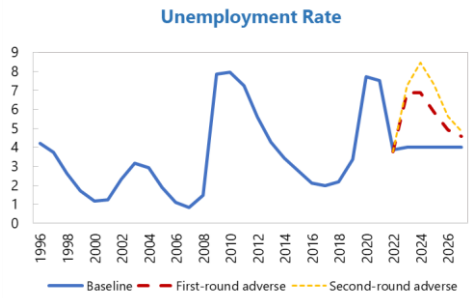
[28] Although the second-round scenario displays a sizeable deleveraging of 14% at the trough, this is much milder than the GFC, when real bank loans contracted by over 50% in the five years after the 2008Q3 peak.

## Figure 18. Iceland: Second-Round Scenario

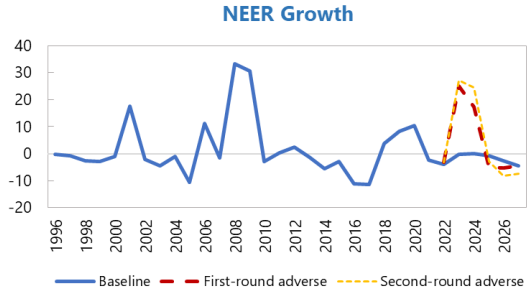
*In the second-round adverse scenario, real GDP would be reduced by an additional 3.8 percent cumulative over the first two years,...*



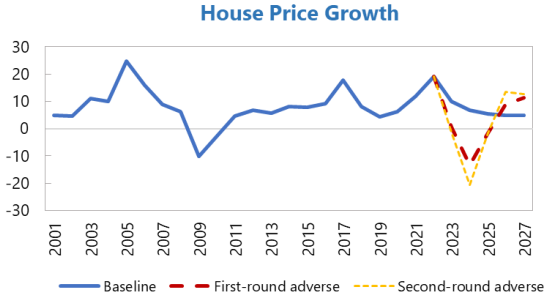

*...while the unemployment rate would increase by an additional 1.6 percentage points cumulative,...*



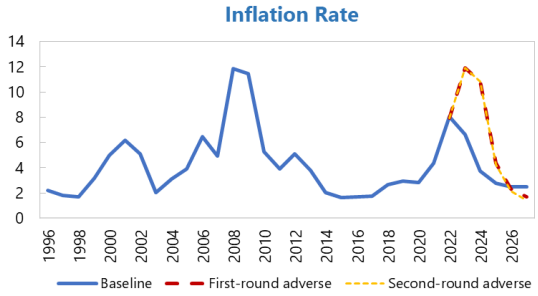

*... the nominal exchange rate would depreciate by an additional 11.4 percent cumulative...*



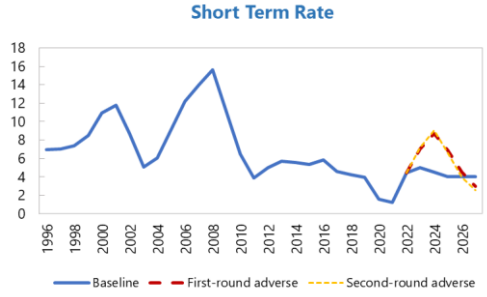

*... and nominal house prices would fall by an additional 9 percent cumulative.*




*Meanwhile, the change in the inflation rate is negligible...*

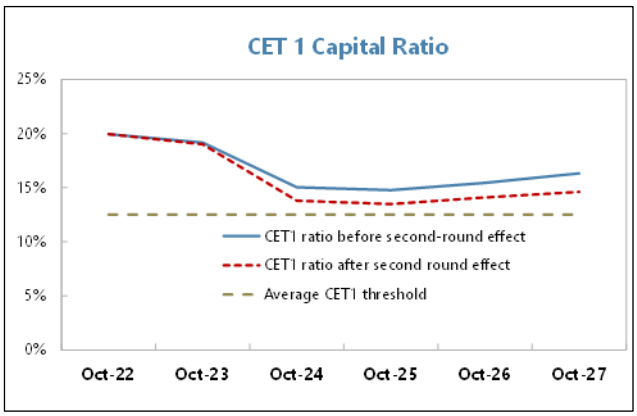



*...and the change in the policy rate is small, at a magnitude of 60bps or less in every year.*




Source: IMF staff.

**56. The quantitative results indicate that the lower profitability is the stronger effect in this case, thus leading to lower capital ratios in the second- than in the first-round.** The bank solvency stress-test based on the second-round scenario results on a path for aggregate CAR that is lower than in the first round by 1.2 percentage points in 2024 and by 1.7 percentage points in 2027 (on average for the three banks). The most important factor driving down profitability in the second-round scenario is credit risk, mainly due to higher PDs driven by higher unemployment. The deleveraging of the lending portfolio also lowers net interest income, although this effect is outweighed by the lower RWAs that tend to increase capital ratios. The gap in capital ratio between the first- and second-round adverse scenarios slightly increases throughout the stress-testing horizon as the lower profitability accumulates over time.




**57. While in the first round all banks remain above the hurdle rate throughout the stress-testing period, in the second round one of the three banks falls slightly below at the trough; aggregate capitalization remains above the hurdle rate throughout.** Thus, the macro-financial linkages exercise confirms the aggregate resilience of the banking sector in terms of solvency even in a severely adverse scenario, while pointing to some vulnerabilities that could be addressed with macroprudential tools such as the CCyB (Box 1).

### Box 1. Calibration of the CCyB using the Macro-Financial Linkages Model

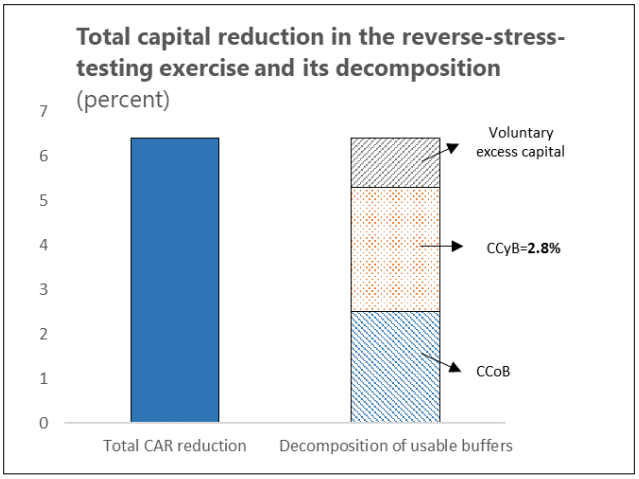
**The macro-financial linkages model can be used to inform the CCyB calibration through a reverse-stress-testing exercise.** The CCyB is implemented as an extension of the capital conservation buffer, ensuring that capital requirements take into account the macro-financial environment in which banks operate. Since there is no universally agreed-upon approach to calibrate the CCyB, the FSAP's solvency stress-test and second-round effects model can provide guidance for its calibration. In particular, the FSAP team conducted a reverse-stress-testing exercise to find the minimum CCyB rate such that, at the trough, all three banks remain above the CAR hurdle-rate throughout the stress-testing period. A caveat of this approach is that it does not provide a full cost-benefit analysis for the calibration of the CCyB, it only informs its calibration with respect to a stress scenario.[1]

**The largest gap between the total CAR at the starting point and the adverse scenario with macro-financial feedback can be used to calibrate a CCyB such that banks have enough capital buffers to remain above the hurdle rate.** Assuming that banks keep a constant buffer in excess of required capital levels and that the hurdle rate is never breached by any bank, the CAR gap between year 0 (starting point) and the trough of the adverse scenario sets the total amount of required macroprudential buffers. The capital buffers that are assumed to be usable in this exercise are the CCoB, the voluntary excess capital, and the CCyB. Taking the first two as given, the third one (i.e., the CCyB) can be set so that banks have just enough buffers to remain above the hurdle rate.

### Box 1. Calibration of the CCyB using the Macro-Financial Linkages Model (concluded)

**A higher CCyB could improve the macroeconomic scenario by supporting higher bank lending through the stress-testing horizon; using the estimated SVAR, a "third-round" scenario was constructed for each CCyB rate to capture this macro effect.** Under the assumption that banks desire to keep a constant buffer in excess of capital requirements, a higher CCyB would result in higher bank capital. The estimated SVAR can be used to forecast the improvement in the scenario conditional on this additional bank capital needed to meet the higher CCyB requirements. This positive shock partially offsets the negative macro-financial feedback captured in the second-round scenario. This leads to a third-round scenario which is less adverse, but which has higher bank lending; once again, the total impact on CAR is uncertain since the two effects work in opposite directions.

**The reverse-stress-testing exercise indicates that an additional 80bps of CCyB (relative to the 2 percent at the starting point) would be required for all banks to remain above the hurdle rate**. The reverse-stress-testing exercise indicates that a CCyB of 2.8 percent would keep all banks above the hurdle rate throughout the stress-testing horizon with the third-round scenario. This value would be similar if the reverse-stress-testing exercise were based on the second-round scenario instead; this is because the improvement in the macro-outlook due to the higher bank capitalization induced by the CCyB is roughly offset by the higher RWAs that result from higher bank leverage. Finally, it is worth noting that the calibration of the CCyB could be potentially over-estimated due to the aforementioned caveat, that is, the macro-financial feedback effects might be already captured, partially if not fully, in the first-round adverse scenario.




[1] This approach is complementary to the one presented in Box 1 of the Macroprudential Policy Technical Note, which is based on a Financial Cycle Indicator. While here the CCyB is calibrated against a particular stress scenario, in the other approach it is the cyclical position of the economy which guides the decision-making process concerning CCyB changes.

# BANKS LIQUIDITY RISK ANALYSIS

## A. Introduction

**58. Three distinct liquidity stress tests were conducted to assess bank capacity to withstand large withdrawals of funding and market liquidity shocks.** The FSAP team performed LCR, cash-flow based, and NSFR stress test for the three D-SIBs in Iceland. The LCR-based stress test measured bank ability to meet short-term liquidity needs in a 30-day horizon against the initial level of high-quality liquid assets (HQLA). The cash-flow based stress test leverages information on maturity profile over a 12-month horizon to investigate potential maturity mismatches and assess the availability of bank counterbalancing capacity to offset net-cash outflows. The NSFR limit of 100 percent, which became binding in 2021, was used on the NSFR stress test to gauge structural long-term refinancing and funding risks.

**59. The liquidity stress tests rely on multiple data sources.** The main LCR, NSFR and cash-flow based stress tests were based on COREP reports as of Oct-2022. To complement the main stress test, comparison on liquidity position between 2019 and 2021 was performed to assess the buildup of liquidity buffers since the pandemic. Data on resident and non-resident deposits was also obtained from CBI supervisory templates to assess vulnerabilities arising from reliance on cross-border funding.

**60. The liquidity stress tests used different thresholds.** The LCR and NSFR based stress test used a 100 percent threshold, which is the minimum regulatory requirement as of Oct-2022. For individual significant currencies, the current LCR regulatory minimum is 50 percent for Krona, 80 percent for Euro. There is no LCR limit set for the US Dollar. For this exercise, however, as is standard in FSAPs, the Basel 100 percent LCR limit was imposed for total currency and significant individual currencies. The cash-flow based stress test used the amount of counterbalancing capacity as the threshold to assess the resilience of banks, with negative amounts indicating bank failure in the test.

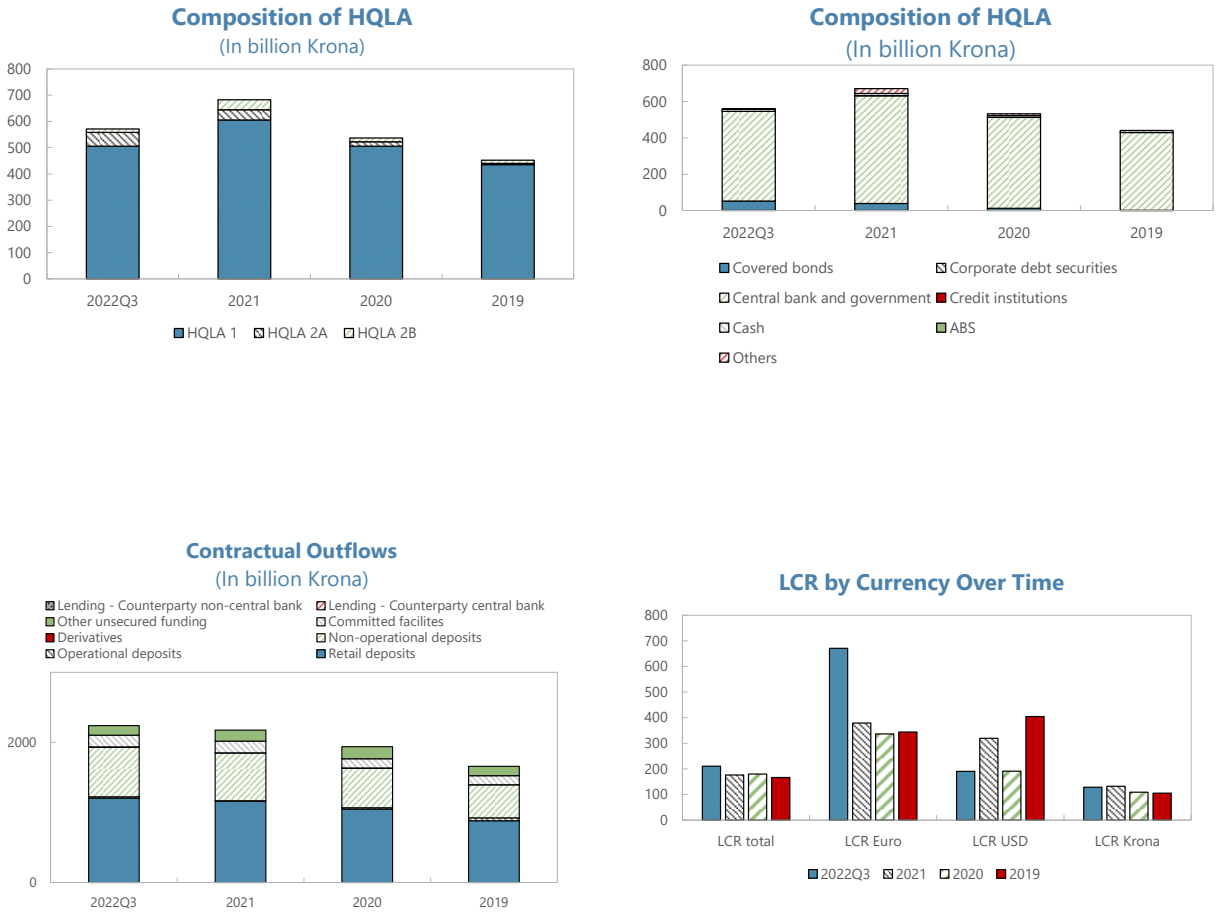
## B. Liquid Assets and Funding Structure

**61. The initial position of bank liquidity profiles points to moderate deterioration post-pandemic** (Figure 19)**.** Since the outset of the pandemic, public liquidity supports, either through outright liquidity injection via central bank liquidity facility or low-cost long-term financing to banks, have been the key instruments to improve liquidity position of the banks. Liquidity support to households and corporates, via lending schemes, direct grants, unemployment benefits and wage subsidies, have also indirectly contributed to the build-up of consumer deposits and bank liquidity buffers. Coupled with tightened lending standards and intensified risk aversion of banks amid the pandemic, the freshly injected liquidity has been mostly placed with the central bank as high-quality liquidity assets (HQLAs), thus notably boosting liquidity indicators of the banking system (Figure 19). However recently, the strong lending growth, dividend payment and share buybacks have led to moderate contraction of liquidity position of the banks, albeit still slightly above the pre-pandemic level, while contractual outflow has increased due to maturing of existing debt issuance. Going

forward, banks are stepping up to build up their liquidity position, either through issuing new bonds to refinance their existing debt or to fulfill ongoing MREL requirement or giving consideration to term deposits with shorter duration so as to attract more retail and wholesale funding. Loan-to-deposit ratio remains high at 150 percent.

**62. The LCRs in significant currencies suggest relatively high historical volatility.** This can be shown in the evolution of LCR by individual currencies between 2019 and 2022Q3, as LCR in US dollar appears to fluctuate between 200 and 400 percent, whereas for the LCR in Euro reached to near 700 percent in 2022Q3, relative to the end-2021 level at around 400 percent.

**Figure 19. Iceland: Bank Liquidity Position**




Source: CBI and IMF.

**63. Maturity mismatches may expose banks to liquidity shortfalls in a sustained liquidity stress environment** (Figure 20). On aggregate, banks obtain most of their funding via wholesale and retail deposits and bond issuance, of which 44 percent were placed within the overnight bucket, which can reduce banks' liquidity position over short term. On the asset side, over 85 percent of cash inflows, mostly comprised of maturing loans, would materialize beyond the first three months. This has led to a maturity mismatch characterized by more frontloaded cash outflows and backloaded cash inflows, potentially leaving banks vulnerable to liquidity gaps under sustained liquidity stress over the longer term. In the meantime, most of the unsecured and covered bonds are becoming due beyond 3 months. These observations underscore the need for continued monitoring of banks' maturity structures to promptly identify and address potential liquidity strains over both short- and long-term horizon.

**Figure 20. Iceland: Bank Liquidity Position Across Time Buckets**

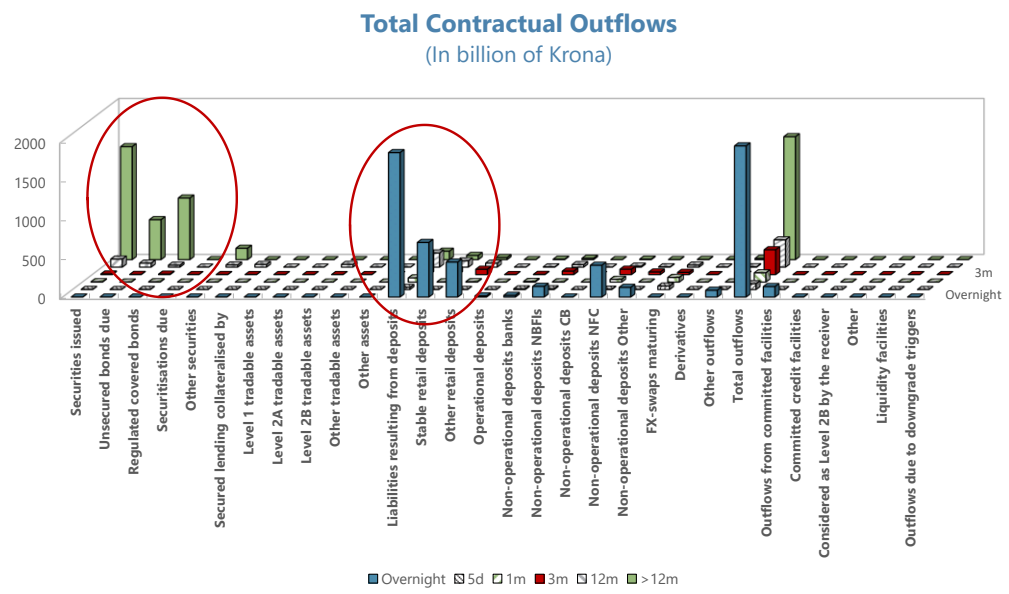
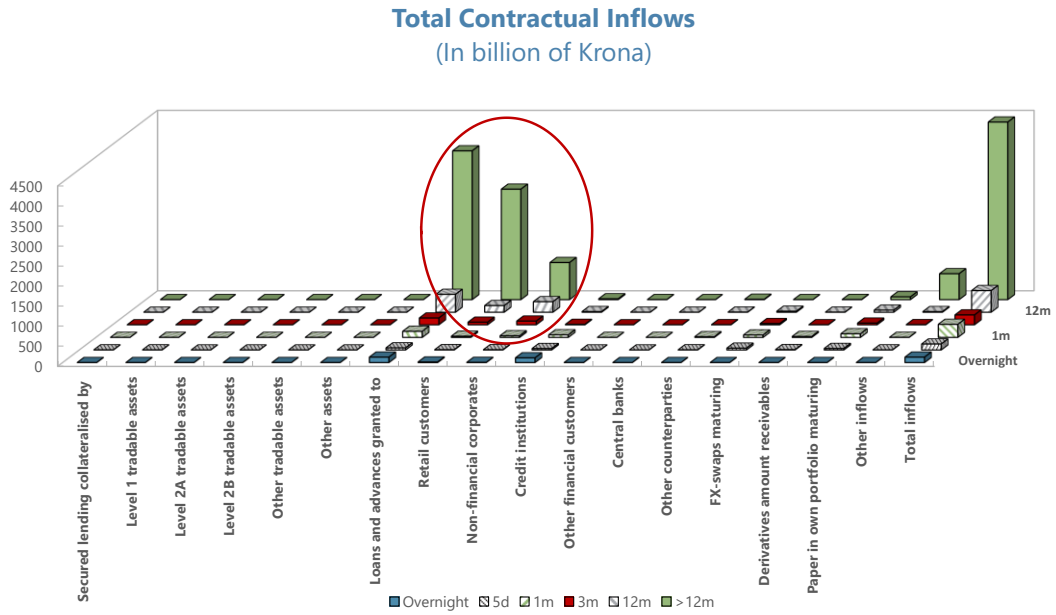


**Figure 20. Iceland: Bank Liquidity Position Across Time Buckets (concluded)**




Source: CBI and IMF.

## C. LCR-Based Liquidity Stress Test

**64. Similar to the bank solvency stress test, the LCR-based stress test was conducted on three D-SIBs in Iceland over six scenarios.**

- The standard LCR scenarios (baseline scenario, S1) applies the standard regulatory parameters as set out by the CRR.

- The retail stress scenario (scenario S2) applies higher run-off rates for retail related claims. The calibration of the run-off rates weighs both historical information of deposit volatility in Iceland as well as parameters used in the past FSAPs within the Euro Area, while also taking into consideration significant structural change in the Icelandic banking sector since the GFC. Under this scenario, banks could use their liquid assets with no additional decline in the market value (the haircut follows the CRR parameters).

- The wholesale stress scenario (scenario S3) applies higher run-off rates for wholesale related claims. The calibration of the run-off rates weighs both historical information of deposit volatility in Iceland as well as parameters used in the past FSAPs within the Euro Area, while also taking into consideration significant structural change in the Icelandic banking sector since the GFC.

Under this scenario, banks could use their liquid assets with no additional decline in the market value (the haircut follows the CRR parameters).

- The retail and wholesale stress scenario (scenario S4) combines scenario 2 and 3 and applies stressed run-off rates for both retail and wholesale related claims, whichever is higher. However, in this scenario banks also face haircuts when liquidating assets to meet funding run-offs. The liquid assets haircuts draw on market value declines from the solvency stress test and are also informed by the ECB valuation haircut when banks need to repo the liquid assets to the central bank.

- The retail and wholesale stress scenario, with mild outflows from pension and foreign funding (S5). This scenario builds on existing scenario with both retail and wholesale liquidity shocks (S4), while also assuming mild outflows from pension and foreign funding, both in the form of deposit outflows and maturing debt securities. For pension funding however, no additional outflow shock was imposed on existing deposits, given the standard LCR parameters already assume 100 percent outflow rates for deposits from bank and nonbank financial customers. The additional outflows from bond maturity takes into account the additional maturing amount between the cut-off date of the exercise (2022Q3) and the current date, to prevent under-estimation of contractual outflows.

- The retail and wholesale stress scenario, with severe outflows from pension and foreign funding (S6). This scenario builds on scenario S5 while adding additional shock from pension and foreign funding, to simulate more severe non-resident deposit outflows, as well as potential early redemption on existing bond maturities funded by pension and foreign investors.

Detailed stress parameters for the LCR stress test can be found in Table 2.

**Table 2. Iceland: LCR Stress Test Parameters**

| Position | Scenario | | | | | |
|---|---|---|---|---|---|---|
| | Scenario S1 Regulatory LCR | Scenario S2 Retail | Scenario S3 Wholesale | Scenario S4 Combo = retail + wholesale + price shock | Scenario S5 S4 + Additional shock 1 (low pension + foreign funding shock) | Scenario S6 S4 + Additional shock 2 (high pension + foreign funding shock) |
| stable retail deposits | 5% | 10% | 5% | 10% | 10% | 10% |
| other retail deposits | 10% | 20% | 10% | 20% | 20% | 20% |
| opertaional deposits | 5-25% | 5-25% | 15-35% | 15-35% | 15-35% | 15-35% |
| non-operational deposits other than financial institutions | 20-40% | 20-40% | 30-50% | 30-50% | 30-50% | 30-50% |
| non-operational deposits financial institutions | 100% | 100% | 100% | 100% | 100% | 100% |
| commited facilities to retail customers | 5% | 10-15% | 5-10% | 10-15% | 10-15% | 10-15% |
| commited facilities to corporate customers | 10-30% | 10-40% | 20-50% | 20-50% | 20-50% | 20-50% |
| pension funding (other than non-poerational deposit) | 0% | 0% | 0% | 0% | 10% | 15% |
| foreign funding (other than non-poerational deposit) | 0% | 0% | 0% | 0% | 15% | 25% |
| level 1 assets | no | no | no | -5/0% | -5/0% | -5/0% |
| level 1 covered bonds | no | no | no | -20/-3% | -20/-3% | -20/-3% |
| level 2A assets | no | no | no | -15/-5% | -15/-5% | -15/-5% |
| level 2B assets | no | no | no | -25/-5% | -25/-5% | -25/-5% |

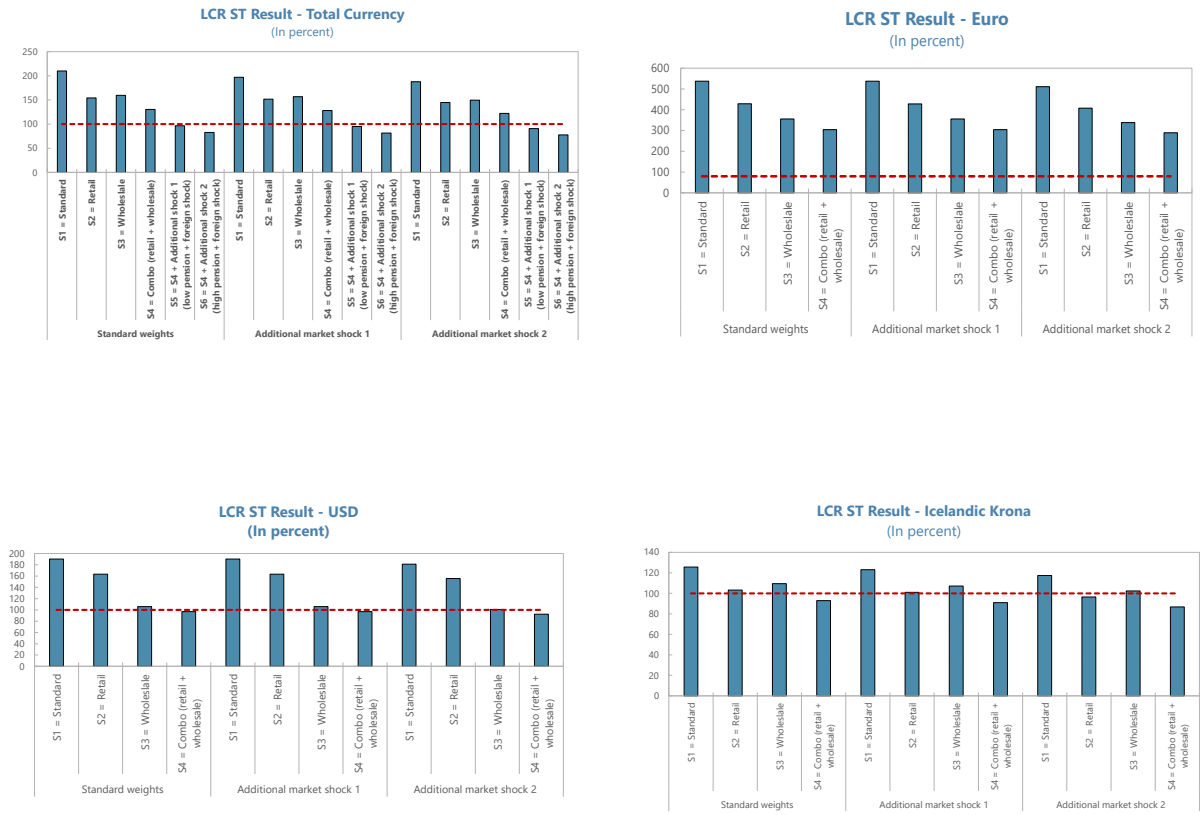
Source: IMF staff.
Note: The HQLA haircuts are informed by market value declines from the solvency stress test where applicable, while the rest are informed by the ECB valuation haircut when banks need to repo the liquid assets to the central bank. Icelandic banks do not hold securities under the amortized (or equivalently HTM) category.

**65. The LCR-based stress test suggests that although the banking system on aggregate is broadly resilient to adverse liquidity conditions, they are not immune to additional liquidity outflows from pension and non-resident FX funding** (Figure 21). On aggregate, the banking sector saw a meaningful decline of its LCR ratio across three main stress scenarios from a starting point of 200 percent as of 2022Q3 to 122 percent in the most severe scenario combining both retail and wholesale shocks, under which one bank saw its LCR ratio marginally below the minimum threshold among the three D-SIBs. Furthermore, when assuming additional liquidity outflow from pension and foreign funding, one more bank breached the minimum threshold, bringing the aggregated LCR ratio further down to around 76 percent. Going forward, this finding warrant developing approaches to continuously monitor funding risks from nonbank financial institutions (including pension funds) and foreign investors.

**66. The LCR stress test was also performed on significant individual currencies.** Using same assumptions as the total currencies stress test, a separate LCR stress test was conducted on bank significant individual currency positions, for Icelandic Krona, Euro, and U.S. dollar separately, to assess bank capacity in meeting large foreign currency outflows. Out of the total banking sample, two banks report LCR template in U.S. dollar while all banks report in Euro and Icelandic Krona.

**67. The LCR results on individual currencies reveal vulnerabilities to domestic and foreign currency denominated outflows** (Figure 21). The exercise follows closely the regulatory thresholds for significant currencies currently active in Iceland while also assuming a homogenous threshold of 100 percent across currencies for comparative purpose. The results for the LCR analysis indicate vulnerabilities across currencies, particularly in Euro, U.S. dollars and Icelandic Krona. This can be explained by various factors, such as weaker initial positions, lower liquidity buffers, non-trivial outflows relative to inflows both in the short-term and long-term, as well as high reliance on funding from foreign investors via deposits, secured and unsecured bonds. Specifically, under existing regulatory minimum (50 percent for Icelandic Krona, 80 percent for Euro and assuming 100 for US dollars) one bank breaches the threshold in U.S. dollars. All D-SIBs meet minimum threshold in Euro and Icelandic Krona. If a 100 percent were assumed for all three significant currencies, one bank breaches the minimum LCR threshold in Euro and one breaches the threshold in U.S. dollars. None of the D-SIBs would be able to meet minimum threshold in Icelandic Krona under the most severe scenario. This could prompt the need to separately monitor and establish LCR requirements at 100 percent for individual significant currencies.

**Figure 21. Iceland: Results for Bank Liquidity Stress Test**




Source: IMF Staff.

## D. Cashflow-Based Liquidity Stress Test

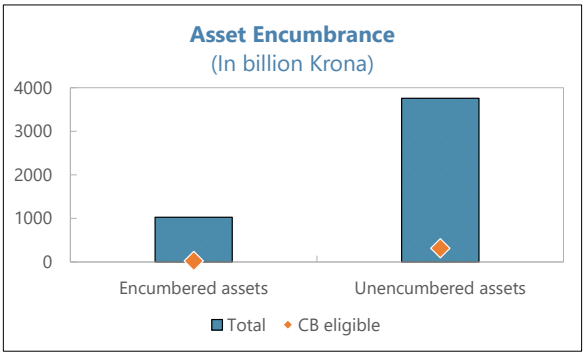
**68. The cash-flow based analysis assesses the adequacy of banks' liquid assets to offset large cash inflow and outflow shocks over time.** The cash-flow based analysis, which builds on maturity ladder data in the COREP report as of 2022Q3, focuses on net liquidity position, which is defined as the differences between cumulated net funding gap (sum of inflows minus outflows across maturity buckets) and cumulated counterbalancing capacity (sum of liquid assets across maturity buckets). If the net liquidity position became negative after utilizing the counterbalancing capacity, a liquidity shortfall would be recognized, and banks would not be able to meet further funding withdrawals.

**69. The maturity profile of banks reveals a certain level of maturity mismatch.** About 50 percent of total outflows are projected to take place in less than 30 days, with the open maturity bucket holding about 44 percent of total outflows. Retail and corporate deposits (both operational and non-operational) are the main contributor for short-term funding. Outflows from committed

facilities were considered immaterial at only 3 percent of total contractual outflows. At the same time, bank issued debt securities, including both secured and unsecured bond, tends to have longer duration, with over 90 percent maturing beyond one year. For inflows, 80 percent of total inflows is concentrated in loans and advances, of which 90 percent have a maturity longer than one year. This implies that banks will rely on the counterbalancing capacity to meet funding shocks for the short term and may experience liquidity shortfall over the longer term.

**70. Outflow and inflow shocks were calibrated based on several working assumptions.** First, higher run-off rates for wholesale funding than retail funding were applied to reflect the first mover advantage of better-informed sophisticated depositors than retail depositors. Second, run-off rates on secured funding sources are lower than unsecured funding sources. Third, non-resident deposits were placed in components subject to higher outflow rate as they are typically treated as unsecured funding source from the stability perspective. Fourth, the inflow parameters are in principle 100 percent of contractual inflows, except for inflows from loans to retail and corporate customers (0 percent). This replicates recent policy responses that allowed the postponement in repayment (debt moratoria) from distressed household and corporate borrowers amid the COVID-19 stress episodes and is consistent with the assumptions that banks are not allowed to deleverage (i.e., maturing loans are replaced by new loans) under stress testing scenarios.

**71. Large lending exposure of banks contributes to low asset encumbrance ratio**. At around 15 percent, the aggregated asset encumbrance ratio remains low and is contributed by a high share of unpledged loan exposure, consistent with the high concentration of lending on bank balance sheet. This led to a low share of central bank eligible assets out of the total unencumbered assets, since debt securities, which are mostly considered CB-eligible, remain at a low share. Going forward, banks could benefit from building up CB-eligible liquid assets to be able to tap into additional funding sources, either through CBI's liquidity facility or other wholesale funding market (e.g., repo market) to solidify their liquidity position.




**72. The cashflow liquidity stress test runs a set of embedded scenarios of increasing severity, for 5-days, 4-week, 3 months, and 12-month horizons.** Three stress scenarios with increasing severity (mild market stress, medium market stress and severe market stress) were applied to all banks. Each of the stress scenarios is combined with two different approaches to the counterbalancing capacity.

- Full CBC: fully endogenous liquidity supply by the central bank as long as banks have unencumbered eligible collateral.
- Full CBC with market haircuts: a full CBC is assumed, but market-specific haircuts and bank-specific market price effects are imposed on elements of the CBC.

Detailed stress parameters for the cashflow based stress test can be found in Table 3. Non-resident deposits are subject to higher shocks, via unstable wholesale deposits from financial institutions (both cross-border banks and NBFIs) and nonfinancial corporations, at up to 100 percent outflow rates under the most severe scenario. Furthermore, different from the LCR stress test which covers 30-day horizon, the cash flow analysis spans longer contractual horizon up to 12 months, including for both covered and uncovered bond, which were assumed at 70 and 100 percent outflows under the most severe scenario, respectively. Therefore, outflows assumptions from bond maturities were more conservative than the LCR stress test, without the need to impose additional shocks. The calibration of the scenarios weighs past stress episodes drawing from historical time series, previous FSAP stress parameters and regional experience in liquidity outflows in the Euro Area and Nordic region, while also taking into consideration important structural improvement in the Icelandic banking sector since the GFC. Market haircuts to CBCs draw from the outcome of market revaluation shock under the solvency stress test, and are also informed by the ECB valuation haircut when banks need to repo the liquid assets to the central bank.

**Table 3. Iceland: Cashflow Stress Test Parameters**

| Type | Item | Range of Run-off Factors (In Percent) across Mild, Medium and Severe Scenarios |
|---|---|---|
| Outflows | Unsecured bonds | 40-100% |
| | Regulated covered bonds | 25-70% |
| | Securitisations and others | 100% |
| | Repos across all asset classes | 100% |
| | Stable retail deposits | 2-10% |
| | Other retail deposits | 5-20% |
| | Operational deposits | 5-30% |
| | Non-operational corporate deposits & other | 20-100% |
| | Derivatives | 100% |
| | Committed facilities | 10-100% |
| | Outflows due to downgrade triggers | 0-100% |
| Inflows | Reverse repos across all asset classes | 100% |
| | Loan inflows from retail and corporates | 0% |
| | Loan inflows from central banks | 100% |
| | Loan inflows from banks and NBFIs | 30-100% |
| | Loan inflows from others | 0-30% |
| | Derivatives | 100% |
| **Type** | **Item** | **Haircut Based on Market Price** |
| Counterbalancing Capacity | Level 1 assets | 95% |
| | Level 1 covered bonds | 90% |
| | Level 2A assets | 85% |
| | Level 2B assets | 50-75% |
| | Other tradable assets | 50% |
| | Non tradable assets | 50% |

Source: IMF staff.

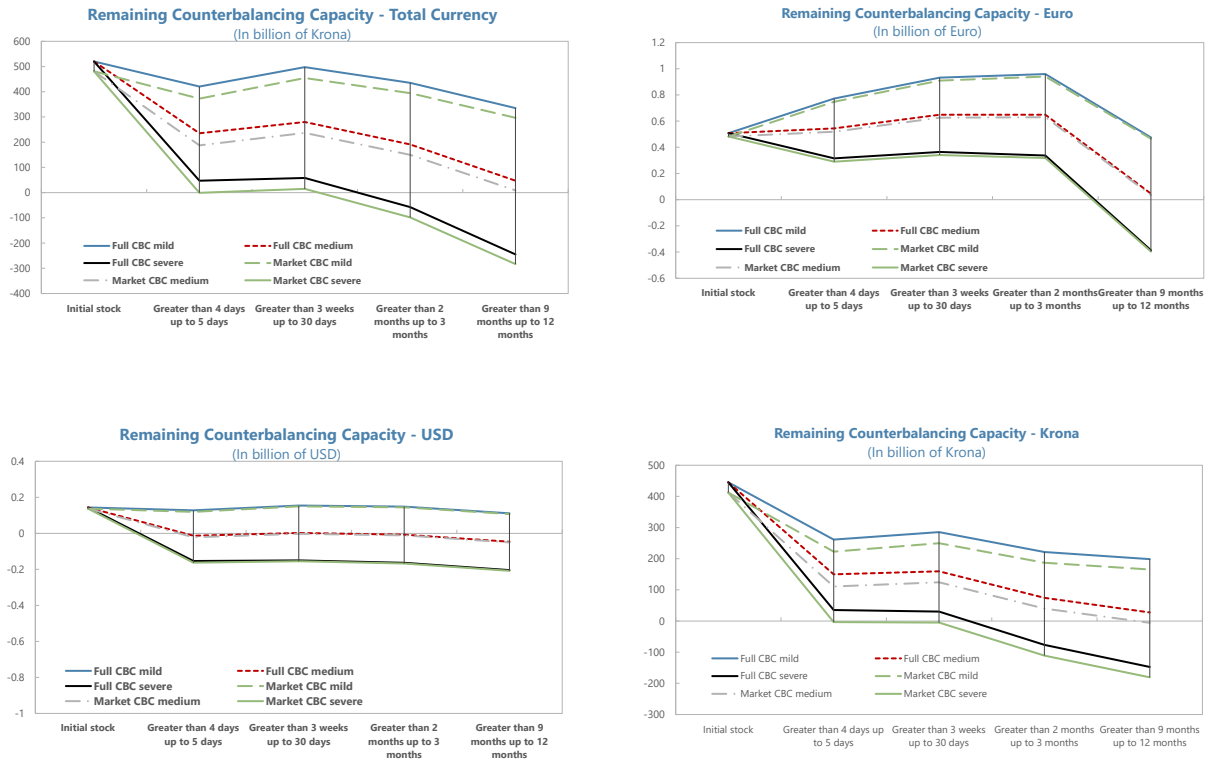
**73. Similar to the LCR stress test, the cashflow based stress test was also performed on major foreign currencies.** Using same assumptions as the total currencies stress test, a separate cashflow-based stress test was conducted on bank significant individual currency positions, for Icelandic Krona, Euro and U.S. dollar separately, to assess bank capacity in meeting large foreign

currency outflows over time. Out of the total banking sample, two banks report maturity ladder template in U.S. dollar while all banks report in Euro and Icelandic Krona.

**74. The bank cashflow-based stress test indicates potential liquidity gaps when extending the analysis beyond 30-days** (Figure 22)**.** Similar to the LCR stress test, banks on aggregate can broadly withstand liquidity outflows supported by their existing counterbalancing capacities in the short-term. However, their liquidity position becomes much weaker beyond 30 days owing to a maturity mismatch characterized by more frontloaded cash inflows and backloaded cash outflows, in particular as most of the unsecured and covered bonds are becoming due beyond 3 months. At the system level, cash shortfall over a 12-month horizon under the most severe scenario amounts to 283 billion, roughly 6 percent of total asset. Bank specific results reveals notable heterogeneity, as two banks would already experience liquidity shortfalls even within 30 days under the most severe scenario with a total cash shortfall at around 2.7 percent of total assets, due to lower counterbalancing capacity and higher outflows than inflows over the short term. Bank specific shortfalls over the 12-month horizon are more pronounced than system level shortfalls, at 348 billion, equivalent to 7.3 percent of total assets. This highlights the importance of regular monitoring of bank specific resilience to large liquidity shocks over both the short- and long-term.

**75. Cashflow-based stress tests focusing on individual currencies reveal common vulnerabilities to domestic and foreign currency denominated outflows** (Figure 22)**.** The cashflow-based exercises were also applied to significant currencies of the banks. The results paint a more adverse picture, as one bank experience liquidity shortfall in Euros while two banks experience shortfalls in US dollars and Icelandic Krona separately, even in the short term. Specifically, cash shortfalls over a 30-days (12-month) horizon were estimated at 0.03 (0.4) billion in Euro, 0.16 (0.2) billion in US dollar, and 108 (234) billion in Icelandic Krona, which represent 0.08 (1.3), 0.5 (0.6) and 2.3 (4.9) percent of total banking assets, respectively. Liquidity shortfalls at the system level, however, appear to be manageable. Over 30-day horizon, no liquidity shortfalls were identified in Euro while 5.1 and 0.2 billion of shortfalls were observed in Icelandic Krona and US dollar, representing 0.1 and 0.5 percent of total assets. Over 12 months, the shortfall became larger, at 0.4, 0.2 and 181 billion in Euro, US dollar and Icelandic Krona, representing 1.2, 0.6 and 3.8 percent of total banking sector assets. This confirms LCR findings that banks' liquidity positions are weaker in individual currencies, such as Icelandic Krona and US dollar, especially over the short-term.

**Figure 22. Iceland: Results for Bank Liquidity Stress Test**



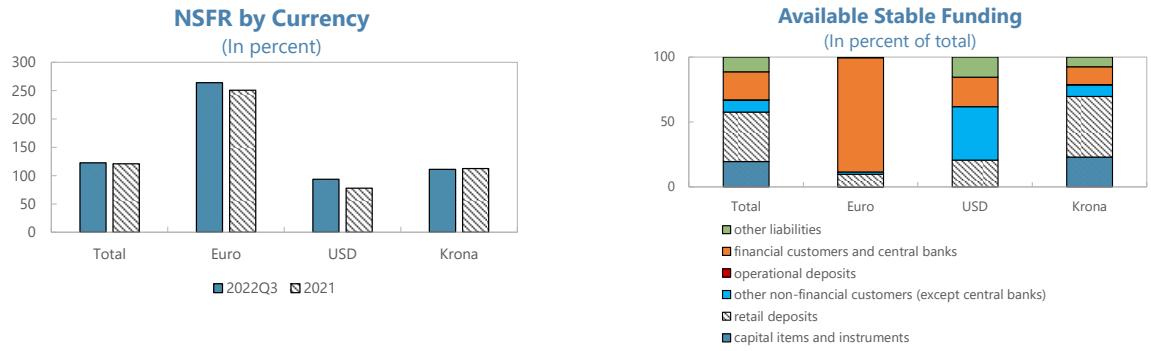

Source: IMF Staff.

## E. NSFR-Based Liquidity Stress Test

**76. There are notable variations in NSFR and stable funding composition across currencies** (Figure 23). As of 2022Q3, the aggregate NSFR of sample banks stood at 123 percent, above the minimum requirement of 100 percent with no single bank below the threshold. The aggregate NSFR has shown marginal improvement since 2021 but with notable heterogeneity across currencies. NSFR in Euro surpassed the others and stands at around 264 percent as of 2022Q3, well above NSFR in total currency and Icelandic Krona, at 123 and 111 percent, respectively. NSFR in US dollar appeared to be less stable, at around 93 percent. Funding composition also differs across currencies, as long-term Euro funding mostly came from other banks while US dollar funding originated mostly from non-financial investors. In the meantime, banks face higher binding constraint from MREL requirement which entails, on an ongoing basis, the issuance of sufficient amount of long-term subordinated debt by the banks to absorb large capital losses in the downturn. By design, such requirement would precede banks breaching the NSFR minimum requirement. Finally, the high

share of long-term loans on bank balance sheet and limited HQLA assets also lead to relatively higher needs of available stable funding (ASF).

**Figure 23. Iceland: NSFR Development**

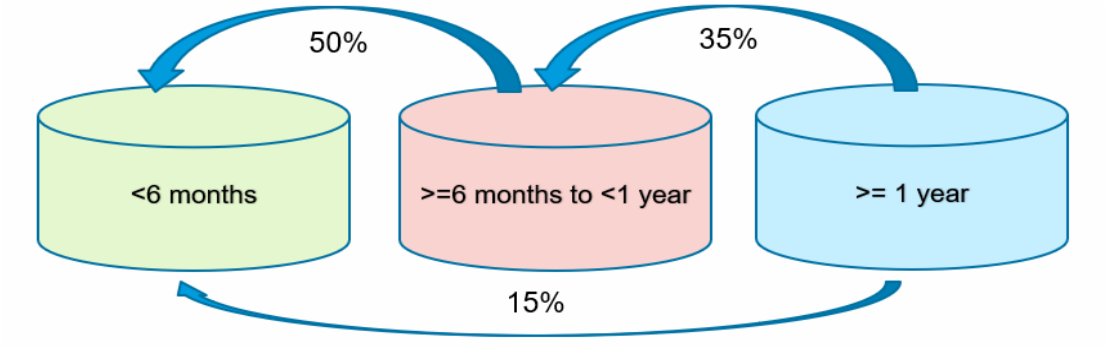



Source: ECB, CBI and IMF staff estimate.

**77. The NSFR stress test adopted a volume-based technique to simulate a migration from long-term to short-term funding.** The focus of stress test is to assess the risks associated with the overreliance on short-term unstable funding and excessive maturity transformation, and to test the resilience of the banks in managing funding risks over a long-term horizon by funding their activities with sufficiently stable sources of funding, in order to prevent systemic liquidity distress and promote funding stability. To this end, the exercise applied pre-defined migration rates from long-term to short-term funding for the following ASF instruments to simulate shocks on funding stability: retail deposits (stable and unstable), liabilities provided by other non-financial customers except central banks, liabilities provided by financial customers and central banks, funding from interdependent liabilities such as relevant credit and liquidity facilities, and other liabilities such as trade payables. Equity instruments were not stressed, assuming banks will not conduct stock transactions such as new issuances or repurchases.

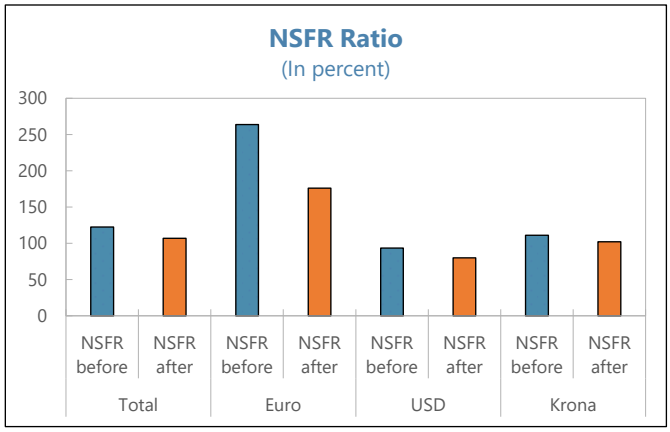
**78. The stress test assumed part of the long-term funding sources would be replaced by short-term funding** (Figure 24). This would require a flow of funding from long-term to short-term maturity bucket, while also allowing a higher migration of funding that is already close to the short-term time bucket. Therefore, the stress test assumed 50 percent of the funding within six- to twelve-month bucket would flow to less than six-month bucket, 35 percent of the funding with more than one year maturity would migrate to the six- to twelve-month bucket, while applying a 15 percent flow rate from over one-year bucket to the less than six-month bucket. The applicable required stable funding and ASF factor, on the other hand, were maintained under the stress scenario.

**Figure 24. Iceland: Methodology—NSFR Stress Test**




Source: IMF staff.

**79. The results of the NSFR stress test suggest banks on aggregate would be able to maintain a stable funding profile under stress, although there are bank and currency specific weaknesses.** The post-shock total currency NSFR saw no bank falling below the 100 percent threshold. Comparison across currencies shows that on aggregate, there is larger decline of NSFR in Euro than in total currencies and Icelandic Krona, though both of them stay above the 100 percent threshold. NSFR in US dollar would continue trailing other currencies at below 100 percent. Finally, individual bank results show one, one and two bank failing below the threshold for Euro, US dollar and Icelandic Krona, respectively.




## F. Recommendations

**80. The FSAP recommends CBI to enhance monitoring of LCR by currencies, and address outlier banks through Pillar 2 and supervisory actions.** Given that the CBI has been regularly monitoring liquidity conditions of the banks and conducting top-down liquidity stress tests, it could leverage its existing framework on both the LCR and cashflow stress test to introduce separate analysis on individual singificant currencies, such as Icelandic Krona, Euro and US dollars, and take preemptive measures to address outlier banks with weak liquidity position, potentially through Pillar 2 and supervisory actions, to ensure that the banks have adequent FX liquidity buffer in each currency to withstand corresponding outflows over both short term and long term.

# BANK INTERCONNECTEDNESS ANALYSIS

## A. Domestic Cross-Sectoral Interconnectedness

**81. The Icelandic balance sheet exposure is rising, and the interconnectedness across domestic sectors is high and concentrated** (Figure 25). Households are highly exposed to pension funds which play a vital role in the domestic financial sector. Pension funds are large and highly interconnected with domestic banks and other financial institutions (OFIs) through deposits, debt securities, and equities. Pension funds also hold significant government bonds, exposing the pension system to sovereign risk.

**82. The driving force of balance sheet exposure mainly comes from household and pension fund asset growth.** Households' assets have been increasing, reaching 307 percent of GDP by 2021. Except during the pandemic, household debt has overall been on a downward trajectory since the GFC, leading to a considerable increase in net assets (Figure 25). The strong financial position enables households to provide significant funding to the economy. A significant portion of households' financial assets are exposed to pension funds and banks in the form of pensions (64 percent of the total) and deposits (13 percent of the total). Households are also indirectly exposed to sovereign risk through the financial system. In addition, households are linked with domestic banks and OFIs from corporate debt exposures (text chart[29]).

**83. The pension fund sector as a whole has a systemic role, acting as investor and lender to the economy.** At end-2022, pension funds' assets amounted to 176 percent of GDP, accounting for 42 percent of total financial sector assets. Their exposures from domestic banks have increased from 250 bn ISK in 2017 to 670 bn ISK in 2021, equivalent to an increase from 6 percent to 10 percent of total pension assets. Some pension funds are active in the mortgage market, offering mortgage loans to their members. By end-2022, the mortgage lending outstanding amounted to 8 percent of the pension funds total assets, accounting for 22.7 percent of the outstanding mortgage loans in the market. Pension funds also hold a considerable amount of domestic sovereign bonds, representing 21 percent of total assets. This indicates significant potential exposures to sovereign credit risks. Moreover, pension funds' foreign assets have increased steadily in recent years, with foreign exchange exposures reaching 75 percent of GDP by 2021. Therefore, it is important to carefully consider and manage potential loss caused by exchange rate risk.

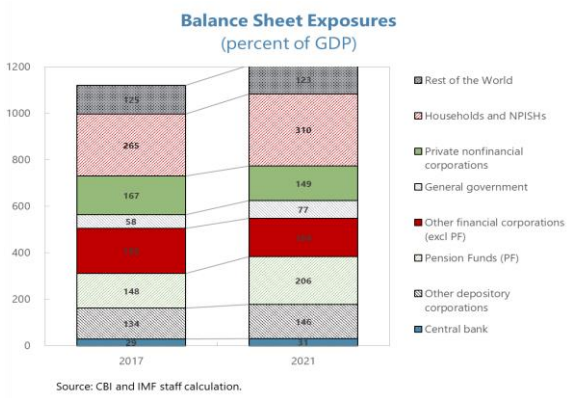
**84. Banks, Pension Funds, and OFIs are important in facilitating the transfer of funds from households, who are the substantial net lender, to nonfinancial corporations (NFCs) and the general government, who are primary borrowers.** By 2021, Iceland's net international investment

[29] The text chart reflects the domestic interconnectedness as of 2021. The size of nodes denotes asset size, and the thickness of edges denotes volume of exposures. Other financial corporates (ODCs) contain money market funds, non-MMF investment funds, other financial intermediaries, financial auxiliaries, captive financial institutions, and insurance companies. The data source is supervisory data.

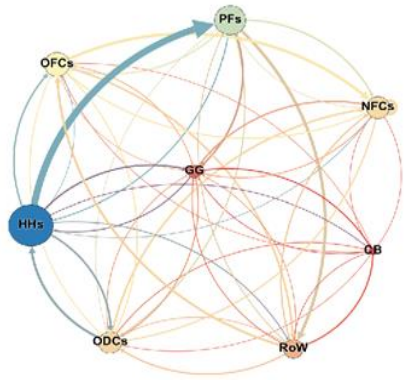
position (NIIP) has strengthened significantly, reaching more than 40 percent of GDP. This indicates that Iceland has become a net creditor to the rest of the world.

## Figure 25. Iceland: Balance Sheet Exposures

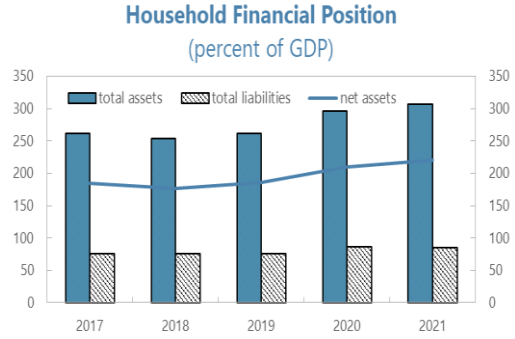
*Balance sheet exposure is on the rise, mainly driven by the growth of households and pension funds.*




*Households and pension funds also play dominating roles in the inter-sectoral financial network.*

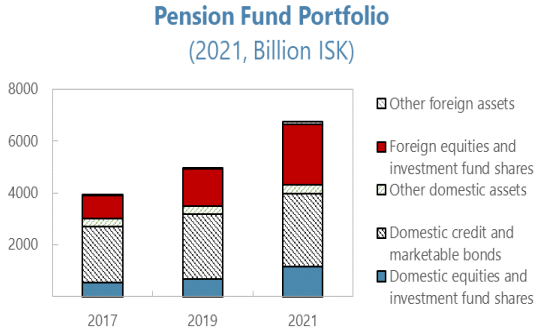



*Households' financial position remained strong…*



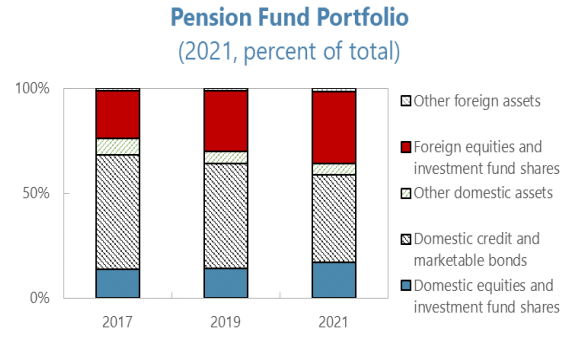

Source: CBI and IMF staff calculation

*Pension funds' assets continued to go up, underlining their important role in domestic mortgage market and bond market…*



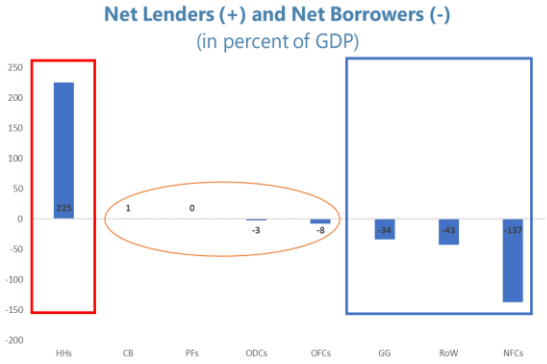

Source: The Icelandic Pension Fund Association

*…with increasing foreign asset exposure.*



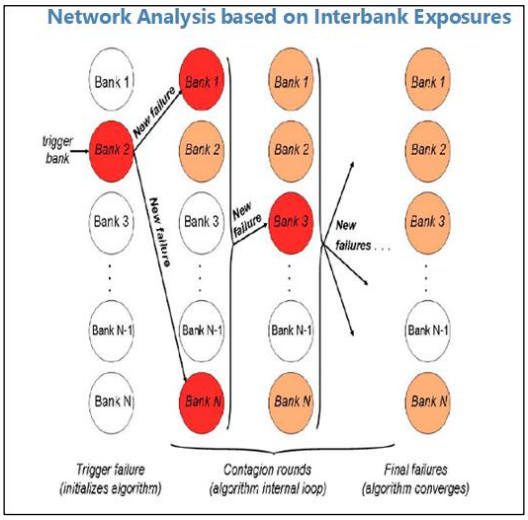

Source: The Icelandic Pension Fund Association

*Households are net lenders; the government, nonfinancial corporates and the ROW are net borrowers.*



## B. Domestic Interbank and Bank-NBFI Network

**85. Contagion risks within the Icelandic banking system were assessed using a network model developed by Espinosa-Vega and Sole (2010).[30]** The model simulates the cascading effect of the failure of a network of banks due to credit and funding shocks. The simulation takes iterations, producing a sequence of bank failures until there is no more failure in the system. A bank is assumed to default when the bank's CET1 ratio drops below 4.5 percent.[31] We assume an initial credit shock to a bank in the system; the bank will default on its debt obligations to its creditors. Creditor banks who are impacted, by assumption, will use their capital to absorb such unexpected losses. If the capital becomes insufficient, they will default, further affecting their creditors. We assume the parameter λ to represent the loss ratio on the exposure claims during a credit shock. In the case of a funding shock, we believe a distressed bank can no longer provide funding to its previous debtors. By assumption, a ρ fraction of the funding is lost, so the debtor bank can only replace (1-ρ) fraction of the previous funding with alternative sources. As a result, they sell their assets at a discount (δ) to compensate for the lost funding, which causes an additional asset worth δ*ρ in the book value term. The debtor bank's capital will absorb the funding shortfall-induced loss. Once insufficient, it will fail (See an example of simulations in the table above).




| Simulation # | Loss Given Default (λ) | Funding shotfall (ρ) | Haircut on fire sales (δ) |
|---|---|---|---|
| 1 | 0.6 | 0.3 | 0.1 |
| 2 | 0.7 | 0.5 | 0.2 |
| 3 | 0.8 | 0.2 | 0.3 |
| 4 | 0.9 | 0.5 | 0.4 |

**86. The test output produces two main indices which quantify domestic interbank linkages:**

- **Index of contagion** measures the average loss of other banks due to the failure of a bank i. The index is computed as $Cont_i = 100 * \frac{1}{N-1} \Sigma_{j=1,j\neq i}^{N} \frac{Lji}{Kj}$, where N denotes the total number of banks in the system, $Lji$ is the total capital loss of bank j due to the bank i's default, and $Kj$ denotes the capital of bank j.

- **Index of vulnerability** measures the average loss of bank i due to the failure of all other banks. The index is computed as $Vuln_i = 100 * \frac{1}{N-1} \Sigma_{j=1,j\neq i}^{N} \frac{Lij}{Ki}$, where N denotes the total number of

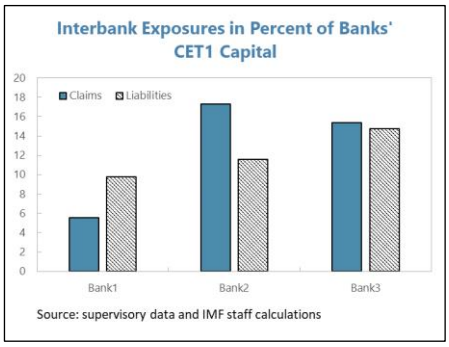
[30] Espinosa-Vega, M., and J., Sole, 2010, "Cross-Border Financial Surveillance", IMF WP 10/105,

[31] According to Basel III capital and liquidity rules, all banks must have a minimum CET1 to risk-weighted assets (RWA) ratio of 4.5 by 2019.

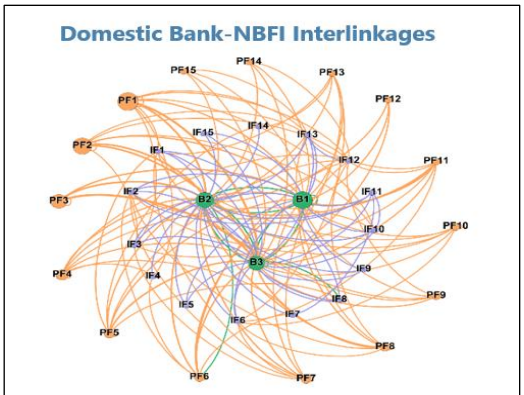
banks in the system, $Lij$ is the total capital loss of bank i due to the default of bank j, and $Ki$ denotes the capital of bank i.

**87. Iceland's domestic banking system is concentrated and interconnected with Non-bank Financial Institutions (NBFIs).** The banking sector comprises four commercial banks and five saving banks, taking up 146 percent of the GDP. The system is dominated by three commercial banks, accounting for 95 percent of total banking assets. Therefore, our interbank exposures analysis matrix contains the three largest commercial banks. The exposure matrix is the total interbank loans and securities collected from the authority and covers each bank's interbank assets and liabilities vis-à-vis each other as of 2022Q2.

**88. The domestic interbank contagion analysis reveals that contagion risks stemming from interbank exposures through credit and funding channels are very limited.** The domestic interbank exposures are small, especially relative to the capitalization of banks. For the three banks in the system, their gross domestic exposures are much smaller than their regulatory capital. Therefore, the test results should manifest, whether under a credit shock or in the face of credit and a funding shock concurring. No single failure of a domestic bank would trigger the failure of other banks in the system. In addition, none of the three banks are found to be undercapitalized[32] after shock. Bank 1 is the most contagious, meaning the default of bank 1 would bring the most server percentage of capital loss to other banks in the system. On the contrary, bank 2 is the most vulnerable, indicating the capital loss rate of bank 2 due to the default of all other banks is the most significant (Figure 24).




**89. The domestic bank-NBFI interlinkages are remarkable, causing a more pronounced effect when shocks propagate through the system.** Except for the three systemic important banks, we consider the largest 15 pension funds and the largest 15 investment funds. In this network, pension funds are the primary creditors having 80 percent of asset exposures from banks and investment banks. In contrast, banks are the primary borrowers holding 94 percent of the total liabilities in the Bank-NBFI system. Banks are the most contagious in the case of a credit shock, causing the most severe capital loss to other institutions. The contagion indices of pensions and investment banks remained limited (Figure 26). Regarding the inward spillover (index of vulnerability), the test results vary




Source: CBI and IMF staff calculation.

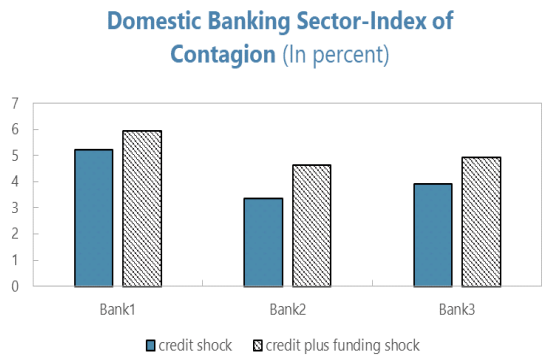
Note: The size of nodes denotes asset size, and the thickness of edges denotes volume of exposures. The chart reflects the interlinkages within banks (implied as B*n*), investment funds (implied as IF*n*), and pension funds (implied as PF*n*).

[32] Undercapitalization is when the bank's CET1 level drops below 4.5 percent.

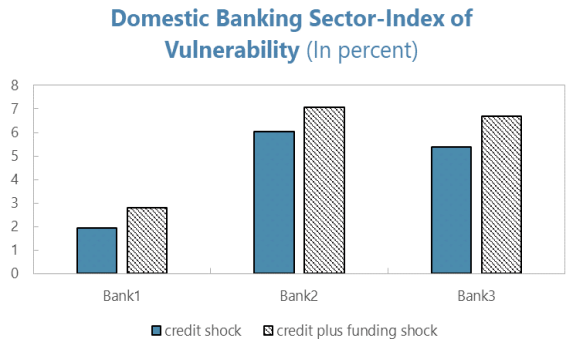
across the type of shocks and institutions. One pension fund and several investment banks are found to be more vulnerable to credit shock than the others, albeit the overall vulnerability level for all institutions remained under 2.5 percent. Banks are the most vulnerable to funding shocks, given their role as the primary borrower in the network.

## Figure 26. Iceland: Domestic Systemic Interconnectedness Test Results

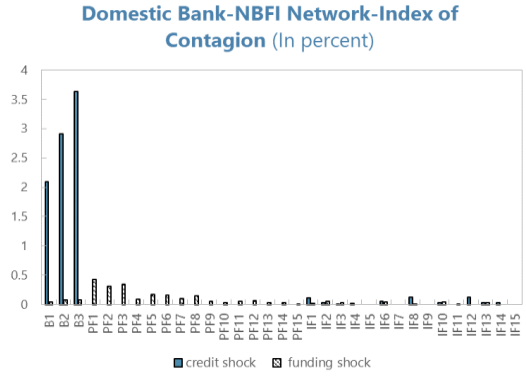
*Bank 1 is the most contagious bank…*



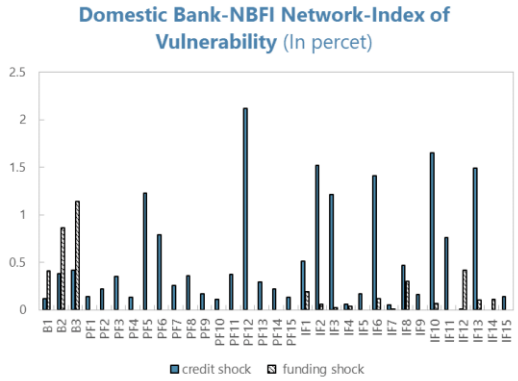

*…Bank 2 is the most vulnerable bank.*




*Banks are very contagious in the case of a credit shock; the contagion index of pension funds and investment funds remained limited…*




*…Few pension funds and investment funds in general are more vulnerable to credit shock; banks are vulnerable to funding shock.*




Source: Supervisory data and IMF staff calculations.

Note: Index of contagion index measures the average loss of other banks due to the failure of a certain bank. Index of vulnerability measures the average loss of a certain bank due to the failure of all other banks in the system.

## C. Cross-Border Interbank Contagion

**90. Fifteen years after the global financial crisis, Iceland has regained a high degree of capital mobility following a period of pervasive capital controls that were gradually lifted over time.** Its integration to global financial markets provides it access to a world of investment, funding, and financial risk sharing opportunities but also exposes it to cross border risks. Time series measurements of the degree of mobility vary, but they coincide in the view that (i) Iceland's long period of high capital mobility was interrupted with the global financial crisis, and that (ii) by 2022 Iceland's degree of capital mobility levels was at least as high as in the early 2000s, or higher (Chin and Ito, 2006, Fernandez and Others, 2016). All the capital flow management measures introduced during the global financial crisis have been removed, and the parameters of those adopted later to stem large capital inflows into government debt markets have been deactivated. In particular, the reserve requirement rate on selected capital inflows adopted in 2016 has been set to zero, but they remain as a possible tool under certain circumstances in the legal framework.

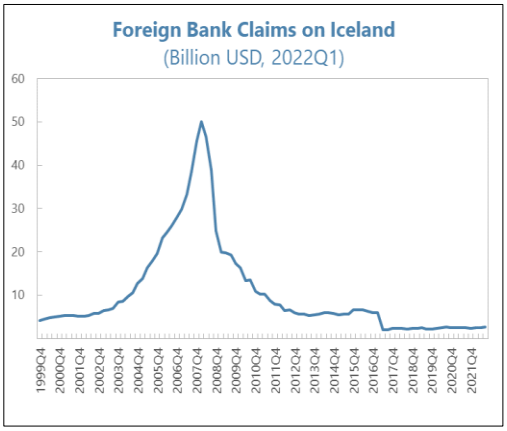
**91. By end 2022, the net foreign asset position of the financial sector was positive, but significant differences exist among types of institutions.** Icelandic banks have an aggregate negative net foreign asset position of about 13 percent of GDP (about 60 percent of capital), but the sizable international reserves of the central bank turn the net foreign position of the banking system positive. In turn, the significant savings of pension funds and other institutional investors abroad further increase the positive net foreign asset position of the financial system.

**92. While banks have a negative net foreign asset position, their exchange rate risk is limited because banks are subject to conservative limits in the net open foreign exchange positions (in percent of capital) they can take.** Banks manage to bring their FX positions within the limits by holding foreign currency denominated assets, in the form of deposits abroad, loans to nonresident corporations typically related to Icelandic firms, direct loans to Icelandic firms that generate foreign exchange, or by taking coverage in derivative contracts. Banks are also subject to regulations on the liquidity of their foreign currency portfolios, and the liquidity of these positions under stress is tested in section 7 systemic liquidity analysis.

**93. The eventual effect of nonresident outflows from the banking system, in principle, could be partly alleviated with central bank backstop facilities or redirection of some of the foreign pension assets abroad into FX denominated instruments by domestic banks.** Most bank cross border liabilities arise from the issue of medium-term foreign currency denominated bonds. While this protects banks against immediate withdrawals, it exposes banks to refinancing risks (access or rates) when bonds amortizations are due. In normal times, banks would deal with these events through refinancing in international capital markets or by undertaking operations in

the foreign exchange market. In stressful situations in which market access becomes more difficult or costly, the central bank could provide against collateral FX support including in the form of FX swaps or by intervening in the foreign exchange market providing the FX liquidity that may be needed. Alternatively, banks may issue FX debt instruments, such as FX denominated covered bonds, that pension funds could purchase, if the price and recovery prospects are right.

**94. The cross-border interconnectedness stress analysis considers the supervisory data of Icelandic banks' total exposures to foreign counterparties and foreign banks' consolidated claims on Iceland from the BIS.** The data reporting date is 2022Q1. Cross-border exposures on a residency basis capture the role of financial intermediation by the financial center and exposures due to the establishment of subsidiaries and branches. The contagion analysis applies the same Espinosa-Vega and Sole (2010) model and parameters used in the domestic contagion analysis (lambda is set to 70 percent, delta is 50 percent, and rho is 35 percent).




**95. The cross-border exposures are geographically clustered with European countries, the U.S., and Canada.** The data shows that over two-thirds of Icelandic banks' foreign exposures come from Europe. Around 30 percent of exposures are vis-à-vis the U.S. and Canada. We consider the impact of a credit shock on the total exposure of the banking sector, including claims to banks, the government, and the nonfinancial sector.

**96. The result suggests that the Icelandic banks are not a source of contagion risk to other major economies but can be negatively affected due to inward spillovers from other financial centers.** Nevertheless, the Icelandic banking sector remains resilient after the shock, and the capital level is above the regulatory minimum (Figure 27). The inward spillover from the U.S. is the most significant among our sample countries.

## Figure 27. Iceland: Cross-Border Interconnectedness Test Results


Source: Supervisory data, BIS consolidated banking statistics and IMF staff calculations.

Note: Iceland CET1 ratio in right bottom panel denotes impact on Iceland capital ratio after simulating credit shock on each of its counterparty country.

## D. Market-Based Interconnectedness Analysis

**97. To complement the balance-sheet exposure data analysis, we also applied the measures developed by Diebold and Yilmaz (2014)[33], which measures the financial market spillovers.**[34] One can understand the occurrence of a financial market spillover from one country to another by examining the proportion of the changes in country A's asset returns that can be linked to disruptions in country B's asset returns. The transmission of financial stress can be measured by gross contributions. The gross outward spillover measures the fraction of one economy's spillover contribution to all spillovers of other economies. In comparison, the gross inward spillover measures the fraction of all possible spillovers an economy receives from others. The difference between the inward and outward spillover reveals whether a country is a net receiver. The market-data-based test uses daily stock price indices and sovereign CDS returns, covering 14 and 11 countries respectively. The data comes from Bloomberg and Haver. The data reporting date is between 2009/01/06 and 2022/11/21. Countries in the sample have strong financial or market linkages with Iceland and data coverage during the reporting period. Returns are computed as a two-day log difference to control for the global trading hour difference.[35]

**98. The results show that global financial conditions have a strong effect on Icelandic financial conditions. The Icelandic stock market is highly interconnected with the foreign market, and Iceland is a net receiver of stock return spillovers in the global market** (Figure 28 and 29). The cross-border linkages in monetary policy or financial regulations can attribute to the connections. The spillover indices demonstrate that among the countries that have close economic and market linkages with Iceland, France, the Netherlands, and Germany are the primary equity return volatility contributors to Iceland. Except for the United States, the net contributors are clustered in Europe.

**99. Iceland is also a net receiver when there are sovereign credit risk spillovers across the network** (Figure 28 and 29). Among the countries in our sample, Iceland is the primary net receiver of sovereign CDS return spillover, which can be explained by multiple reasons, such as the market size and the country's sovereign credit situations. On the contrary, Italy appears to be a primary source of net return connectedness to all other countries in the sample, followed by France and Belgium.

[33] Diebold, Francis X., and Kamil Yilmaz. 2014. "On the Network Topology of Variance Decompositions:

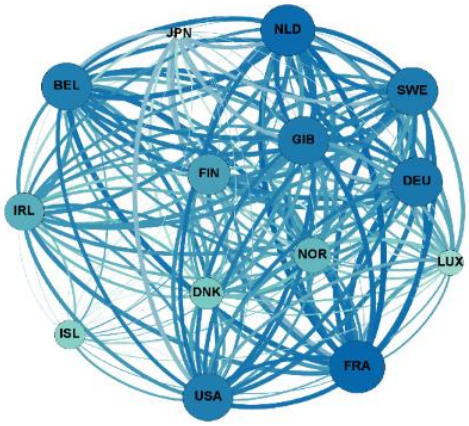
Measuring the Connectedness of Financial Firms," The Economic Journal 119 (January), 158–171.

[34] While this methodology is meant to complement the balance sheet data analysis, and the data are publicly available and easy to acquire, it has its disadvantages. The key caveat here is that this methodology cannot identify causality. In addition, it does not distinguish the directions of co-movement in equity prices, since negative or positive price responses to shocks are taken as the same in this model.

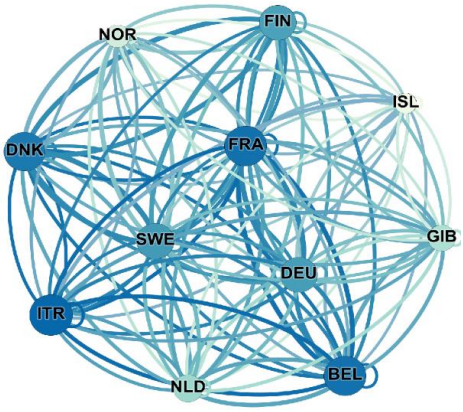
[35] Holidays are not included in trading days. We drop a missing date when more than half of the countries have missing values on that specific date. The reaming missing observations are interpolated based on existing observations.

## Figure 28. Iceland: Cross-Border Interconnectedness by Sector

*Total Stock Return*



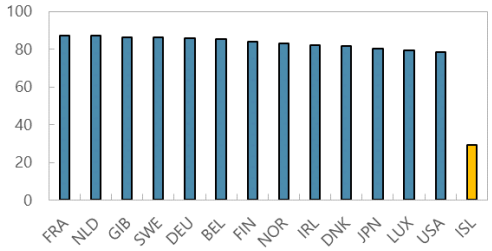

*Sovereign CDS*



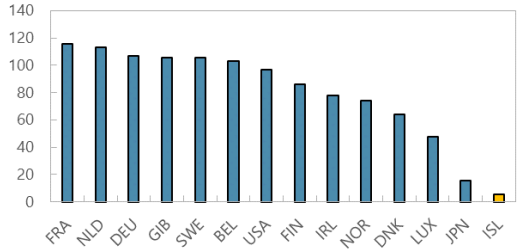

Source: Bloomberg, Haver, and IMF staff calculations.

## Figure 29. Iceland: Gross and Net Contributions to Systemic Risk

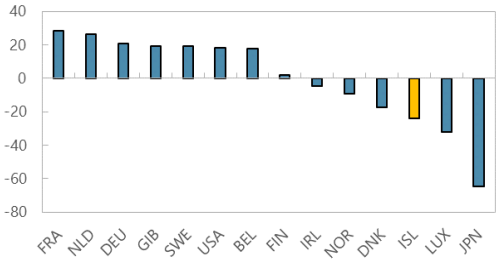
### Stock Market: Gross Inward Spillovers




### Stock Market: Gross Outward Spillovers




### Stock Market: Net Contribution to Systemic Risk




### Sovereign CDS: Gross Inward Spillovers

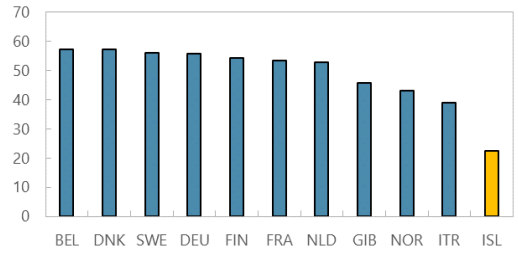
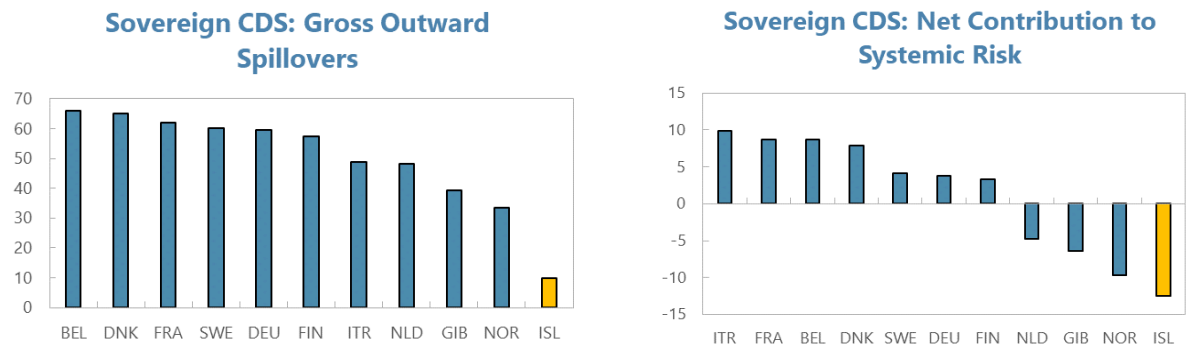


**Figure 29. Iceland: Gross and Net Contributions to Systemic Risk (concluded)**




Source: Bloomberg, Haver, and IMF staff calculations.

Note: The gross outward spillover measures the fraction of one economy's spillover contribution to all spillovers of other economies. In comparison, the gross inward spillover measures the fraction of all possible spillovers an economy receives from others. The net contribution is the difference between the outward and inward gross spillover.

# SYSTEMIC LIQUIDITY ANALYSIS

## A. Introduction

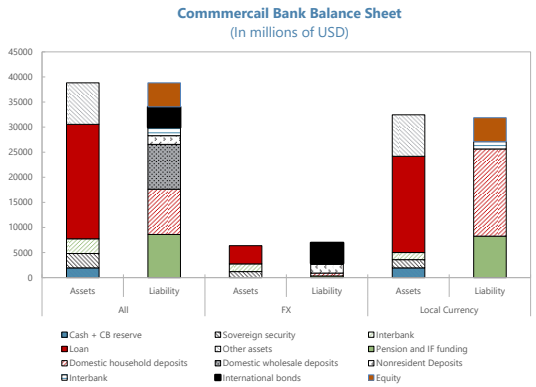
**100. As a small open economy with a concentrated banking system, Iceland is highly exposed to adverse systemic liquidity event, driven by both domestic and global factors.** For example, an exit of foreign investors from the financial system could lead to sizable withdrawal of FX deposits, outflows from bank bond maturities or early redemptions, or sales of existing holdings of domestic sovereign securities, potentially leading to asset price spirals. Given that the three D-SIBs in Iceland are very similar in terms of business model, they are susceptible to a higher level of reputational risks than other counties under stress. An idiosyncratic FX liquidity stress could be easily transmitted to other banks due to a sudden confidence loss in the entire financial system, thus amplifying the initial shock.

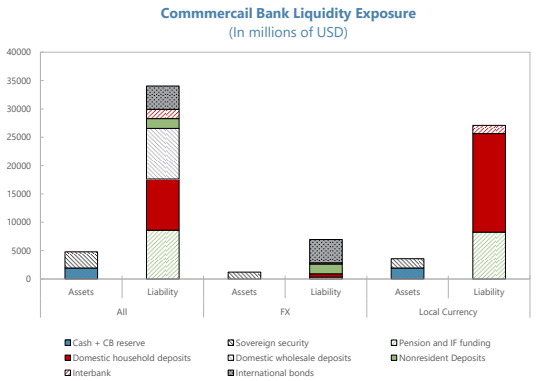
**101. The systemic liquidity stress test attempts to uncover important transmission channels of FX liquidity shocks among sectors and assess the adequacy of FX liquidity buffers in the financial system.** By using aggregated cross-sectoral flow-of-funds data, the exercise mapped FX liquidity linkages among various sectors in the economy to identify 1) the key sectors in providing FX liquidity in the financial system, 2) the key transmission channels of a FX liquidity shock, such as via direct FX liquidity withdrawal or via currency conversion into FX from local currency as an additional form of capital outflows due to a loss of confidence, 3) the adequacy of the FX liquidity buffer in the banking sector to withstand FX outflows, for instance from pension funds, investment funds or foreign investors, and 4) the capacity of the CBI in providing FX liquidity support to meet market FX demand in times of stress, especially from commercial banks. The exercise uses bilateral sectoral claim data at the aggregated level as of end-2021, and covers central bank, commercial banks, pension and other NBFIs (including investment funds), corporates and households, and foreign investors or borrowers. The stress test assumes a combination of FX liquidity shocks with increasing severity, from FX deposits from nonresident deposits, households and nonfinancial corporates, asset reallocation of pension and other investment funds, as well as potential outflows from the maturities of international bonds. Two main types of output consist of ending FX liquidity balance of the banking sector and level of international reserves pre- and post- shock.

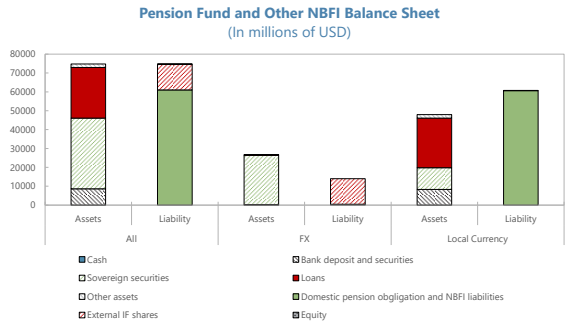
## B. Overview of Sectoral Balance Sheet and Systemic Liquidity Linkages

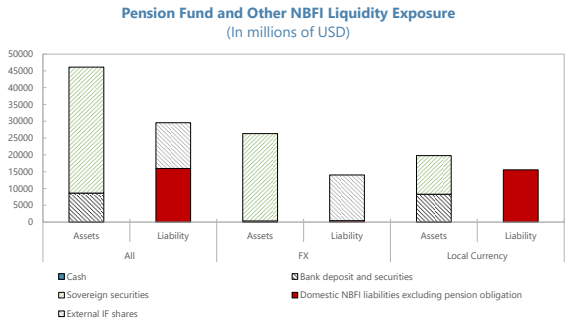
**102. Stylized balance sheet data suggest overall adequacy of the system FX liquidity buffer, although there could be sector specific imbalances** (Figure 30). Asset managers, including pension and other NBFIs, tend to hold more FX assets than FX liabilities, which make them the net FX lender in the market, reflective of their investment strategy and rising risk appetite towards foreign market. Most of their FX assets are also highly liquid and denominated in either bank FX deposits or marketable debt securities. Commercial banks, on the other hand, have a balanced FX position by mainly issuing FX deposits and bonds nonresident on the liability side, while issuing FX loans to the private sector and deposits to other banks, and investing in foreign sovereign securities. Nonetheless, when excluding less-liquid assets such as foreign currency loans from the balance sheets, commercial banks reveal certain FX imbalances, as they appear to have limited FX liquidity buffer to meet large FX withdrawals should such funding stress materialize rapidly.

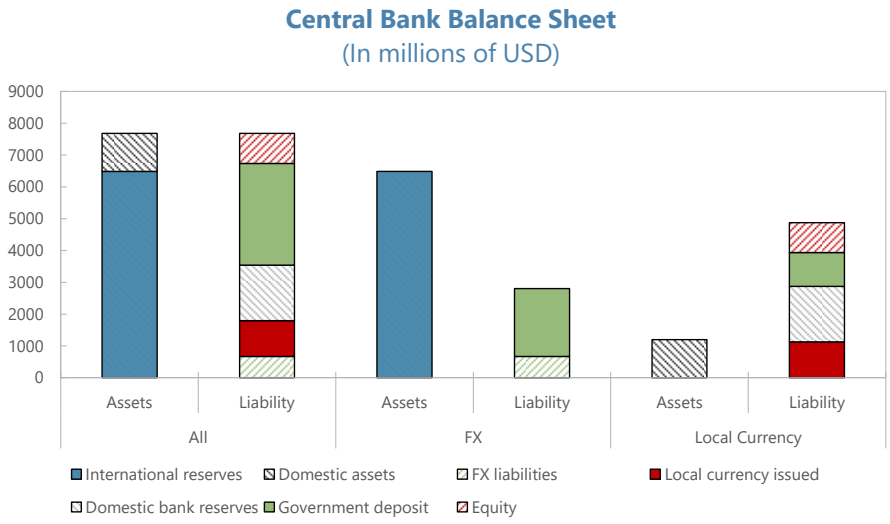
## Figure 30. Iceland: Stylized Balance Sheet by Sector




Source: IMF Staff.

**103. The CBI has ample international reserves.** As of end-2021, the gross international reserves stand at around 6.5 billion US dollar and are accumulated through either foreign borrowings or organically though trade surpluses, mostly via tourism activities. Out of total FX borrowings, roughly 67 percent are through the issuance of government bonds denominated in foreign currencies and placed at the CBI to boost the gross international reserves, while the rest comes from direct foreign liabilities of the CBI. As a result, the net international reserves, when netting out both forms of FX borrowings, amount to roughly 3.7 billion US dollar.

**104. The assets of pension funds abroad can also be a source of stability.** Under certain type of capital outflow movements, pension funds can provide stability to both domestic bond markets and the exchange rate market. For instance, when nonresidents suddenly disinvest in the domestic currency assets, perhaps through fire sales, to meet their own obligations abroad or to self-insure themselves against possible liquidity needs, pension funds could find it in their interest to temporarily take positions in the assets left behind by nonresidents liquidating some of their investments abroad at good prices in terms of ISK and dollars, factoring the currency depreciation. In so doing, they would be alleviating some pressure in both the foreign exchange markets and domestic bond markets. A similar equilibrating mechanism would take place if pension funds exceeded their foreign exchange investment limits, but in this case, the exchange of assets abroad for domestic assets would not necessarily be beneficial for pension funds and could affect the return of their portfolios. In deep crises that could scar the economy with long-term impact in productivity, in the interest of their pensioners, could temporarily bring assets from overseas at the appropriate rate of return and market exchange rates.

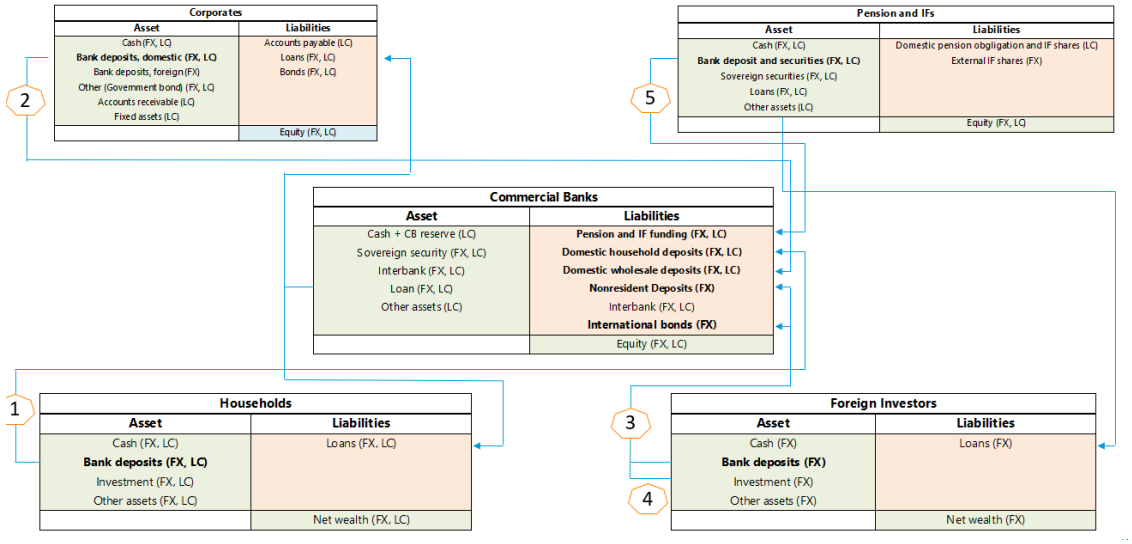
## C. Methodology

**105. The stress test simulates various liquidity outflow scenarios with increasing severity** (Figure 31). The exercise, which assumes a loss of confidence in the domestic market with ensuing capital flight, features a joint materialization of outflows from domestic household and corporate deposit, nonresident deposits, international bond maturity, as well as additional funding shock from pension and other NBFIs stemming from reallocation of assets from onshore to offshore. Such combined FX liquidity shocks are imposed with increasing severity to simulate high co-movement under stress and are benchmarked against either the existing LCR parameters over a 30-day horizon for household and corporate deposit outflows, or historical stress episodes observed in Iceland such as runoff rate for nonresident deposits. The assumptions on the outflow from international bond takes into account both the existing maturity structure, and potential early redemption which could lead to a higher outflow rate than the contractual amount. Additionally, a series of single factor sensitivity analysis was performed to gauge the relative contribution of individual shocks to the changes in the net FX liquidity position of commercial banks and international reserves. Finally, currency depreciation was assumed at 30 percent across all the adverse scenarios.[36]

[36] As currency depreciation could automatically increase the foreign investment ratio of the pension funds even in the absence of reallocation of assets, the assumption of a 30 percent depreciation under the adverse scenario could act as an offsetting factor to curb FX liquidity outflows from pension funds. Nonetheless, a milder outflow shock from pension funds does not alter the overall findings materially.

**106. The exercise allows local currency conversion which can amplify the initial FX liquidity stress** (Figure 31). Local currency (LC) conversion may occur when domestic and foreign investors attempt to move domestic assets cross-border. This may require investors (household, corporate, nonresident investors, pension funds and other NBFIs) to convert part of the local currency investment into foreign currency, further amplifying FX outflows from the system. Although it is not mandatory for the banks to facilitate this type of transaction, in this analysis we still assume a portion of local currency being converted to foreign currency to augment the initial capital flight, to take into account the mounting uncertainties of the global market and high volatility of liquidity flows observed in Iceland history.

**Figure 31. Iceland: Systemic Liquidity Stress Test—Transmission Channels and Shock Parameters**




| Shock | Variable | Range (In percent) | Local Currency Conversion Allowed? (Y/N) | Range of Local Currency Conversion |
|---|---|---|---|---|
| Shock 1 | HH FX deposit shock | [10,20] based on LCR | Y | [5,10] |
| Shock 2 | NFC FX deposit shock | [20,40] based on LCR | Y | [10,20] |
| Shock 3 | Nonresident deposit shock | [20,80] based on LCR and historical stress episodes | N | N/A |
| Shock 4 | International bond outflows | [15,30] | N | N/A |
| Shock 5 | Funding shock from pension funds and other NBFIs due to share redemption and asset reallocation | [20,40] | Y | [10,20] |
| Shock 6 | FX liquid asset haircut | [2,20] based on LCR and solvency stress test, lower haircut for global safe assets, higher haircut for other domestic FX assets | N | N/A |

Source: IMF staff.

**107. The exercise made certain behavioral assumptions on the pecking order of asset liquidation**. The exercise uses typical setup in the framework which assumes that banks would prefer to exhaust their existing FX reserves before liquidating other FX assets on their balance sheet. Other sectors use local FX bank deposit first before using other FX liquid assets on its balance sheet to withstand FX liquidity outflows.

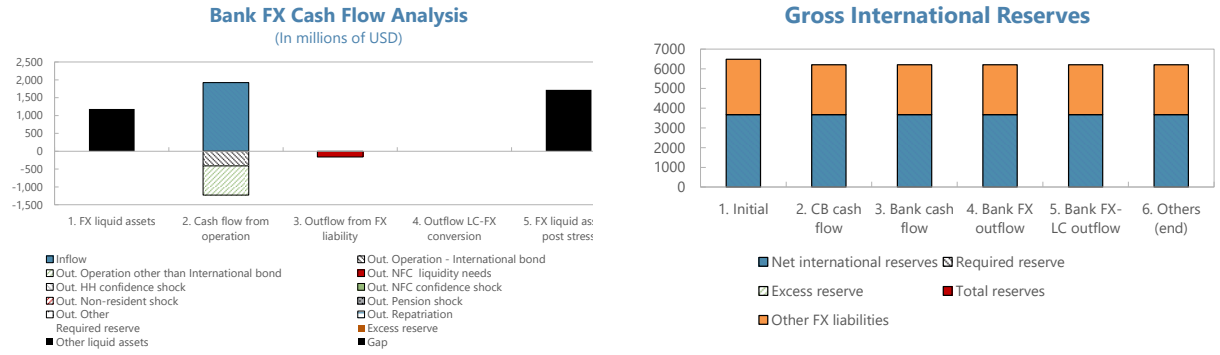
## D. Results

**108. The systemic liquidity stress test points to a meaningful FX liquidity gap of the banking sector** (Figure 32)**.** By imposing a combination of FX liquidity shocks from household, NFC, nonresident, pension and other NBFIs and international bond funding outflows, the analysis identified notable FX liquidity shortfalls of the banking sector, which points to the needs to further shore up FX liquidity buffers of the banks. Specifically,

- The baseline scenario, which assumes only inflows and outflows from normal operation without additional liquidity shocks, suggests that banks in general have sufficient FX liquidity buffer to meet FX regular financial and operational needs, without FX liquidity support from the CBI.
- The mild scenario which assumes mild deposit and bond funding outflows without local currency conversion also produces a comfortable level of FX liquidity buffer of the banks post shock.
- Under the severe scenario assuming larger shocks for all types of outflows, banks could face sizable FX liquidity gaps. Such gaps can be even larger when local currency conversion is allowed resulting in a maximum FX liquidity gap of 3.4 billion US dollars, about half of the gross international reserves. The gap would be larger should pension funds or other NBFIs decide to move some domestic assets offshore. Going forward, this finding warrant developing approaches to continuously monitor banks' liquidity risks associated with funding shocks from nonbank financial institutions (including pension funds) and foreign investors.

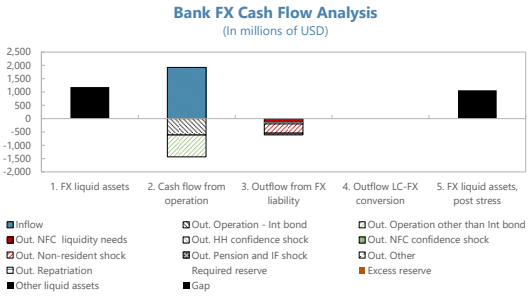
**Figure 32. Iceland: Results for Systemic Liquidity Stress Test**

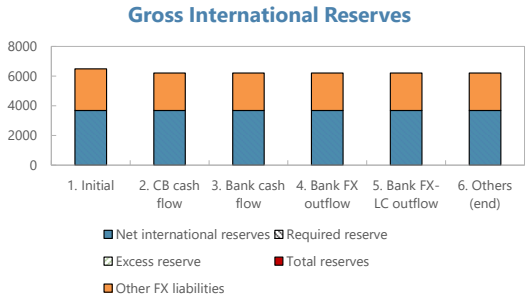
*Baseline scenario assuming business as usual.*



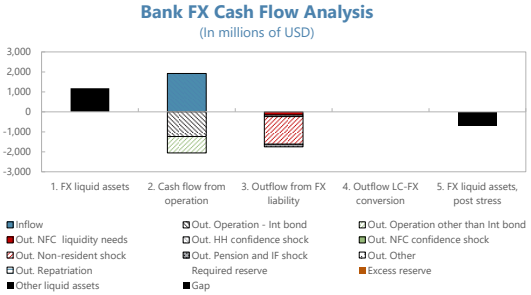
## Figure 32. Iceland: Results for Systemic Liquidity Stress Test (concluded)

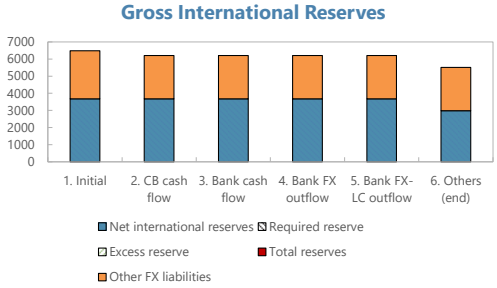
*Mild scenario assuming the following run-off rates: 10 percent for household FX deposits, 20 percent for NFC FX deposits, 20 percent non-resident FX deposits, 20 percent for pension and NBFI FX funding and 15 percent for international bonds.*



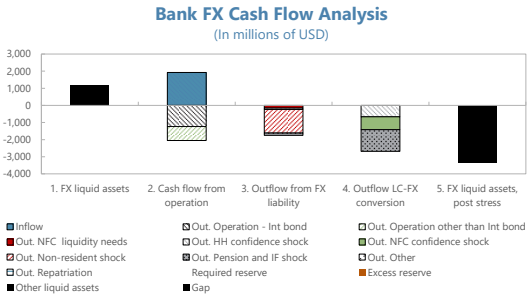



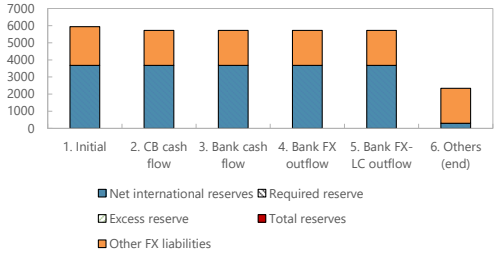

*Medium scenario assuming the following run-off rates: 20 percent for household FX deposits, 40 percent for NFC FX deposits, 80 percent non-resident FX deposits, 40 percent for pension and NBFI FX funding and 30 percent for international bonds.*




*Severe scenario assuming medium scenario with additional local currency conversion from household local currency deposits (10 percent), NFC local currency deposits (20 percent), and pension and other NBFIs funding (20 percent).*

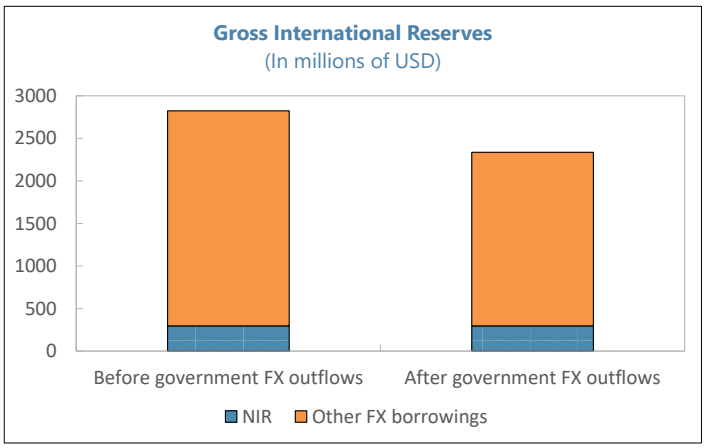



Source: IMF Staff.

Note: For the right panels, since there is currently no FX reserve requirement imposed on the Icelandic banks by the CBI, the value of required reserve, excess reserve and total reserve are set to 0.

**109. Nonetheless, the analysis confirmed the adequacy of the international reserves of the central bank and its capacity to backstop the FX liquidity needs of commercial banks under stress** (Figure 32 bottom panel). Specifically, both the gross international reserves and net international reserves remain positive under the most severe scenarios. However, such FX buffer may only be channeled to banks via direct central bank liquidity support or swap agreements with other European banks[37], as there is currently no FX reserve requirement or excess reserves from the commercial banks. Nonetheless the net international reserves post shock becomes significantly lower, due to the initial large netting effect from the local government FX deposit – obtained via the issuance of FX government bond - placed at the CBI. Out of the total FX government bonds outstanding, 500 million Euro is scheduled to mature in 2024. Another 500 million and 750 million will be paid off in 2026 and 2027, respectively. When assuming an additional 500 million Euro outflow from the CBI to meet the 2024 maturity, the gross international reserves would decrease by same amount, without impacting the net international reserves.




## E. Sensitivity Analysis

**110. The scenario-based systemic liquidity analysis was also complemented by a series of single factor sensitivity analysis to identify potential tipping points that could lead to FX liquidity strains of the banks.** The complementary exercise simulates a range of shocks for each source of FX liquidity outflows considered in the scenario-based analysis. Given the exercise assumes the materialization of a single shock instead of multiple shocks simultaneously, the severity of each shock was also augmented compared to scenario-based analysis, thus allowing the identification of potential tipping point leading to FX gaps of the banks driven by each risk factor, which is akin to a series of reverse stress tests. Since the size of the shocks are in general larger at the upper bound, the exercise can also be interpreted as banks experiencing sustained liquidity shocks over a longer term beyond 30 days. Specifically, the following shock variables and ranges of severity were considered independently:

- The outflow rates from international bond range from 20 to 60 percent.
- The outflow rates from non-resident FX deposits range from 40 to 100 percent.

[37] In 2008, the Central Bank of Iceland established swap arrangements with the central banks of Sweden, Norway, and Denmark for EUR 500 million. Having these types of arrangements could provide comfort to investors, thus reducing the likelihood and magnitude of systemic withdrawals of liquidity.

- The outflow rates of FX funding from pension fund and other NBFIs range from 20 to 40 percent, along with local currency conversion from 10 to 30 percent, respectively.
- The outflow rates of FX deposits from domestic households range from 10 to 20 percent, along with local currency conversion from 5 to 15 percent, respectively.
- The outflow rates of FX deposits from domestic corporates range from 20 to 40 percent, along with local currency conversion from 10 to 50 percent, respectively.

**Figure 33. Iceland: Single Factor Sensitivity Analysis**


Source: IMF Staff.

**111. The sensitivity analysis indicates that the single factor shocks would need to be sufficiently large to fully exhaust bank existing FX liquidity buffers** (Figure 33). For example, on the upper bound of the liquidity shocks, only a 60 percent international bond outflows and a 100 percent of non-resident deposit outflows would lead to marginal FX liquidity gaps in the banking system. Similarly, banks can withstand stand-alone shocks from households, corporate and NBFI FX funding shock up to 20, 30 and 30 percent, combined with LC conversions up to 15, 30 and 20 percent, respectively, as most household, corporate and domestic NBFI funding are denominated in local currency, and retail deposits are considered more stable than other types of deposits. Nonetheless, a high local currency conversion would need to be assumed for the FX outflows from the domestic sector to lead to a full depletion of banks' FX buffers. For instance, when the LC conversion for NFC (or NBFI) goes above 50 (or 30 percent), then the banking system would experience FX liquidity pressure, which could lead to small FX liquidity gaps at 154 or 320 million US dollars, equivalent to a 2.6 and 5.4 percent reduction of the gross international reserves, respectively.

## F. Recommendations

**112. The FSAP recommends CBI to develop stress testing approaches to assess funding risks from nonbank financial institutions (including pension funds) and foreign investors.** Given the close linkages between banks, NBFIs and foreign investors, the CBI could regualraly assess concentraiton risks of funding between sectors and conduct systemic liquidity stress analysis to simulate banks' loss of funding from NBFIs (including pension funds) and foreign investors, should they change their investment behavior by re-allocating assets cross border, as well as to ensure the capacity of the CBI to provide the needed FX liquidity support to the financial system in times of stress.

# PENSION FUND STRESS TEST

## A. Scope and Sample of the Analysis

**113. The FSAP conducted top-down and bottom-up risk analysis for pension funds.** Given the characteristics of a mostly defined-ambition (DA) regime in Pillar II[38], where pension members bear the investment risk, the impact of the adverse scenario was calculated on future pension values. Additional sensitivity tests, an assessment of liquidity risk, and work on pension funds' investment behavior and mortgage lending complemented the risk analysis.

**114. The Icelandic pension fund market, comprising the mandatory Pillar II and the voluntary Pillar III, is one of the world's largest, with assets of almost ISK 7 trillion at end-**

[38] For more details on the structure of the Icelandic pension system, please refer to the TN on Pension Fund Oversight.

**2022, or 176 percent of GDP.** Pillar II schemes are mostly designed as defined-ambition[39] and offered by 21 pension funds. In total, they manage ISK 5.9 trillion while Pillar III providers—besides pension funds, these comprise also banks and (foreign) life insurers—manage ISK 1.0 trillion in defined-contribution schemes. Both segments are rather concentrated, with the four largest providers in Pillar II holding a cumulated market share of 61 percent, and just two large providers in Pillar III accounting for almost half of the market (Figures 34A-B).

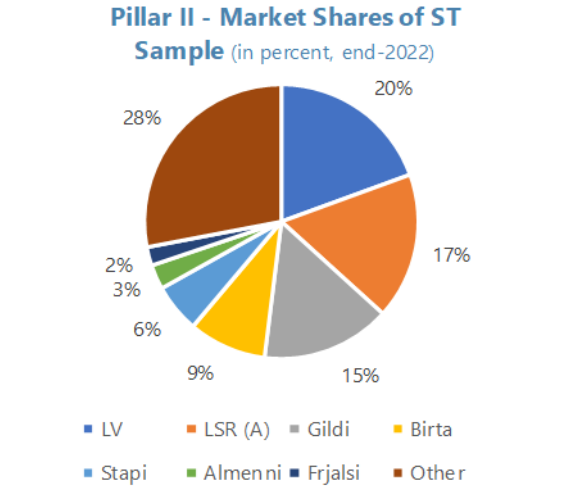
**115. Investment assets of Icelandic pension funds are dominated by stocks, inflation-linked bonds and loans, and foreign-denominated assets—at the same time, the pension fund sector is a major funding source for domestic banks, corporates and the sovereign** (Figure 34C). Directly held stocks account for 19 percent of Pillar II and 7 percent for Pillar III assets—further stock market exposures arise from substantial holdings in (mostly foreign) investment funds. Around one third of Pillar II assets is invested in inflation-linked fixed-income assets, including mortgages which as a subcategory account for 10 percent of assets. Fixed-income assets are to a large extent unrated, specifically domestic corporate bonds and mortgage loans, highlighting the need for pension funds to effectively manage their credit risks. Pension funds in Iceland provide substantial funding to domestic banks, across the different asset classes the combined exposure has increased from ISK 250 billion in 2017 to 670 billion in 2021, or from 6 to 10 percent of pension fund assets—this corresponds to 14 percent of banks' financial liabilities. Especially in Pillar III these exposures are mostly in the form of deposits, while being mostly bonds and stocks in Pillar II. The share of foreign-denominated assets has been increasing in recent years (Figure 34D). As of end-2022, 37 percent of Pillar II assets were denominated in foreign exchange (24 percent in Pillar III), mostly in US dollar. Resulting currency risks are typically not hedged, as pension funds consider foreign-denominated investments as a partial inflation hedge based on a long-term correlation of the value of the Krona and inflation rates.

**116. Icelandic pension funds have over decades maintained a very solid track record of achieving real investment returns, but 2022 ended with a markedly negative performance**. From 1995 to 2021, Pillar II pension funds yielded 4.3 percent on average in real terms. In about half of the years during this period, returns between 6 and 12 percent were achieved, but negative outliers like in 2008 (-22 percent) had a lasting impact. Also 2022 marked an unusually weak year with a negative real return of -12 percent for the median fund, resulting from a combination of negative returns both on the stock and the bond market, and a relatively high inflation rate. Due to the downturn, funding ratios of several DA schemes have dropped below 100 percent, but the large majority remained within the tolerance limits within which no adjustments to pension benefits were required.

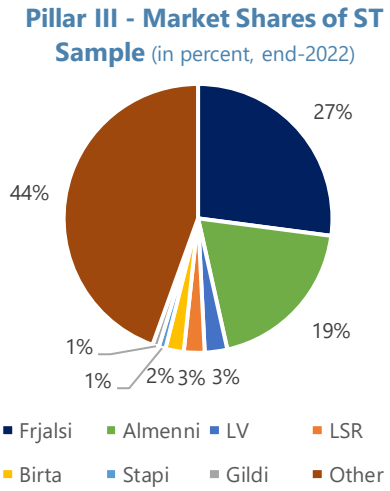
[39] Defined-ambition regimes in Iceland do not guarantee but target a minimum payout at retirement (56 percent replacement rate until 2022, and 72 percent from 2023 onwards). For more details, refer to the TN on Pension Fund Oversight.

## Figure 34. Iceland: Pension Fund Market and Asset Allocation

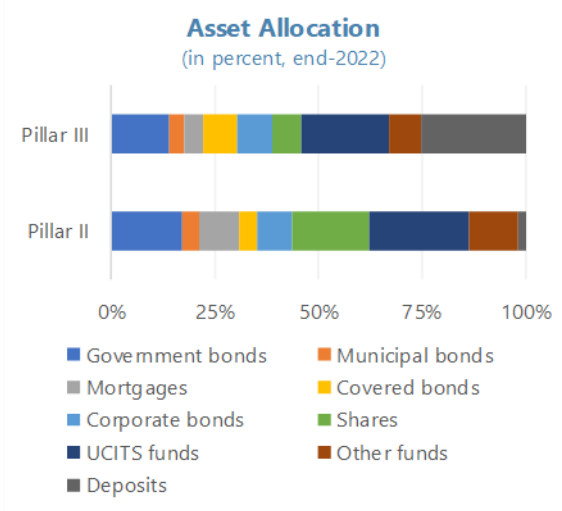
*A) The pillar II market is highly concentrated, and the DA schemes of the four largest providers account for a market share of 61 percent.*



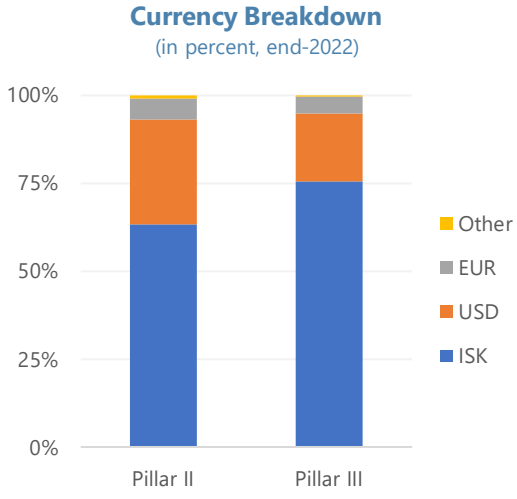

*B) In the Pillar III segment, two pension funds dominate. Further large providers stem from the banking and insurance sector and are not included in the risk analysis (here subsumed under "Other").*




*C) Pillar II assets growth-oriented with stock holdings of 19 percent and further indirect holdings through investment funds. Pillar III schemes are characterized by highly-liquid assets, incl. 25 percent in deposits.*




*D) 35 percent of pension fund assets are denominated in foreign currencies (37 percent in Pillar II), mostly in US dollars.*




Source: IMF staff calculations based on CBI data.

**117. For most parts of the analysis, the sample included the seven largest pension funds, thereby achieving a market coverage of 77 percent in terms of Pillar II DA assets.** Within the sample, the funds differ considerably in terms of size (Table 4): Based on assets, the largest pension fund is about nine times larger than the smallest, and based on active members the difference between the largest and the smallest entity amounts to a factor of four. Also, pension funds vary with regard to the average age of their members and average annual contributions, with some funds targeting particularly either blue-collar or white-collar employees. However, regarding the composition of investments assets, differences are much less pronounced. While funds with a younger membership typically invest more in shares, the share of foreign-denominated assets is rather similar in the sample, ranging from 33 to 42 percent.

**Table 4. Iceland: Pension Fund Sample**

| | | Minimum | Median | Maximum |
|---|---|---|---|---|
| Assets | *ISK bn* | 130 | 546 | 1,147 |
| Contributions (2022) | *ISK bn* | 8 | 15 | 40 |
| Number of active and deferred members | *thousands* | 35 | 84 | 237 |
| Number of active members | *thousands* | 14 | 21 | 55 |
| Average member age | *years* | 40.3 | 43.3 | 47.2 |
| Average annual contributions per active member (2022) | *thousands* | 473 | 732 | 1,209 |
| Shares (directly held) to Total assets | *percent* | 9 | 16 | 25 |
| Bonds at fair value to Total bonds and mortgages | *percent* | 7 | 24 | 33 |
| Foreign-denominated assets to Total assets | *percent* | 33 | 39 | 42 |

Notes: Data refers to Pillar II only and, unless indicated otherwise, to end-2022.
Source: IMF staff based on CBI data and company submissions.

## B. Scenario and Methodology

**118. The scenario for the projection of future pension values is derived from the adverse macrofinancial scenario which is also used for the banking sector ST.** The stagflation scenario, comprising, inter alia, intensifying spillovers from Russia's war in Ukraine, an abrupt global economic downturn, and a sudden correction in Icelandic asset markets, is highly relevant also for the pension fund sector. Accordingly, the most relevant market and credit risk variables for pension funds include interest rates, stock prices, the external value of the Krona, as well as the inflation rate (Table 5).

**Table 5. Iceland: Adverse Scenario for Pension Funds**

| | | 2023 | 2024 | 2025 |
|---|---|---|---|---|
| Interest rates | | | | |
| short-term (1y) | *percentage points* | 1.71 | -0.52 | -2.77 |
| long-term (10y) | *percentage points* | 2.12 | -0.23 | -2.79 |
| Stocks | | | | |
| domestic, listed | *percent* | -79.8 | -14.1 | 25.9 |
| domestic, unlisted | *percent* | -20.0 | -3.5 | 6.5 |
| foreign, listed | *percent* | -32.0 | -5.0 | 10.0 |
| foreign, unlisted | *percent* | -8.0 | -1.3 | 2.5 |
| House prices | *percent* | -13.5 | -8.8 | 8.0 |
| ISK External value /1 | *percent* | -30.6 | 0.4 | 8.3 |
| Inflation rate | *percent* | 11.9 | 10.8 | 4.3 |

1/ Negative values denote a depreciation of the Krona.

Source: IMF staff.

**119. The analysis of future pension values focuses on the difference at retirement age between the baseline and the adverse scenario**.[40] In both scenarios, the future pension value is being projected for representative members with 10 or 30 years to retirement. Their accrued pension benefit is shocked with the market risk stresses in each of the first three years of the projection horizon, 2023–2025, while afterwards annual investment returns would again be in line with the baseline scenario. For this baseline projection after t+3y, future investment returns are projected based on a bootstrapping of historic returns for individual asset classes, based on each pension fund's asset allocation as of the reference date. It is assumed that retirement funds maintain their asset allocation over the full projection horizon and re-balance it annually. Contributions during 2023–2025 are higher in the adverse scenario than in the baseline due to higher inflation. Contributions after t+3y are assumed to increase at a constant rate of 4.0 percent per year.

**120. Future pension values were simulated for two representative fund members, with different characteristics as regards their age, current accrued pension savings, and current contributions**:

- 10 years prior to retirement; ISK 25m accrued pension savings; ISK 1.2m annual contributions.
- 30 years prior to retirement; ISK 10m accrued pension savings; ISK 1m annual contributions.

[40] For more details on the scenario and the modeling, see the Pension Fund Stress Testing Matrix in Appendix IX.

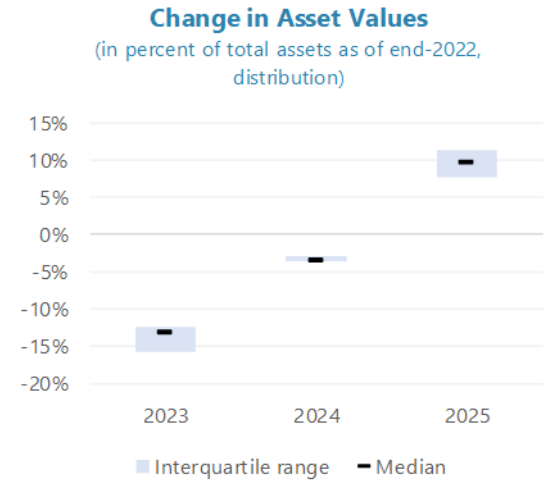
The analysis does not aim at modelling exactly the future pension value, but only the difference between the baseline and the adverse scenario.

## C. Impact on Future Pension Values

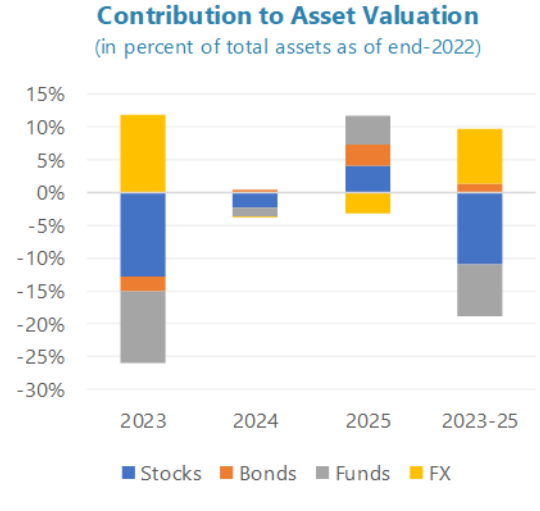
**121. In the adverse scenario, assets of pension funds would decline considerably in the first years of the projection horizon, ultimately also reducing future pension values materially** (Figure 35). For the median pension fund, asset values decline by 13 percent in 2023 and another 3 percent in 2024, before recovering in 2025 (+10 percent). Most of the valuation impact stems from lower stock prices, held both directly and through investment funds. Especially in the first year, the depreciation of the Krona counterbalances the decline through an increase in the value of foreign-denominated investments.

**Figure 35. Iceland: Impact on Pension Fund Assets**

*Asset values would decline substantially in 2023 (by 13 percent for the median pension fund), followed by further declines in 2024 and a partial recovery in 2025.*




*In the first year, pension funds are hit mostly through falling stock markets (also indirectly through fund holdings). The ISK depreciation would increase the value of FX-denominated assets.*

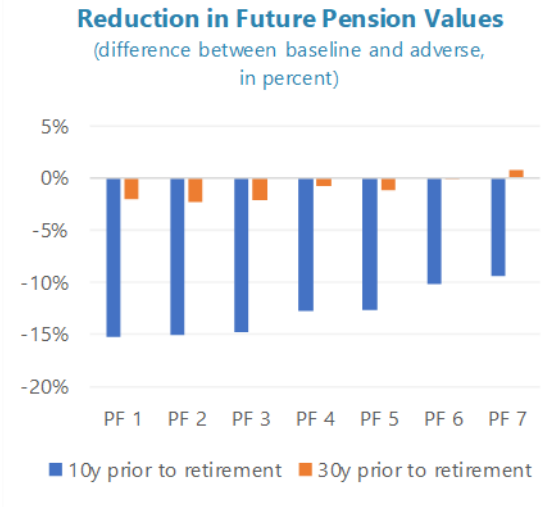



Source: IMF staff calculations based on CBI data.

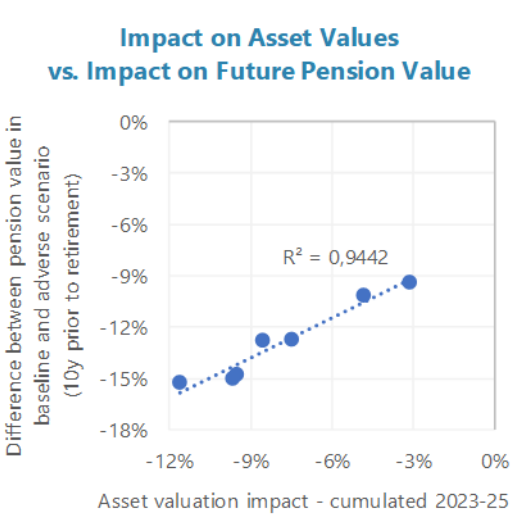
**122. The adverse scenario has a sizable impact on members with only few years to retirement** (Figure 36). Future pension values would accordingly decline by between 8 and 15 percent—and 13 percent for the median pension fund—for a member with 10 years prior to retirement. Younger members with 30 years to retirement, for which the future pension value depends more on future accruals, are less impacted—their pension values decline by less than 1 percent in the case of the median pension fund, and results range from minus 2 percent to plus 0.5 percent.

**Figure 36. Iceland: Future Pension Values**

*For a representative member with 10 years prior to retirement, the pension value in the median fund declines by 13 percent, but results vary between pension funds from -9 to -15 percent.*




*Cumulated asset value changes in 2023-25 are naturally highly correlated with declines in future pension values.*




Notes: Future pension values can in some cases be higher in the adverse scenario than in the baseline as higher inflation in the adverse scenario also causes an upward level shift in contributions which persists until retirement age.

Source: IMF staff calculations based on CBI data.

**123. Currently, Icelandic pension funds have not adopted a life-cycle investment strategy in Pillar II—a common practice though in Pillar III.** Severe downturns could therefore hit member cohorts close to retirement age, and pensions become very sensitive to the performance in the latter years of the professional career. Consideration could therefore be given to a mechanism which reduces investment risk for pre-retirement members by adopting a more conservative asset allocation and locking-in accrued pension values. While such a change, either as a one-time switch or through a gradual de-risking, adds complexity to the pension system, social benefits might outweigh this drawback.

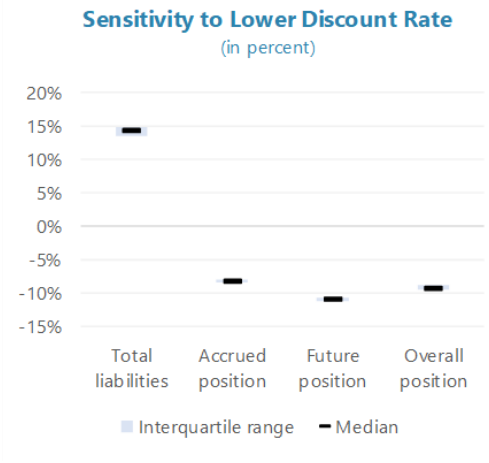
## D. Sensitivity Analyses

**124. Pension funds are sensitive to changes in the valuation regime for liabilities, including the discount rate and mortality assumptions** (Figure 37A). Liability durations of pension funds are on average around 30 years. Hence, if the discount rate would be lowered from 3.5 percent—a level maintained since 1998—to 3.0 percent, pension funds' liabilities would increase by 15 percent, very uniformly across the sample. The actuarial position would decline by almost 10 percentage points, with a slightly larger decline for the future position (-11 percentage points) than for the accrued position (-8 percentage points).

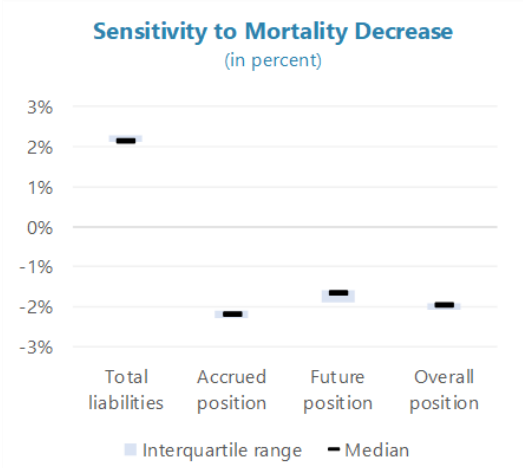
**125. Longevity risks in the sector are largely contained after most funds have implemented new mortality tables in 2021/22 which include dynamic longevity adjustments.** A further decline in mortality rates by 10 percent across all age cohorts would increase liabilities by around 2 percent while the actuarial position would decline by 2 percentage points (Figure 37B). All pension funds in the sample showed very similar sensitivities to both the change in the discount rate and the mortality decrease.

**Figure 37. Iceland: Pension Fund Sensitivity Analyses**

*A) Lowering the reference rate from 3.5 to 3.0 percent would increase the value of liabilities by almost 15 percent and deteriorate the actuarial position.*




*B) Assuming a decline of mortality rates by 10 percent would increase liabilities only slightly by around 2 percent.*




Source: IMF staff calculations based on CBI data and company submissions.

## E. Liquidity Risks

**126. Liquidity risks within Pillar II are contained as both inflows and outflows are predictable with a high level of certainty**. The mandatory Pillar II scheme does not allow for any withdrawals, and outflows are strictly related to retirement, death (spouse and child allowances) and disability—all being largely predictable with accordingly low liquidity risks. In addition, the sector as a whole is still accumulating funds and growing, with contributions exceeding pension payments.[41] Finally, as of end-2022, the large pension funds held no derivatives or other off-balance instruments from which margin calls could arise.

**127. Within Pillar III, cash flows can be more volatile, depending on pension fund member behavior, but so far no strains have been observed, however withdrawals in exceptional circumstances can have an impact.** Cash flows are impacted through transfers of pension rights between funds at the request of members, and mortgage loan repayments which members can

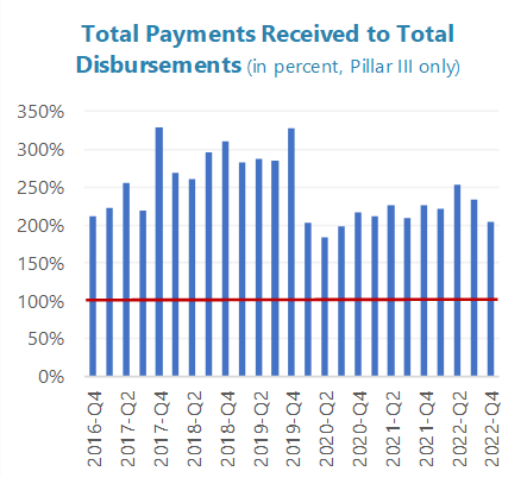
[41] A few funds were closed for new members already in the 1990s and have by now reached a decumulation phase—however, their market share is limited, and assets are typically invested in a more liquid and conservative way.

request to be deducted from their monthly contributions. While these two factors can typically be managed well by larger and medium-sized funds, more volatile outflows can occur through extraordinary withdrawals which the Icelandic government has allowed during the Financial Crisis and the Covid-19 pandemic. Although such withdrawals remained well below the allowed limits (total withdrawals in 2020 and 2021 amounted to ISK 23 billion and 13 billion, respectively), still the aggregated impact on pension funds' cashflows was noticeable (Figures 38A-B). Net cashflows, though, have remained positive in all quarters for almost every pension fund in the sample, and the quarterly outflows of those funds which experienced an outflow have not exceeded ISK 100 million in any given quarter.

**128. Flows in Pillar III are not highly correlated with flows in the domestic investment fund sector, but some structural differences between the phase prior to Covid-19 and since 2020 can be observed.** Prior to 2020, both inflows to investment funds and the ratio of Pillar III premiums to disbursements tended to be higher—and both have equally declined afterwards (Figures 38C-D). This might indicate a lower savings propensity of households or willingness to invest in riskier assets, being in line with a fall in the gross savings rate which used to be at around 26 percent between 2017 and 2019, and at 21 percent in 2020 and 2021.

**Figure 38. Iceland: Pension Fund Liquidity Risks**

*A) Payments into Pillar III are constantly exceeding disbursements, although extraordinary withdrawals during the Covid-19 pandemic have lowered net inflows.*




*B) The quarterly outflows of those funds which experienced an outflow have not exceeded ISK 100m in any given quarter.*

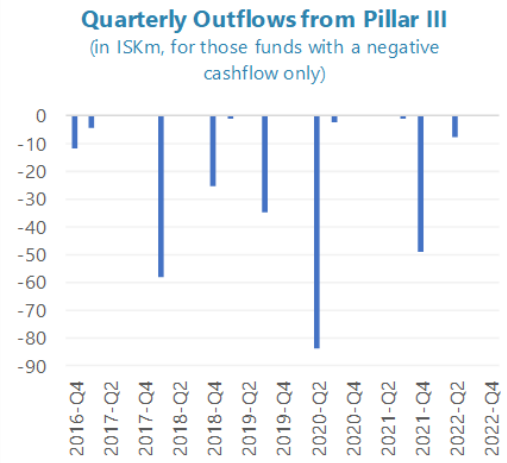
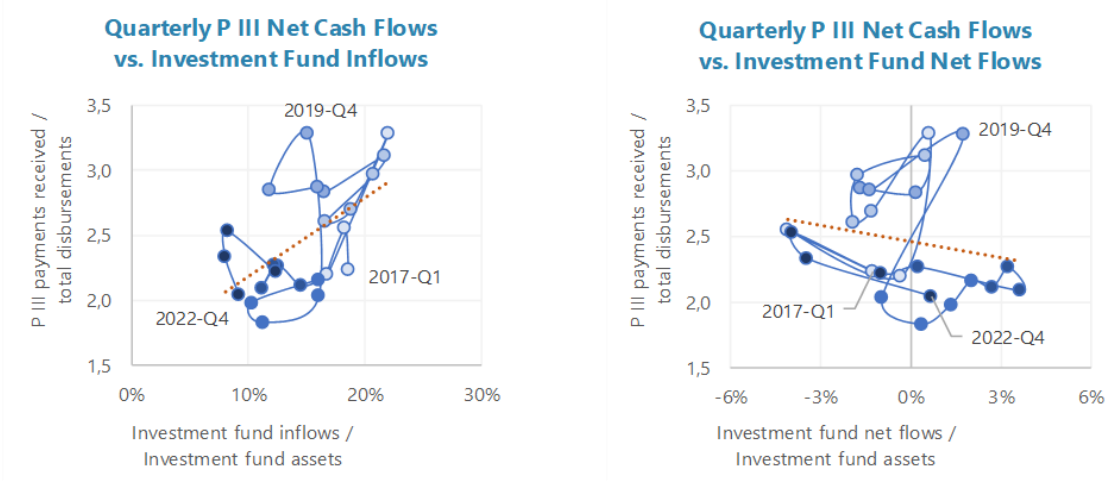


**Figure 38. Iceland: Pension Fund Liquidity Risks (concluded)**

*C-D) Quarterly net flows in Pillar III and the investment fund inflows are not highly correlated, but a structural break between 2019 and 2020 is recognizable in both markets…*



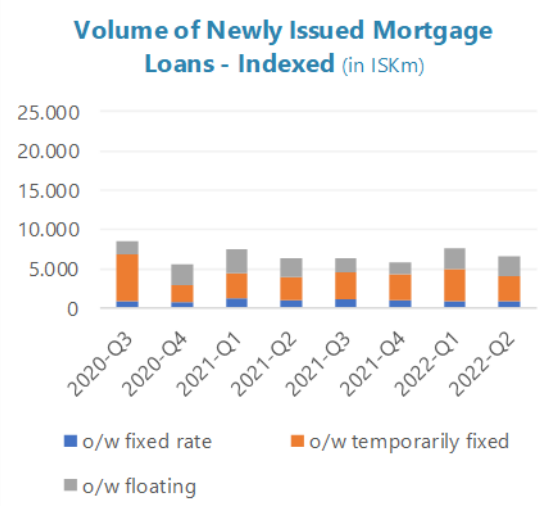

Notes: In the scatterplot graphs, each dot represents a quarter from 2017-Q1 to 2022-Q4. The intensity of the color increases with each year.
Source: IMF staff calculations based on CBI data and company submissions.

## F. Further Vulnerabilities

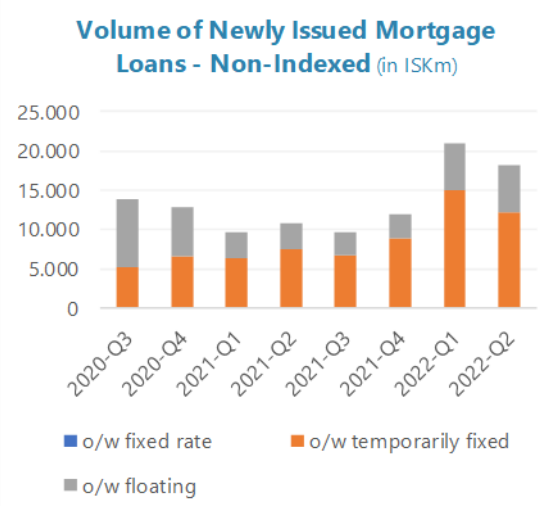
**129. Further asset-side vulnerabilities could potentially arise from mortgage lending amid rising interest rates.** As of end-2022, pension funds hold a share of around 22.7 percent in the mortgage lending market. After some decline of their lending volumes in 2020/21, volumes increased again in the first half of 2022, in particular in non-indexed loans (Figures 39A-B). Like banks, pension funds are subject to macroprudential requirements which have been introduced to cap the loan-to-value (LTV) and the debt-service-to-income (DSTI) ratio. Over the last two years, mean LTV ratios of newly issued loans have been fluctuating around 50 percent, and mean DSTI ratios have increased to slightly above 20 percent (Figures 39C-D). While losses on mortgage loans have been very low in recent years, an increase in default probabilities could be expected in an environment of rising interest rates and stretched household finances.

**Figure 39. Iceland: Pension Fund Mortgage Lending**

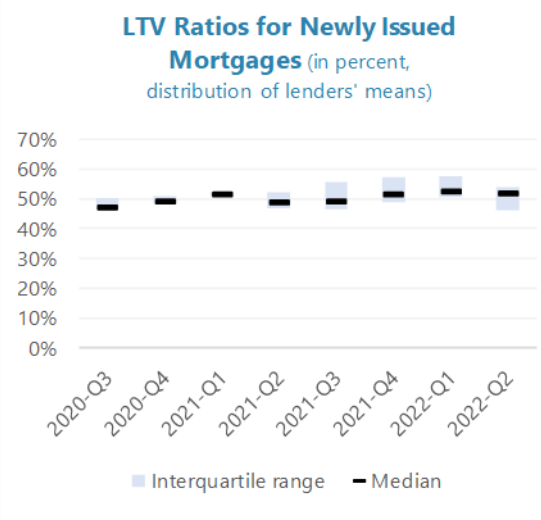
*A) The volume of indexed mortgage loans issued by pension funds has been stagnating between ISK 6 and 8bn in each quarter since the beginning of 2021…*



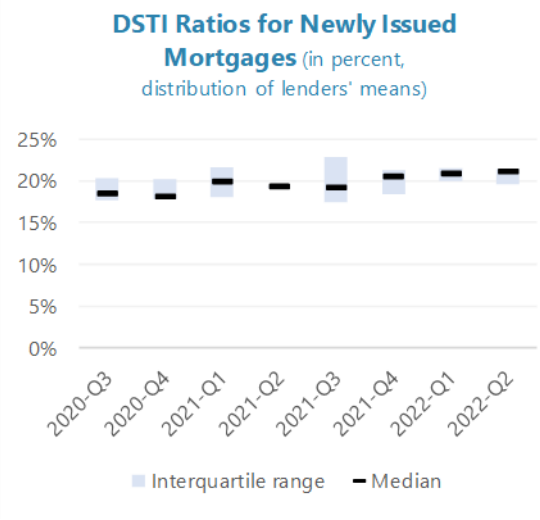

*B) … while the volume of non-indexed mortgage loans picked up significantly in 2022, especially for loans with temporarily fixed interest rates.*




*C) While for individual pension funds LTV ratios of newly issued mortgage loans can vary widely, the mean ratios within the sample have been fluctuating around 50 percent recently…*




*D) … and the mean DSTI ratios have increased slightly, ranging slightly above 20 percent for most pension funds as of mid-2022.*

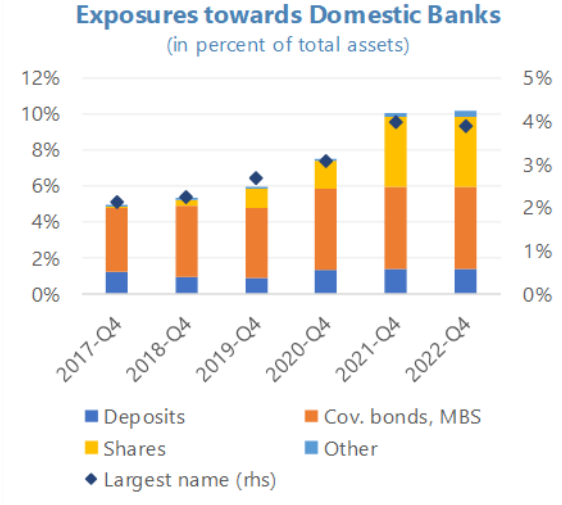



Source: IMF staff calculations based on CBI data.

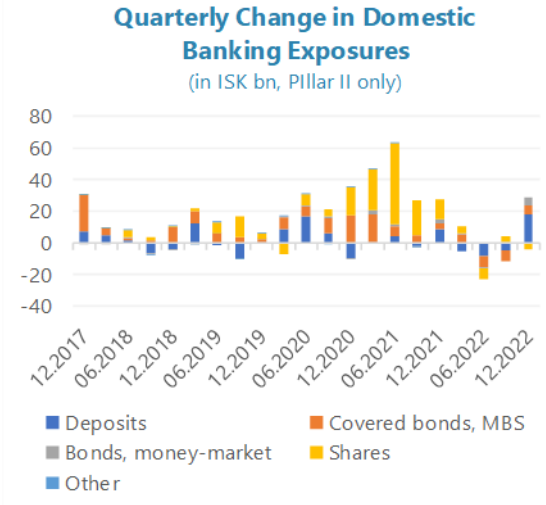
**130. All the large pension funds have concentrated exposures towards the three large domestic banks** (Figure 40). For each of the two largest banks, the exposure accounts on average for more than 3 percent of pension fund assets, and exposure to the whole domestic banking sector amounts to slightly more than 10 percent. Banking exposures are mostly through (covered) bonds, shares and deposits (45, 38 and 14 percent, respectively). While the single-name concentrations remain below prudential investment limits stated in the Pension Fund Act, the sectoral concentration warrants closer monitoring.

**Figure 40. Iceland: Pension Fund Exposures to Domestic Banks**

*Exposures towards the domestic banking sector have increased to 10 percent of assets, also driven by recent privatizations. The exposure towards the largest banking counterparty amounts to close to 4 percent.*




*2022-Q2 and Q3 were the first quarters since 2018 with declining absolute exposures towards domestic banks. Most volatile are share exposures, driven by market value changes and recent bank privatizations.*



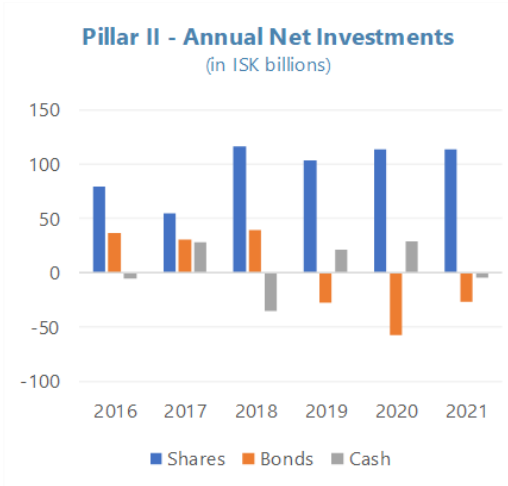

Source: IMF staff calculations based on CBI data.

**131. Pension funds have traditionally been a steady source of funding for the domestic banking sector, despite some smaller divestments in two quarters of 2022.** With their constant inflows, pension funds have expanded their banking exposures in recent years, most notably through (covered) bonds and shares. The total volume of deposits is, though, prone to some more volatile fluctuations and withdrawals of up to ISK 10 billion have occurred in several quarters. The rather volatile exposures through shares are largely resulting from market value changes, but structurally also by recent privatization and initial public offerings, e.g., of Arion Banki in 2018 and Islandsbanki in 2021. In the second and third quarter of 2022, the exposures towards domestic banks declined, for the first time since 2018, but again mainly driven by lower bond and share prices.

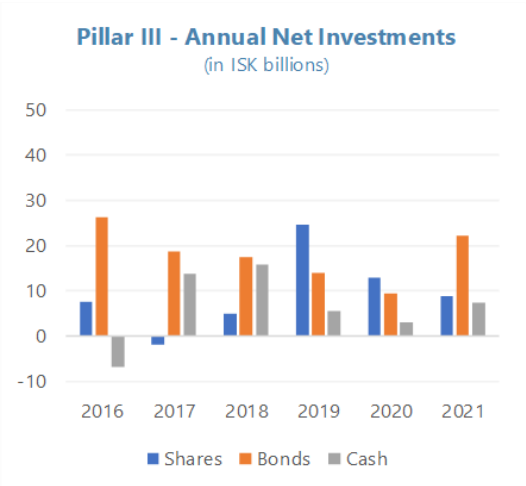
**132. Based on annual investment flow data, Icelandic pension funds appear to be rather long-term investors, not adopting changes to their strategic asset allocation too frequently**. Especially in Pillar II, pension funds invest very steadily in equity markets—since 2018 with almost no change in the annual net investments (Figure 41). However, in 2020 amid higher market volatility, aggregated numbers hint at some re-allocation within the equity portfolio, resulting in a higher turnover. Between 2019 and 2021, the exposure to bonds was reduced—a trend which might have reverted since then as higher interest rates made bond investments more attractive. Among Pillar III funds, investments in equity markets are more volatile than in Pillar II, while they have remained net buyers of bonds since 2016.

**Figure 41. Iceland: Pension Fund Annual Investment Flows**

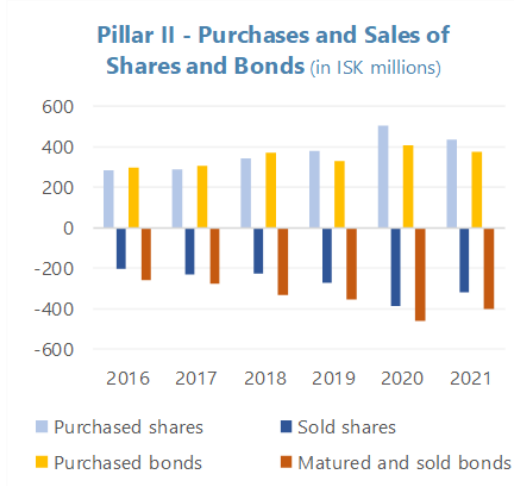
*Pillar II pension funds are steady net investors in the stock market, while bonds have been divested between 2019 and 2021.*

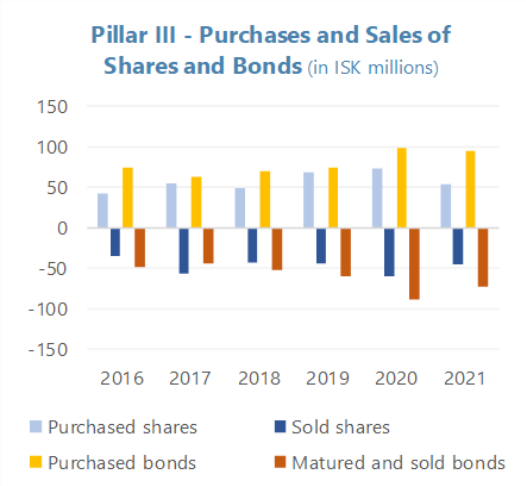



*In Pillar III, equity purchases are more volatile, instead net investment flows into bonds have been positive in every year since 2016.*




*In 2020, the volume of both purchased and sold securities reached a new high, indicating some significant trading activity and portfolio re-allocations.*




Source: IMF staff calculations based on CBI data.

## G. Recommendations

**133. The FSAP recommends further work by the CBI on ensuring and constantly improving supervisory reporting quality,** The supervisory approach of the CBI leverages strongly on automated data analytics and depends on good data quality. Hence, it is important to constantly improve quality assurance, also through the use of automated validation rules which would reject inconsistent pension funds' reporting.

**134. If higher inflation and interest rates persist, the CBI should closely monitor the effects of such an environment on pension funds.** In particular, funds' investment behavior should be monitored, as well as counterparty default risk if interest rate coverage of corporates was to deteriorate. Similarly, the CBI should monitor pension fund members' behavior with regard to their propensity to switch their Pillar III provider and have their pension savings transferred, or with regard to using contributions as a means to repay mortgage loans. The focus of the liquidity analysis should be particularly on smaller pension funds and those where Pillar III cash flows are already volatile.

**135. Finally, the CBI should further analyze pension funds' lending practices in the mortgage sector.** Losses on mortgage loans have been very low recently, and LTV and DSTI ratios hint at lower risks than in the banking sector. Nevertheless, the pricing of mortgage loans and whether it reflects all underlying risks should be further investigated, as well as the provisioning for expected losses, and pension funds' risk management practices.

# NON-FINANCIAL CORPORATE STRESS TEST

**136. The FSAP stress test on NFCs uses firm-level data to identify pockets of vulnerabilities and complement banking system analysis.** The analysis uses historical data for a well-represented sample (about 8,500 companies in 2020 from ORBIS)[42] of Icelandic NFCs and relies on the methodology from Tressel and Ding (2021).[43] The paper provides two approaches, namely a multi-factor sensitivity analysis and dynamic scenario-based stress test techniques, to assess the impact of shocks on firm's ability to service their debt, and on their liquidity and solvency positions. For the second approach, they use firm-level panel regressions that relate firm-level indicators to past firm-level structural and cyclical characteristics, industry fixed effects and macro-financial conditions. While Iceland specific analysis provides, to some extent, similar results, we rely on the cross-country evidence from Tressel and Ding (2021) to establish relationships between firm-level indicators and macro-financial conditions since their results rely on a wider sample, thus prove more unbiased estimates.

**137. Stress test analysis imposed macroeconomic scenarios on the end-2020 firm-level data to derive model-based estimates on select indicators for subsequent years.** Baseline and adverse macro scenarios for the NFC analysis are in line with the bank stress testing. In addition, the NFC analysis uses inputs from corporate bond spread, short- and long-term funding cost, and

[42] The main firm-level data source, ORBIS (Bureau van Dijk) reports about 24,000 non-financial companies for the 2020, the latest vintage available when the analysis was done. The NFC sample represents about 70 percent of active firms reported by Statistics Iceland. The sample is revised down significantly to remove outliers and eliminate dormant firms through the analysis period.

[43] Tressel, T. and X. Ding, 2021, "Global Corporate Stress Tests—Impact of the COVID-19 Pandemic and Policy Responses", IMF Working Paper 21/56.

financial condition index to generate results for the dynamic scenario-based stress tests under baseline and adverse scenarios.[44]

**138. A sensitivity analysis suggests a large portion of firms under debt at risk, if there is a material change in interest expenses**. The data for 2020 suggest that for a median firm, the interest coverage ratio was already constrained, profits (ROA) were low, and the debt ratio was high, despite a reasonable cash coverage. A 30 percent change in interest expenses, for instance due to interest rate hike, increases the share of firms at risk by 5 percent and debt at risk by 13 percent for the firms with interest coverage ratio falling below the threshold. Similarly, a hike in interest rate expenses also yields a surge in the share of firms with cash balance below zero as well as the share of firms with equity below zero, and subsequently their related shares of debt at risk (Figure 42).

**Figure 42. Iceland: Corporate Sector Vulnerabilities—Sensitivity Analysis**

**Summary Statistics of Key Indicators**

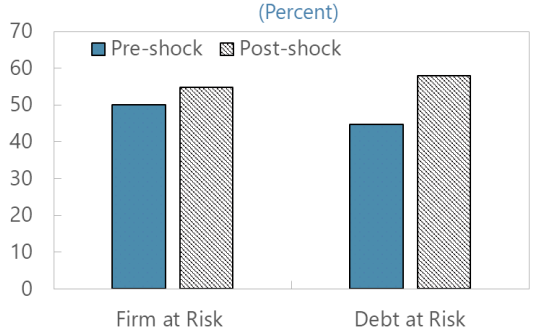
(Percent)

| | Debt/ Asset | ICR* | ROA | Equity/ Asset | Cash/ Asset |
|---|---|---|---|---|---|
| 25th percentile | 19.48 | -0.72 | -5.81 | -5.93 | 0.85 |
| Median | 39.23 | 0.99 | 0.49 | 17.62 | 4.34 |
| Mean | 41.84 | 2.14 | 1.16 | 15.37 | 11.07 |
| Weighted mean | 40.40 | 1.90 | 0.09 | 35.32 | 4.24 |
| 75th percentile | 61.53 | 3.65 | 8.09 | 43.31 | 15.66 |
| Std. dev. | 26.11 | 7.20 | 15.30 | 39.27 | 14.99 |

Notes: ICR presents value.
Sources: ORBIS, and IMF staff calculations.

**ICR Sensitivity**

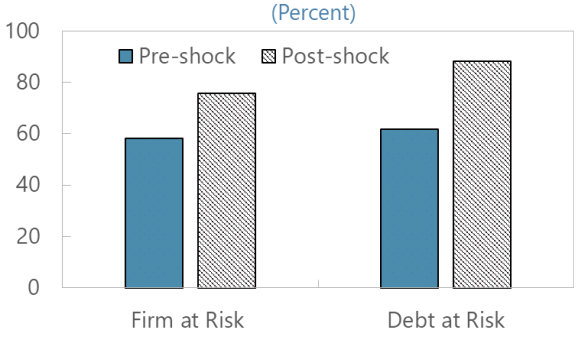
(Percent)




Sources: ORBIS and IMF staff calculations.

**Cash Sensitivity**

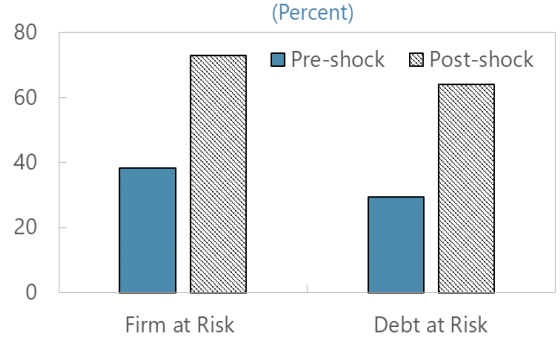
(Percent)




Sources: ORBIS and IMF staff calculations.

**Equity Sensitivity**

(Percent)




Sources: ORBIS and IMF staff calculations.

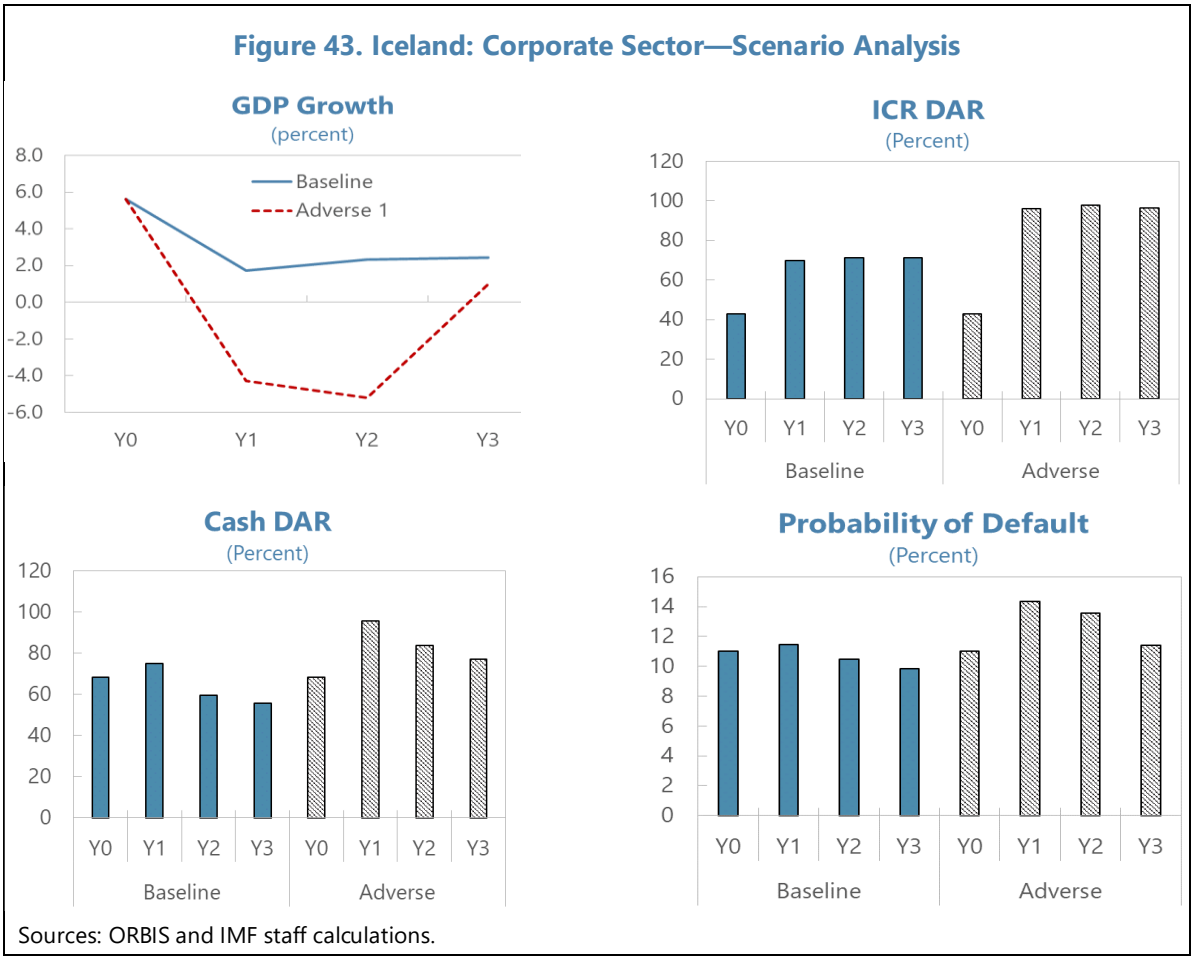
[44] We use historical data from the recently published financial condition index (FCI) by the CBI. The baseline and adverse scenarios for the FCI are constructed drawing mainly on the historical correlation between macro and financial indicators.

**139. The stress test analysis shows that debt at risk and the probability of default increases, more significantly under the adverse scenario (Figure 43).**

- Under the baseline scenario, from 2020 to 2022 (the base year for the adverse scenario), the share of debt for firms with an ICR<1 increases from 43 percent to about 70 percent and the share of debt for firms with cash<0 increases from 68 percent to 75 percent within a year. The probability of default increases by about one percent.

- The adverse scenario envisages a large slowdown for two consecutive years, followed by a gradual recovery. Reflecting economic growth's central role for the profitability and viability of companies, in the adverse scenario ICRs deteriorate and the share of debt for firms with an ICR<1 rises to 96 percent, 26 percentage point higher than under the baseline, in the first year. The share of debt in firms with cash<0 also surges, 25 percentage point higher than under the baseline. The probability of default peaks at 14.3 percent, about 3 percentage points higher than under the baseline, in the first year and remains high in the subsequent years.

**Figure 43. Iceland: Corporate Sector—Scenario Analysis**




Sources: ORBIS and IMF staff calculations.

# Appendix I. Capital Flow Management Measures in the Icelandic Toolkit

**1. The legal framework explicitly considers the possibility of adopting capital flow management measures to support financial stability.** These tools can be used in a way consistent with the IMF's institutional view on the liberalization and management of capital flows and should abide by Iceland's international obligations under OECD and EFTA agreement. Analytical research under the IMF's integrated policy framework umbrella is studying the optimal way and conditions to deploy these instruments. The most important capital flow management measures in the Icelandic toolkit are the possibility of adopting capital flow management measures on outflows, preemptive reserve requirements on selected capital inflows and conducting intervention in the thin interbank foreign exchange market.

**2. Capital outflow controls are reserved for emergency circumstances in which large capital flows can endanger financial stability.** When other measures are not possible, the central bank, with approval from the Ministry of Finance, can adopt capital outflow controls can restrict or halt the flow of selected types of investments for up to 60 days without parliamentary approval. The possibility of capital outflow controls increases transfer risk to foreign investors considering investments in Iceland, and this way reduce the size of cross border exposures in the country.

**3. Capital flow management measures can also be used preemptively under some circumstances to reduce the profitability of risky cross border investment in Iceland**. The central bank, with approval of the Ministry of Finance, is allowed to set reserve requirements on selected inflows into krona-denominated assets (bonds, deposits, and unit shares in funds and other financial arrangements that invest in krona assets). These type of reserve requirements were adopted in 2016 with the intention to dampen and influence the composition of inflows of foreign currency to domestic debt markets and high-yield deposits as well as to strengthen the transmission of monetary policy. Its rate originally was set at 40 percent was gradually reduced and set to zero in 2019. It is like those adopted by Chile in 1991. Studies of that experience have shown that they did not affect the total amount of capital inflows but did affect their composition.

# Appendix II. Risk Assessment Matrix

**Table 1. Iceland: Risk Assessment Matrix**

| Risks | Relative Likelihood | Impact if Realized |
|---|---|---|
| **Intensification of regional conflict(s).** Escalation of Russia's war in Ukraine or other regional conflicts and resulting economic sanctions disrupt trade (e.g., energy, food, tourism, and/or critical supply chain components), remittances, refugee flows, FDI and financial flows, and payment systems. | **High**<br>• Escalation would trigger commodity price shocks, and a global slowdown.<br>• Worldwide tourism flows are further subdued, coupled with spillovers from lower than envisaged trading partner activity. | **Medium**<br>• Further de-anchoring of inflation expectations sustains a rise in real estate markets.<br>• Tighter financial conditions, and higher credit risk.<br>• Iceland's low dependence on fossil fuels is mitigating factors. |
| **Abrupt global slowdown or recession.** Global and idiosyncratic risk factors combine to cause a synchronized sharp growth slowdown, with outright recessions in some countries. | **Medium (U.S.) / High (Europe)**<br>• In the U.S amid persistently high inflation driven by tight labor markets, supply disruptions and continued commodity price shocks, the Fed tightens policies faster and by more than anticipated, resulting in a "hard landing", housing market correction, and a stronger U.S. dollar. Negative demand shock triggered by rapid interest rate increases depresses U.S. households' net worth and consumer spending.<br>• In Europe the fallout from the war in Ukraine is exacerbated by a gas shutoff by Russia, resulting in acute gas shortages and further supply disruptions, which trigger a recession and sharp fall in real incomes and reduced import demand. | **High**<br>• Spillovers through trade and financial channels and downward pressures on some commodity prices, possibly depressing export revenues.<br>• Knock-on effects from higher risk spreads, external financing costs and lower tourism earnings.<br>• Rising unemployment causing defaults and a housing market correction. |

| Table 1. Iceland: Risk Assessment Matrix (concluded) | | |
|---|---|---|
| **Risks** | **Relative Likelihood** | **Impact if Realized** |
| | **Medium**<br>• The Fed reacts by tightening abruptly and higher than expected. The resulting repositioning by market participants leads to a sharp tightening of financial conditions and higher risk premia, including for credit, equities, and emerging and frontier market currencies.<br>• The de-anchoring of inflation expectations increases risk premia, sending long-term bond yields and corporate spreads to historic heights, with plunging house prices and consumer confidence that deepen the recessions. | **Medium**<br>• Currency depreciation puts pressure on inflation; high premium complicates government financing.<br>• Rise in interest rates exacerbates vulnerabilities in household balance sheets through floating rate. mortgages, the real estate market falls, causing feed-back effects to the banking system.<br>• Pension fund's assets depreciate, causing income loss to households. |
| **A sudden correction in the domestic real estate market** | **Medium**<br>• Real estate prices have increased rapidly in Iceland over the last years and are assessed to be overvalued.<br>• While there are no signs of looser lending standards, the share of indexed loans is high compared to Iceland's peers.<br>• There are risks to repayments due to capacity linked to downside scenarios and indexation as well as litigation over the flexible interest rate loans. | **Medium**<br>• A drop in real estate prices, would result in higher impairment charges for banks, causing defaults or delayed loan repayments by highly leveraged households.<br>• Lower house prices could depress domestic demand through reduced consumption, hitting banks' profits further. |
| **Systemic financial instability.** Sharp swings in real interest rates, risk premia, and assets repricing amid economic slowdowns and policy shifts trigger insolvencies in countries with weak banks or non-bank financial institutions, causing markets dislocations and adverse cross-border spillovers. | **Medium**<br>• Risk-off sentiment has intensified amid market turmoil triggered by the liquidity and solvency problems of a few weak banks. This has enlarged reputational risks of wider market participants and dent market confidence, leading to sharp swings in the value of marketable assets. | **Medium**<br>• Sharp correction in asset price may lead to valuation losses of banks which hold marketable asset instruments.<br>• Large interest rate swings may intensify credit risks of borrowers that are sensitive to interest rate movement.<br>• Net interest margin of the banks may become volatile, potentially leading to further losses in profit. |

# Appendix III. Growth at Risk

**1. The Growth-at-Risk (GaR) framework is a macro-financial surveillance tool.** The evolution of macro-financial vulnerabilities and changes in domestic and external financial conditions can provide important signals about evolving risks to future economic activity (Prasad et al., 2019). The GaR analysis helps to quantify macro-financial risks to growth, assess the relative importance of the macro-financial factors that impact the entire probability distribution of future GDP growth—rather than only the central forecast, and monitor how risks to economic activity may evolve over time. The analysis thus provides a basis for preemptive policies to mitigate downside risks.

**2. The GaR analysis for Iceland focuses on the likely impact of financial conditions and macroeconomic vulnerabilities on future growth.** To reflect the multifaceted risks to growth, a large set of variables is aggregated into seven main regressors—also called partitions, using principal component analysis (PCA). Data coverage started in 2003, at a quarterly frequency. The partitions are (see Table 1):

**Table 1. Iceland: List of Variables Entering each Partition**

| Housing market conditions | Stock market conditions | Money market conditions | Bond market conditions | FX market conditions | Main Trading Partners Macro Conditions | World Financial Conditions |
|---|---|---|---|---|---|---|
| Residential Real Estate Prices | Stock prices | CBI key policy rate | Yield on 10-year non-indexed government bond | Real effective exchange rate | France unemployment rate | VIX |
| Credit system lending to households | Stock price volatility | Spread between 3 month interbank and CBI key policy rate | Yield on 10-year inflation-indexed government bond. | Long-term interest rate differential between Iceland and Germany, using yields | EU unemployment rate | STOXX 50 Volatility Index |
| Household interest expense to disposable income | | | Total loans to non-financial corporate sector | | USA unemployment rate | Term spread of EU (10-year yield EU - 1 year yield EU) |
| | | | | | Netherlands unemployment rate | Difference between Euribor 3m and T-bill Euro 3m |

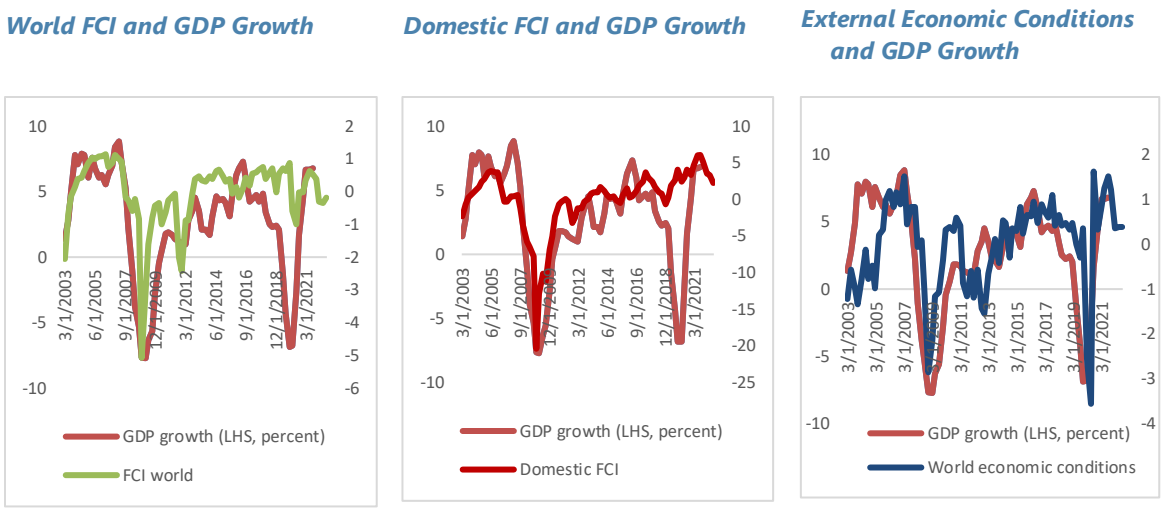
- *Domestic financial conditions* capture the price, spreads and volatility of local financial instruments, as well as leverage encompasses variables related to the size of balance sheets. All selected variables are categorized by different markets including housing, money, stock, bond, and FX market conditions.

- *Macroeconomic conditions in main trading partners* unemployment in France, Nederland, the USA, and EU which can affect Iceland not only through trade, but also through tourism and investor's confidence.

- *World financial conditions* are intended to capture foreign financial developments specific to the euro area, as well as rest of the world.

Overall, the partitions match quite accurately the large movements they are expected to cover. For instance, domestic financial conditions are broadly consistent with the CBI's financial conditions[1], and the world financial conditions and macroeconomic conditions in main trading partners partitions capture correctly the global financial crisis in 2008, the European crisis of 2011, and the COVID crisis of 2020. Results indicate a strong relationship between explanatory variables and GDP growth (Figure 1).

**Figure 1. Iceland: Co-Movement of Explanatory Variables and Real GDP Growth**




Source: IMF staff calculations.

**3. Quantile regressions are estimated on the following specification.** For a given quantile q in {5%, 25%, 50%, 75%, 90%}, the model estimates the following quantile regressions (Figure 2)[2]:

$$Y_{t+h,q} = \alpha_y^q Y_t + \alpha_{hm}^q HM_t + \alpha_{bm}^q BM_t + \alpha_{sm}^q SM_t + \alpha_{mm}^q MM_t + \alpha_{fm}^q FxM_t + \alpha_{tp}^q TP + \alpha_w^q W_t + \varepsilon_{t+h}^q$$

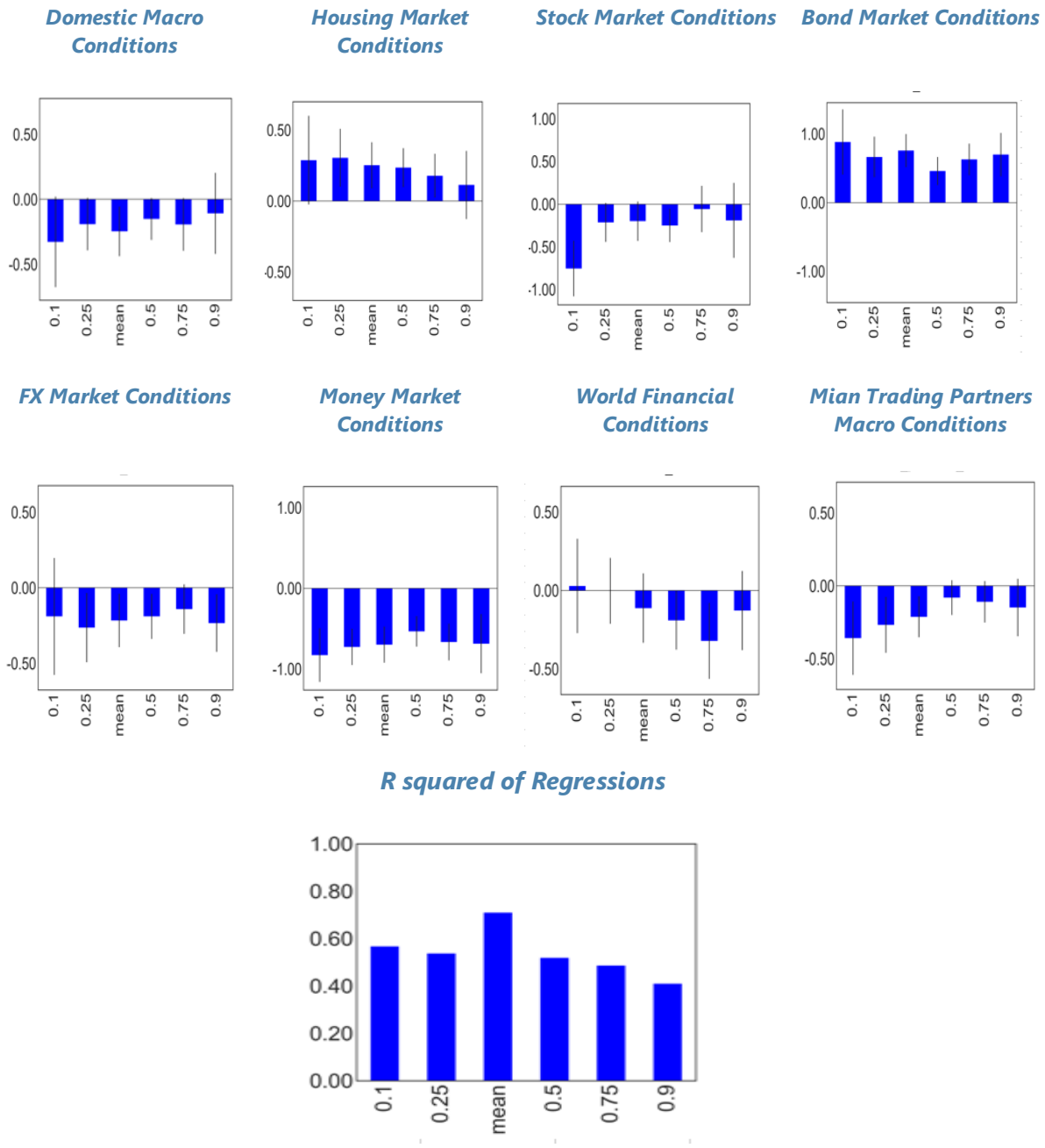
where $Y_{t+h,q}$ represents the quantiles (q) of the future distribution of GDP growth (y) h quarters ahead; HM, BM, SM, MM and FxM are the predictors of corresponding financial conditions in housing, bond, stock, money, and FX markets, respectively. TP and W are two predictors

[1] Financial Stability 2023/1 (cb.is).

[2] Standards linear regressions consider the impact of the regressors on the conditional mean of the dependent variable, while quantile regressions investigate the impact of the regressors on various points (quantiles) of the dependent variable's conditional distribution.

corresponding to the main trading partners macroeconomic and world financial conditions derived from the PCA. $\varepsilon_{t+h}^{q}$ is the error term.

**Figure 2. Iceland: Quantile Regressions Coefficients with Confidence Interval**

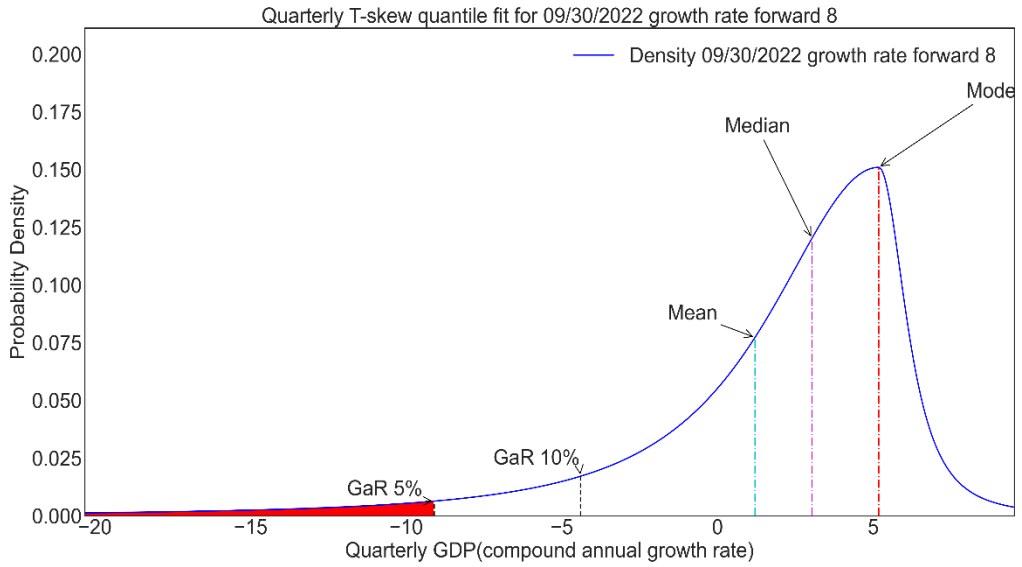



Source: IMF staff calculations.

**4. A skewed t distribution is fitted on the empirical conditional quantile function for each specific time horizon to estimate the tail risks around the baseline.** Further details are discussed in Adrian et al. (2016). Using the skewed t-fitted curve, a probability density function can be derived for future GDP growth at each time horizon.

**5. The GaR model suggests relatively high risks around the baseline for Iceland's GDP growth.** Based on the financial conditions at 2022:Q3, a severely adverse outcome (given by the 5 percent left tail) is for GDP growth to fall below 2.3 percent one-year ahead and below 9.1 percent in the two-year horizon (Figure 3). This is a relatively severe risk outlook, given the still-elevated leverage, and reflects the dominating effect of the high price of risk, itself a reflection of tightening global and domestic financial conditions and a deterioration of macroeconomic conditions in trading partner countries.

**Figure 3. Iceland: Probability Densities of GDP Growth Eight Quarters Ahead**



# Appendix IV. Macro-Financial Linkages

**1. Table 1 displays the estimated coefficients corresponding to the following regression:**

$$\Delta rloans_t = \alpha + \beta \cdot \Delta requity_{t-1} + \sum_{i=1}^{2} \gamma_i \cdot \Delta rloans_{t-i} + controls$$

where $rloans$ is log outstanding stock of loans to domestic HHs and NFCs divided by CPI, and $requity$ is log banking system total equity and minority interests divided by CPI. Bank equity is introduced with a lag into the regression to try to mitigate potential endogeneity issues. The estimated coefficient $\hat{\beta}$ has a positive sign, which indicates that higher bank capitalization leads to more lending. Its value has the interpretation that a 1 percent increase in bank capital leads to a 0.12-0.17 percent increase in bank real loans (where the range 0.12-0.17 corresponds to the different sets of controls displayed in Table 1).

**Table 1. Iceland: Estimates of Regression of Real Bank Loans on Bank Capital**

| | Δ ln(real loans) | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| L.Δ ln(real equity) | 0.1240*** | 0.1336*** | 0.1487*** | 0.1698*** | 0.1327* |
| | (0.0262) | (0.0434) | (0.0432) | (0.0528) | (0.0791) |
| L.Δ ln(real loans) | | -0.0084 | -0.0098 | -0.0259 | 0.0131 |
| | | (0.1733) | (0.1527) | (0.1528) | (0.1600) |
| L2.Δ ln(real loans) | | 0.1887 | 0.1656 | 0.1315 | 0.055 |
| | | (0.1324) | (0.1202) | (0.1352) | (0.1533) |
| Other controls | | | | Δln(RGDP), ΔUR, Δln(NEER), Δln(CPI), Δpolicy rate | Δln(RGDP), ΔUR, Δln(NEER), Δln(CPI), Δpolicy rate, Δln(US GDP), ΔFFR, Δln(oil price) |
| GFC Dummy | N | N | N | N | Y |
| Covid Dummy | N | N | N | N | Y |
| R-squared | 0.1072 | 0.1443 | 0.2154 | 0.3132 | 0.465 |

Standard errors in parentheses
p-values: *** <0.01, **<0.05, *<0.10

**2. The macro impact of a structural credit supply shock was estimated using a Bayesian SVAR. Based on the results displayed in Table 1, log bank real equity was chosen as the measure of bank capitalization.** A specification with 2 lags was chosen. The identification of the structural shock is based on block exogeneity assumptions and sign restrictions. As described in the main text, the block exogeneity assumption establishes that bank equity cannot have a direct impact on any of the other variables in the SVAR except bank lending. Table 2 displays the sign restriction assumptions used for identification. These sign restrictions were imposed for quarters 0 and 1 after

the shock, except in the case of unemployment, in which case the sign restriction was imposed for quarters 0 through 8.[1]

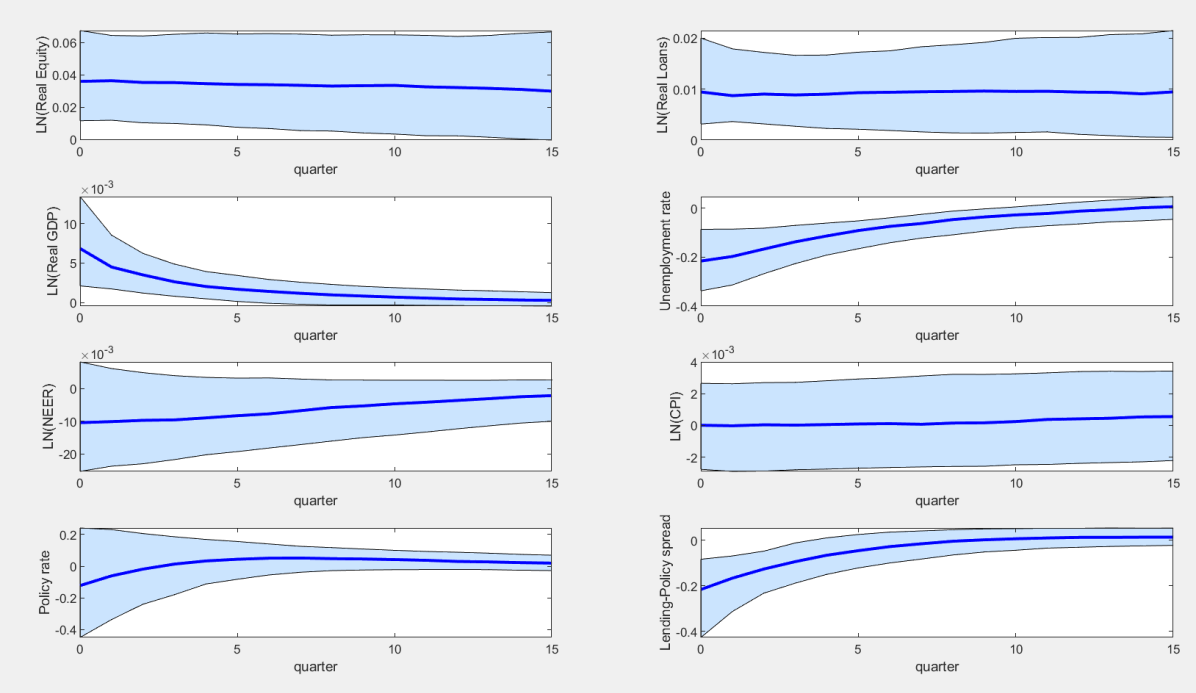
**Table 2. Iceland: Sign Restrictions for SVAR**

| | | |
|---|---|---|
| Endogenous | ln(real equity) | + |
| | ln(real loans) | + |
| | ln(real GDP) | + |
| | Unemployment | - |
| | ln(NEER) | |
| | ln(CPI) | |
| | Policy rate | |
| | Lending-Policy spread | - |
| Exogenous | ln(US real GDP) | |
| | ln(Oil price) | |
| | US FFR | |

**3. Figure 1 displays the median impulse responses obtained from the Bayesian SVAR (together with one standard-deviation bands) corresponding to a credit supply shock. The positive impact of a credit supply shock on bank capital and lending is very persistent.** The confidence bands are quite wide, reflecting significant uncertainty in the estimation; this could be due to the limited number of observations and the large shocks suffered by the banks within the sample. Meanwhile, the negative impact on economic activity, as captured by GDP and unemployment, is more short-lived. The IRFs for the nominal exchange rate, the CPI and the policy rate are not statistically different from zero. Lastly, the spread between the lending and policy rates goes down on impact and fades out after a few quarters.

[1] Imposing the sign restriction for quarters 0 through 8 instead of 0 and 1 for unemployment yielded an IRF with a more sensible shape.

## Figure 1. Iceland: Credit Supply Shock Impulse Response Functions[1]




[1] The charts display the median impulse-response functions together with one-standard deviation bands obtained from the Bayesian SVAR.

Sources: IMF staff calculations.

# Appendix V. The Estimation of the PD Satellite Models

**Table 1. Iceland: The Estimation of the PD Satellite Models**

| | PD household | PD corporate | Coverage ratio |
|---|---|---|---|
| | (Logit) | (Logit) | (Logit) |
| Real gdp growth, yoy, percent | -0.02 | | |
| Unemployment rate, percent | 0.18* | 0.35* | 1.23 |
| Inflation, percent | | | |
| Short term rate, percent | | | 1.34 |
| Long term rate, precent | | | 0.07 |
| Term premium, percentage point | | 0.3* | |
| Exchange rate, yoy, percent | | | |
| Stock market price, yoy, percent | | -0.01* | |
| Housing price, yoy, percent | -0.02 | | |
| Housing price, yoy, 1-year lag, percent | | | -0.18 |
| Indexed mortgage, 1-year lag, percent | 0.17* | | |
| Indexed term deposit, percent | | | |
| Non-indexed term deposit, percent | | | |
| GFC dummy | | | |
| R square | 0.34 | 0.75 | 0.11 |
| Root mean square error | 0.9 | 1.11 | 4.9 |
| Number of observations | 78 | 78 | 35 |

Note: * indicates P value less than 5 percent. All dependent variables are confirmed to be stationary under Dickey-Fuller test.

# Appendix VI. The Estimation of the Interest Rate Satellite Models

## Table 1. Iceland: The Estimation of the Interest Rate Satellite Models-Liabilities

| | Overnight retail deposits | Overnight wholesale deposits | Overnight wholesale FX deposits | Indexed term deposits | Non-indexed term deposits |
|---|---|---|---|---|---|
| | (Percent) | (Percent) | (Percent) | (Percent) | (Percent) |
| Real gdp growth, yoy, percent | | | | | |
| Unemployment rate, percent | 0.11* | 0.03 | | | |
| Inflation, percent | | | | | |
| Short term rate, percent | 0.39* | 0.24* | 0.16* | | |
| Long term rate, precent | | | | 0.73* | 1.42* |
| Term premium, percentage point | | | | | |
| Exchange rate, yoy, percent | | | 0 | 0 | 0.05* |
| Stock market price, yoy, percent | | | | | |
| Housing price, yoy, percent | | | | | |
| Indexed mortgage, 1-year lag, percent | | | | | |
| Indexed term deposit, percent | | | | | |
| Non-indexed term deposit, percent | | | | | |
| GFC dummy | | 0.43 | | 0.52 | 0.74 |
| R square | 0.67 | 0.66 | 0.6 | 0.79 | 0.83 |
| Root mean square error | 0.94 | 0.63 | 0.52 | 0.87 | 1.66 |
| Number of observations | 107 | 107 | 87 | 107 | 95 |

Note: * indicates P value less than 5 percent. All dependent variables are confirmed to be stationary under Dickey-Fuller test.

## Table 2. Iceland: The Estimation of the Interest Rate Satellite Models - Assets

| | Indexed mortgages | Non-indexed mortgages | Corporate loans | Consumer loans |
|---|---|---|---|---|
| | (Percent) | (Percent) | (Percent) | (Percent) |
| Real gdp growth, yoy, percent | | | | |
| Unemployment rate, percent | | | | |
| Inflation, percent | -0.09* | 0.01 | 0.05 | 0.3* |
| Short term rate, percent | | | | 0.55* |
| Long term rate, precent | | 0.05 | 0.34* | 0.41 |
| Term premium, percentage point | | | | |
| Exchange rate, yoy, percent | | | | |
| Stock market price, yoy, percent | | | | |
| Housing price, yoy, percent | | | | |
| Indexed mortgage, 1-year lag, percent | | | | |
| Indexed term deposit, percent | 0.66* | 0.26* | 0.32 | 0.51 |
| Non-indexed term deposit, percent | | 0.93* | 0.88* | 0.38 |
| GFC dummy | 0.83* | | | |
| R square | 0.81 | 0.99 | 0.96 | 0.89 |
| Root mean square error | 0.89 | 0.58 | 0.96 | 1.7 |
| Number of observations | 78 | 78 | 78 | 78 |

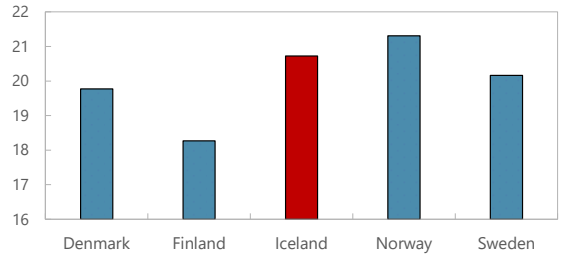
Note: * indicates P value less than 5 percent. All dependent variables are confirmed to be stationary under Dickey-Fuller test.

# Appendix VII. Financial Soundness Indicators—A Regional Comparison

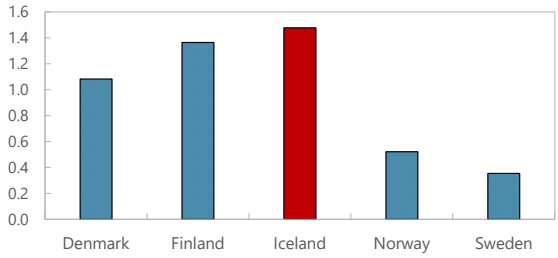
## Financial Soundness Indicators

(In percent, latest available until end-2022)

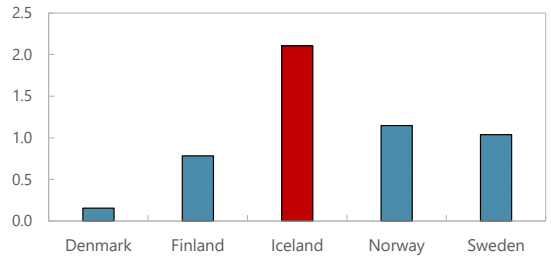
**T1 capital ratio**
(In percent)



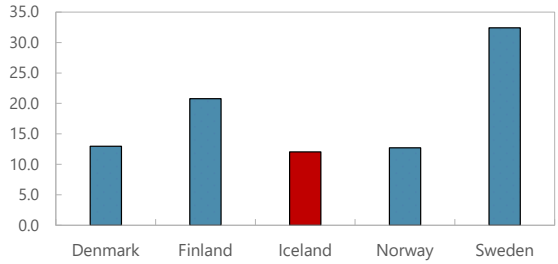

**NPL Ratio**
(In percent)



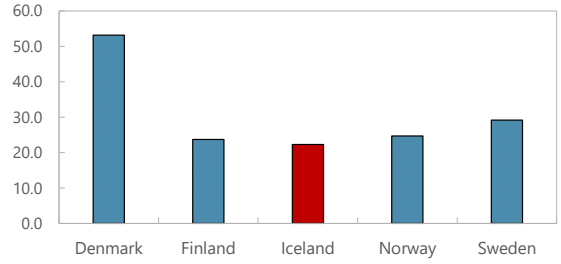

**Return on Assets**
(In percent)



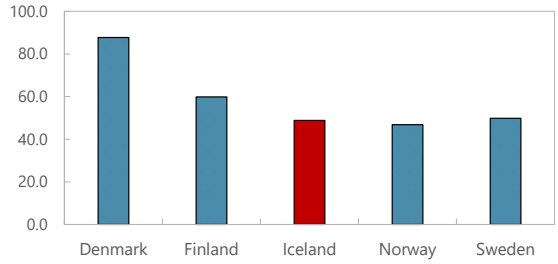

**Liquid Assets to Total Assets**
(In percent)




**Liquid Assets to Short Term Liabilities**
(In percent)




**Cost to Income**
(In percent)




Source: IMF Financial Soundness Indicators.

# Appendix VIII. Banking Sector Stress Testing Matrix

| Domain | | Top-down Stress Test by FSAP Team—Assumptions |
|---|---|---|
| **Banking Sector: Solvency Risk** | | |
| 1. Institutional perimeter | Institutions included | • Top three commercial banks (under IFRS9). |
| | Market share | • The top three commercial banks account for about 95 percent of the deposit taking corporations (excl. central bank) assets. |
| | Data source and baseline date | • Supervisory data provided by the Central bank of Iceland. Other data sources include public sources (EBA Transparency Exercises, Banks' Annual Reports, Statistics Iceland), commercial databases (Fitch, Haver Analytics), IMF Global Assumptions (GAS) and IMF WEO.<br>• Data as of October 2022.<br>• Consolidated at national bank level. |
| 2. Channels of risk propagation | Methodology | • Balance sheet-based tool developed by MCM.<br>• Satellite models developed by the FSAP team. |
| | Satellite models for macro-financial linkages | • Credit risk: Parameter (PD, LGD, EAD) projections generated by product. Modeling relies on IFRS9 modeling and transition matrices. Analysis uses as starting points the PDs and LGDs reported by banks.<br>• Net Interest Income: Based on two complementary approaches (structural and empirical). The empirical approach relies on estimates from regression models using individual bank or system level data and pass-through estimates. The structural model combines this with repricing ladders on the portfolio of assets and liabilities.<br>• Net Fees and Commission income and other income/expenses: bank-panel model or by assumption.<br>• Market risk: Duration approach for interest rate instruments and consideration of equity, FX and inflation risks. |
| | Stress test horizon | • 5 years (2023-2027). |
| 3. Tail shocks | Scenario analysis | • Baseline from the March 2023 WEO, complemented with VAR model to project scenario consistent additional variables.<br>• An adverse scenario with severity calibrated to a 2.2 standard deviation shock to real GDP growth relative to baseline over 2023-2024. Macro-financial simulations are realized based on an Iceland-specific VAR model and benchmarked against the "other advanced economies" group dynamics in a similar scenario implemented in the Global Financial Models (see Vitek (2018)).<br>• Macro-financial scenarios for foreign countries and relevant interest rates rely on the GFM simulations |

| Domain | | Top-down Stress Test by FSAP Team—Assumptions |
|---|---|---|
| **Banking Sector: Solvency Risk** | | |
| | | • The adverse scenario is characterized by a U-shaped path for real GDP growth, tightening of global financial conditions, global supply chain disruptions, and rise of commodity prices, a de-anchoring of inflation expectations and a trade-off for monetary policy between unemployment and inflation, as described in the RAM.• The VARX model is specified as follows: The vector of endogenous variables (Y_t) includes real GDP, unemployment rate, CPI index, policy rate, nominal effective exchange rate (NEER), and a measure of real loans, given by the CPI deflated sum of NFC and household loans. The vector of exogenous variables (X_t) includes the US real GDP (as a measure of global demand), and the oil price (as a measure of global prices) and a dummy for the GFC (2008Q4). The selection of variables is conditioned by trading off degrees of freedom against the necessity (i) to reflect the relevant source of the shocks, (ii) to capture variables of relevance to the stress test (and captured in the IMF's global models used for adverse scenario generation) and (iii) to limit possible missing variable bias. L_1 and L_2 are the lag length for endogenous and exogenous variables, respectively, and are chosen to be L_1=L_2=4. All variables, other than unemployment and policy rates, are in logs. The path of external variables in the VARX for the baseline and adverse scenario is taken from the global model maintained by MCM, which ensures the shocks of the global adverse are consistent with other FSAPs. |
| | Sensitivity analysis | • Concentration analysis on top lending exposures of the banks.<br>• Sensitivity analysis on further rising in interest rates.<br>• Sensitivity analysis on further credit deterioration in covid-sensitive sectors. |
| 4. Risks and buffers | Risks/factors assessed | • Credit risk (corporates, households, sovereign).<br>• Interest rate risk in the banking book.<br>• Market risk from fixed income securities (interest rate, spreads), FX inflation and equity risks. |
| | Behavioral adjustments | • Balance sheet assumptions such that credit growth ensures that credit to GDP ratio remains constant. Counter-factual analysis enabling macro-feedback loop.<br>• New credit production endogenously consistent with credit growth assumption.<br>• No write-off or cure allowed over projection horizon.<br>• Hedging strategy is not considered. |

| Domain | | Top-down Stress Test by FSAP Team—Assumptions |
|---|---|---|
| **Banking Sector: Solvency Risk** | | |
| 5. Regulatory and market- based standards and parameters | Calibration of risk parameters | • PDs and LGDs obtained from supervisory files, or where not available estimated at the asset class level.<br>• Dynamics based on model estimated PDs in line with the scenario considered (WEO baseline, adverse scenarios).<br>• Projections of PDs and the starting positions of the transition matrices were used to guide shifts of transition matrices over the risk horizon to calculate loan loss provisions under the IFRS9 approach. |
| | Regulatory/ accounting and market-based standards | • Regulatory capital ratios and IFSR9 accounting standards. |
| 6. Reporting format for results | Output presentation | • Aggregate results (regulatory capital and leverage ratios) and contributions to evolution of capital ratios. |

| Domain | | Top-down Stress Test by FSAP Team—Assumptions |
|---|---|---|
| **Banking Sector: Liquidity Risk** | | |
| 1. Institutional perimeter | Institutions included | • Top three commercial banks. |
| | Market share | • The top three commercial banks account for about 95 percent of the deposit taking corporations (excluding central bank) assets. |
| | Data and baseline date | • Liquidity Coverage Ratio, Net Stable Funding Ratio, and Cash flow table from supervisory data.<br>• Data as of October 2022.<br>• Consolidated at national bank level. |
| 2. Channels of risk propagation | Methodology | • The cash-flow stress test analyzes the net cash balance, accounting for available unencumbered assets,<br>• Contractual cash inflows and outflows, and behavioral flows.<br>• The test is to be repeated for all significant currencies for the reporting banks.<br>• The analysis is complemented with LCR and NSFR stress tests. |
| | Stress test horizon | • For the cash-flow analysis, the horizon of stress events varies by scenario and can extend up to a period of 12 months.<br>• The horizon for LCR stress test is one month. |
| 3. Tail shocks | Scenario analysis | • Baseline and various scenarios are considered, with varying intensity of adverse liquidity conditions and reflecting different liquidity risks. |
| | Sensitivity analysis | • Further withdrawal of funding from pension and foreign funding. |

| Domain | | Top-down Stress Test by FSAP Team—Assumptions |
|---|---|---|
| **Banking Sector: Liquidity Risk** | | |
| 4. Risks and buffers | Risks/factors assessed (how each element is derived, assumptions) | • Funding liquidity risk is reflected in funding and asset roll-off rates, the latter providing cash inflows are related to non-renewal of maturing assets.<br>• Market liquidity risk is reflected in asset haircuts, which could be influenced by market movements, potential fire sales and collateral supply considerations. |
| | Behavioral adjustments | • Liquidity from the central bank's emergency lending assistance (ELA) is not considered.<br>• The cash-flow analysis may consider some behavioral assumptions about a counterparty's ability or willingness to transact based on banks' solvency and liquidity conditions. |
| 5. Regulatory and market-based standards and parameters | Calibration of risk parameters | • Stress funding run-off rates, asset roll-over rates, and asset haircuts are calibrated based on empirical evidence and relevant international experiences. The HQLA haircuts are informed by market value declines from the solvency stress test where applicable, while the rest are informed by the ECB valuation haircut when banks need to repo the liquid assets to the central bank. Icelandic banks do not hold securities under the amortized (or equivalently HTM) category. |
| | Regulatory/accounting and market-based standards | • The LCR hurdle rate is set at 100 percent at the aggregate currency level (per Basel III and domestic regulation) and at 100 percent for significant foreign currencies (per domestic regulation).<br>• NSFR per Basel III; limit of 100 percent. |
| 6. Reporting format for results | Output presentation | • Outputs include (1) Changes in the system-wide liquidity position, (2) number of institutions with LCR/NSFR below regulatory limits, and (3) amount of liquidity shortfall. |
| 7. Infrastructure | | • Infrastructure developed by IMF staff based on FINREP/COREP data input. |

| Domain | | Assumptions |
|---|---|---|
| **Banks, Pension Funds, and Investment Funds: Interconnectedness Analysis** | | |
| 1. Institutional Perimeter | Institutions included | • Interbank network: 3 commercial banks (out of 4) accounting for 95 percent of total banking sector assets, ranked by unconsolidated assets.<br>• Inter-pension fund network: largest 15 pension funds ranked by total assets.<br>• Inter-Investment fund network: largest 15 investment funds ranked by total assets.<br>• Inter-financial sector network: banks, pension funds, and investment funds for the network and exposure analysis; and<br>• Aggregate cross-sectoral exposure data: financial sector and domestic real sector interconnectedness. |
| | Data and starting position | • Domestic interconnectedness.<br>• Data source: supervisory data.<br>• Starting position: three snapshots: 2011, 2017, and 2022 to reflect evolvement; Data granularity: institutional level bilateral exposure data among all entities, including within the banking sector, pension fund sector, and investment fund sector; and across-sectors including between central bank, banks, pension funds, other financial corporates, non-financial corporates, general government, households, and the rest of the world.<br>• Cross-border interconnectedness.<br>• Cross-border data for banking sector and pension funds at institutional level, based on the supervisory data and BIS cross-border exposures statistics.<br>• Financial market data for sovereign CDS spreads and equity returns data from 2001 to 2022. |
| 2. Methodology | Overall framework | • Interbank and cross-border balance sheet exposure based on Espinosa-Vega and Juan Sole (2010).<br>• Failure thresholds are institution-specific, considering regulatory requirements and applicable buffers.<br>• Cross-border: Market price-based spillover model by Diebold and Yilmaz (2014).<br>• Assess overall price-based banking sector and pension funds international interconnectedness and main spillover directions. |
| 3. Risks and buffers | Risks | • Credit shock and funding shock bringing capital impairment due to interbank exposures and intra-financial exposures. |
| | Buffers | • Domestic interconnectedness: institution's own capital and liquidity buffers.<br>• Banks: minimum CET1 ratio is considered.<br>• Pension funds: minimum solvency capital ratio. |

| Domain | | Assumptions |
|---|---|---|
| **Banks, Pension Funds, and Investment Funds: Interconnectedness Analysis** | | |
| 4. Reporting format for results | Output presentation | • Domestic and cross-border interconnectedness and contagion analysis.<br>• Inter-financial sector network: a network chart based on exposures.<br>• Aggregate inter-sectoral network: a network chart based on the exposures between CB, ODCs(banks), PFs, OFCs, NFCs, GG, HHs, and ROW.<br>• Index of vulnerability and contagion for inter/intra-sectoral exposures at institutional level.<br>• Distribution of the spillover indices based on institution size, institutional sector, and other characteristics.<br>• Market data contagion analysis.<br>• Cross-country interconnectedness charts on sovereign CDS and equity return.<br>• Spillover indices at country level on sovereign CDS and equity return. |

| PENSION FUNDS: FUTURE PENSION VALUES, LIABILITIES, AND LIQUIDITY RISK | | | |
|---|---|---|---|
| | | **Top-down** | **Bottom-up** |
| 1. Institutional perimeter | Number of institutions | 7 occupational pension funds (defined ambition)<br>Almenni, Birta, Frjalsi, Gildi, LSR, LV, Stapi | |
| | Market share | 77 percent of Pillar II assets, 76 percent of Pillar II contributions; excl. closed defined-benefit schemes | |
| | Data | Statutory returns, company submissions | Company submissions |
| | Reference date | December 2022 | |
| 2. Channels of risk propagation | Methodology | Investment assets: market value changes of assets after price shocks, affecting future pension values<br>Liabilities: valuation change after changing assumptions on future wage inflation, asset returns | Liabilities: valuation change after changing the regulatory discount rates and biometric assumptions |
| | Time horizon | • Adverse scenario: 2023-2025<br>• Medium- to long-term projections for future pension values (up to 30 years) | • Instantaneous shock |
| 3. Scenario analysis | Tail shocks | • Adverse scenario:<br>• Interest rates: short-term rates +171 bps, long-term rates +212 bps in 2023<br>• Equity price: -79.8 percent for listed domestic shares, and -32.0 percent for foreign shares in 2023<br>• ISK depreciation: -30.6 percent in 2023<br>• Inflation: 8.6 percent in 2023 | • Not applicable |
| | Sensitivity analysis | • Default of largest bank / non-financial counterparty | • Reduction in the discount rate from 3.5 to 3.0 percent<br>• Decrease in mortality by 10 percent across all age cohorts |
| 4. Risk factors assessed | | • Market risks: interest rates, share prices, property prices, FX rates, credit spreads<br>• Credit risks: Default of largest bank (and non-financial) counterparty | • Regulatory risk / interest rate risk<br>• Biometric risks: Mortality |

| PENSION FUNDS: FUTURE PENSION VALUES, LIABILITIES, AND LIQUIDITY RISK | | | |
|---|---|---|---|
| | | **Top-down** | **Bottom-up** |
| 5. Regulatory/accounting standards | | • National GAAP | • National GAAP |
| 6. Reporting Formats for results | Output presentation | • Impact on value of assets<br>• Impact on future pension values<br>• Dispersion across companies<br>• Contribution of individual shocks | • Impact on value of assets and liabilities<br>• Dispersion across companies<br>• Contribution of individual shocks |

# Appendix XI. Non-Financial Corporate Stress Testing Matrix

| Domain | | Assumptions |
|---|---|---|
| | | **Top-down Analysis by FSAP Team** |
| 1. Institutional perimeter | Institutions included | • About 8,500 non-financial companies. |
| | Market share | • About 25 percent of active firms in 2020. |
| | Data source and reference date | • Orbis (Bureau van Dijk) database for company level data.<br>• Statistics Iceland for aggregate sectoral key indicators.<br>• Data as of December 2020. |
| 2. Channels of risk propagation | Methodology | • Dynamic Scenario-Based Stress Tests and Sensitivity Analysis (Tressel, T. and Ding, X., 2021, "Global Corporate Stress Tests—Impact of the COVID-19 Pandemic and Policy Responses", IMF WP 21/212).<br>• Probability of default (PD). |
| | Time horizon | • Instantaneous shock and 3 years (2021-2023). |
| 3. Tail shocks | Scenario analysis | • Baseline scenarios in line with the bank solvency stress test and October 2022 WEO.<br>• An adverse scenario with a lower GDP growth consistent with the severity of bank solvency stress test, and a tightening of financial conditions, global supply chain disruptions, and rise of commodity prices. |
| | Sensitivity analysis | • Interest rate shock. |
| 4. Risks and buffers | Risks/factors assessed | • Bankruptcy, default on any loans or bonds, ICR falling below specific thresholds. |
| | Behavioral adjustments | • None. |
| 5. Regulatory and market- based standards and parameters | Regulatory/ accounting standards | • National accounting standards in line with EU Directives and Regulations. |
| 6. Reporting format for results | Output presentation | • Aggregate results with the impact on debt distress, contribution of individual shocks. |